










ADDENDUM OF DATA RELATED TO DRYING OF FAECAL SLUDGE FROM ON-SITE SANITATION FACILITIES AND FRESH FAECES

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Preface

The present document consists of an addendum of data to the Handbook of Methods for Faecal Sludge Analysis. It is part of a project funded by the Bill & Melinda Gates (BMGF) through the OPP1164143, untitled "Characterization of faecal material during drying". This project was granted for funding after the 5-years Transformative Technologies convening at the BMGF headquarters in 2016, where drying was recognized as a gap in the transformative technologies for the implementation of innovative sanitation technologies. Indeed, drying is a unit operation that plays a relevant role in the faecal sludge treatment chain and reuse of the treated faecal matter. It enables to minimize the volume and weight of the faecal waste, deactivates pathogen organisms and turns the sludge into a suitable fuel. However, drying is challenging to put into practice, and requires the understanding of the process and the evolution of the material characteristics along with the transformation. Currently, there is a lack of available data in the literature about faecal sludge drying, which makes more challenging the implementation of technologies. In this context, this project aims at providing data and knowledge about the behaviour of faecal sludge during drying, which is expected to contribute to the development of guidelines of best practices. One important objective of the project is the dissemination and efficient sharing of the generated data and knowledge. One of the ways selected to meet with this objective is through the present addendum of data.

The addendum of data compiles the results from experiments directly related to drying or having indirect implications in the process. The data was obtained from experimental work conducted from 2013 to date, and involving several research institutions. As the addendum of data is an initiative led by the Pollution Research Group at the University of KwaZulu-Natal, most of the data come from this research group. Partner institutions adhered to this initiative and shared their data, including: (i) Swansea University through the SPECIFIC research group; (ii) Cranfield University through their Bioenergy laboratory; (iii) Duke University through their WASH-AID centre; (iv) Laval University through their Civil and Water Engineering department; (v) Victoria University through their Public & Environmental Engineering laboratory; (vi) Swiss Federal Institute of Aquatic Science and Technology (EAWAG) through their Sanitation, Water and Solid Waste for Development (SANDEC) department. We express our gratitude to these institutions for their contribution that made possible to consolidate the addendum.

In the addendum, the data is organized in datasheets that are categorized in different thematics according to the content. In each datasheet, the data is displayed as graphs and includes an interpretation. In addition to this, the datasheets contain the basic information that is required to understand how the data was obtained, including the information about the feedstock, laboratory equipment, experimental conditions and performed analysis. The datasheets also offer the bibliographic references about where the results can be found in literature and the hyperlink to access to the raw files with the data. Moreover, this document includes a background with a landscape about faecal sludge drying, description of the fundamentals aspects from faecal sludge drying to understand better the significance and applicability of the data, and a summary of the analysis from results from the datasheets with their implications.

We expect that the addendum of data will have a positive impact in the sanitation sector by being a helpful resource to sanitation practitioners for the development, implantation, operation, optimization and improvement of drying technologies.

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Table of contents

List of Figures

List of Tables

Abbreviations

ABR	Anaerobic baffled reactor
BMGF	Bill & Melinda Gates Foundation
CST	Capillary suction time
DEWAT	Decentralized wastewater treatment plant
DTG	Differential thermal gravimetric
EC	Electrical conductivity
EPS	Extracellular polymer substances
EAWAG	Swiss Federal Institute of Aquatic Science and Technology
FTIR	Fourier Transformation Infrared Red
MIR	Medium Infrared Drying
LaDePa	Latrine Dehydration Pasteurization
STA	Simultaneous thermal analysis
TGA	Thermo-gravimetric analyser
VIP	Ventilated improved pit
VSS	Volatile suspended solids
SANDEC	Sanitation, Water and Solid Waste for Development
UDDT	Urine diversion dry toilette

Chemical nomenclature

C	Carbon
Ca	Calcium
CO	Carbon Monoxide
CO_2	Carbion Dioxide
H_2O	Water
H_2S	Hydrogen Sulfide
K	Potassium
Mg	Magnesium
N	Nitrogen
NH_3	Ammonia
NH_4^+	Ammonium
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_2^-	Nitrites
NO_3^-	Nitrates
NOx	Nitrogen oxides
P	Phosphorous
PAH	Polycyclic aromatic hydrocarbons
$PM_{2.5}$	Particulate matter of less than 2.5 µm size
PO_4^{-3}	Phosphates
S	Sulphur
SO_2	Sulphur dioxide
VOC	Volatile organic compounds

Background

Faecal sludge drying landscape

This section introduces the generalities of the drying process. It describes its application in the sanitation field for the treatment of faecal sludge with the reasons for its implementation and challenges.

Definition of drying

Drying is defined as the removal of water or any other solute from a moist solid, slurry, or liquid. This process is a common chemical engineering unit operation with diverse applications in the chemical, biotechnology, food, polymer, ceramic, pharmaceutical, pulp and paper, mineral and wood processing sectors. Drying is regularly conducted by the addition of heat for moisture evaporation, which is referred to as thermal drying. Other drying methods include freeze-drying, which is based on the sublimation of frozen moisture at low pressure, and natural evaporation. The term ‘drying’ must not be confused with the term ‘dewatering’, which is a common language misuse in practice.

Thermal drying is a process that involves coupled heat, mass and momentum transfer phenomena with a change of phase from liquid to vapour water. In this process, thermal energy is provided to the material in order to evaporate the moisture within it. The provided heat is diffused within the material where the major part will be utilized for moisture evaporation and a small fraction to raise the temperature of the material. The evaporated moisture is transferred from the solid to the environment, which involves the movement of moisture as liquid or vapour within the material, driven by mass and momentum transfer phenomena.

Drying technologies

Drying technologies are categorized into three major groups according to the method of providing heat into the system. Dryers are known as direct or adiabatic when they expose the moist solid to a hot gas stream. Dryers, where the moist solid is heated by conduction or radiation, are called indirect or non- adiabatic. The most conventional drying technologies categories are as following:

- Convective drying where the material is in contact with a gas stream, which can be hot air or superheated steam;
- Contact drying where the material is in contact with a hot surface;
- Radiative drying where the heat is provided through a given type of radiation, which can be infrared, microwave or dielectric;
- Solar drying where the heat is provided from solar irradiance.

It is possible to combine different types of drying technologies to gain in performance. Moreover, innovations are under development for the improvement of the process, such as the use of acoustic waves or vibrations during drying for intensifying the heat and mass transfers and, at the same time, promoting solid-liquid separation.

If the reader is interested in having more details about drying technologies, Mujumdar (2006) has compiled a broad number of technologies with the involved fundamental aspects, characteristics and applications in an engineering handbook about industrial drying.

Importance of faecal sludge drying

Faecal sludge is a slurry composed of colloidal material, particles and polymers that form a network with the moisture. Typically, faecal sludge presents a high moisture content that can go from around 70 to 98%wt (Koné and Strauss, 2004; Zuma *et al.*, 2013; Niwagaba, Mbéguéré and Strande, 2014), implying that moisture is the major constituent of sludge in all cases. The high amounts of moisture and nutrients in the sludge lead to an enabling environment for the development of microorganisms. In addition, one gram of faeces from a sick person can contain about 10^6 viral pathogens, 10^4 – 10^6 bacterial pathogens, 10^4 protozoan cysts and 10-10^4 helminth eggs (Wagner, Lanoix and Organization, 1958). Faecal sludge can, therefore, lead to infectious diseases to Humans such as cholera, dysentery, hepatitis A, typhoid, and polio, as well as parasite infections (Freeman *et al.*, 2017).

Drying is an important step for the treatment and disposal of faecal sludge for its safe disposal and resource recovery. Drying allows to eliminate or reduce the biohazard characteristic of the sludge, by killing the pathogenic organisms present on it by the effect of moisture reduction and also high temperatures in the case of thermal drying. Moreover, the mass and volume of sludge are drastically reduced during drying, leading to lower handling, transportation, and storage costs. In addition, the moisture reduction during drying leads to the increase of the calorific value, consequently turning the sludge into a suitable biofuel.

Drying is a necessary step prior to further processing, such as pyrolysis or combustion, or it can lead directly to a pathogen-free product that could be used as biofuel or in agriculture.

Application of the drying process for faecal sludge treatment

Faecal sludge drying is typically conducted in drying beds, where the sludge is spread on a basin and left there for a few weeks. This method combines both dewatering and drying processes: moisture is removed from the bottom by percolation through a bed of filter media and at the bottom by evaporation (Dodane and Ronteltap, 2014). However, this practice requires long drying times of a few weeks duration and cannot guarantee a satisfying level of pasteurization (Koné and Strauss, 2004; Seck *et al.*, 2015). With the emergence of new technologies in the sanitation sector, thermal drying has gained great interest as it can treat important throughputs of material in a relatively short time and lead to low moisture contents.

Table 1 summarizes a non-exhaustive list of faecal sludge drying technologies that have been deployed in the field or are under development. It can be noted that most of the technologies rely on convective and contact drying, while only a few cases are based on infrared, microwave and solar methods. The current faecal sludge dryers vary on size, going from small units in onsite sanitation facilities with in-situ treatment (e.g. reinvented toilets funded by the Bill & Melinda Gates Foundation) to large-scale processes in faecal sludge treatment plants (e.g. Omniprocessor”). The use of alternative drying methods, such as superheated steam drying and fry-drying, have not been explored up to now, but they have shown to have a great potential for sewage sludge drying (Bennamoun, Arlabosse and Léonard, 2013).

Table 1. List of faecal sludge drying technologies

Type of drying	Technology	Application	Place in the treatment process	Energy source	Source
Convective drying	Belt dryer	Faecal sludge treatment plant from Tide Technocrats	Drying before a pyrolysis unit for biochar production	Heat from the combustion of the pyrolysis fumes	(Tide-Technocrats, 2016)
	Vertical multi-tray dryer	Reinvented "Firelight" Toilet from Janicki Industries	Drying before a combustion system	Heat from faecal sludge combustion	(SuSana, 2015)
	Rotary dryer	Faecal sludge treatment plant from Pivot	Final treatment (reuse of the product as biofuel)	Combustion of paperboards	(Pivot, 2016)
Contact drying	Hot surface wall screw conveyor	Faecal sludge treatment plant, "Omniprocessor", operated from Janicki Industries	Drying before a combustion system	Heat from faecal sludge combustion	(Villarreal, 2015)
	Heated rotary plate	Reinvented "A Better Toilet" from Research Triangle Institute	Drying before a combustion system	Heat from faecal sludge combustion	(RTI, 2013)
Convective, contact, radiative drying	Drying in the top of a fixed bed with a smouldering front at the bottom	Reinvented "Sanitation NoW" from Toronto University	Drying before a smouldering system	Heat from faecal sludge smouldering	(Yermán, 2016)
Radiative	Infrared drier "LaDePa" (Latrine Dehydration Pasteurisation)	Treatment of faecal sludge from VIP latrines in eThekwini municipality	Final treatment (reuse of the product in agriculture)	Diesel generator providing the hot air and electricity	(Harrison and Wilson, 2012; Mirara *et al.*, 2015)
Radiative	Microwave dryer	Treatment of faecal sludge in emergency cases	Final treatment	Microwave radiation generated using electricity	(Mawioo *et al.*, 2017)
Solar	Greenhouse dryer	Faecal sludge treatment plant from Pivot	Pre-drying before the rotary dryer (see above)	Solar energy	(Pivot, 2016)

Technological gaps

Thermal drying is a challenging process to put into application, with usual high capital and operating costs. The high capital costs could be due to the requirements of thermal insulation and piping, materials resilient to high temperature, instrumentation and process control equipment. The high operating costs are related to the inherent high energy demand for moisture evaporation. In addition, the drying system may require of frequent maintenance due to the fouling and clogging nature of faecal sludge.

As the latent heat of water vaporization is already high, it is of high importance to minimize the energy consumption as possible. A way to achieve this is through the setup of a dewatering stage before drying, in particular for faecal sludge with high moisture content. The dewatering process should remove as much moisture as possible to reduce the need for thermal drying and thus to increase the efficiency of the process.

The source of energy to run the drying process constitutes a major factor of consideration. As it can be noticed for some technologies in Table 2, the heat from combustion can be recovered for drying when faecal sludge is used as a biofuel. When there is no available source of waste heat in the nearby (for example from combustion), drying requires the continuous supply of an external source of energy, such as electricity or fuel, which can lead to high costs at the long term. The use of solar thermal energy could be an interesting possibility to provide a free source of energy to the system and subsequently decrease the operating costs. It could also serve as an additional source of energy in a faecal sludge combustion process, which will permit to get an enough low moisture content of the sludge for a more positive energy balance. A faecal sludge treatment flow diagram considering the aspects mentioned above is proposed in Figure 1.

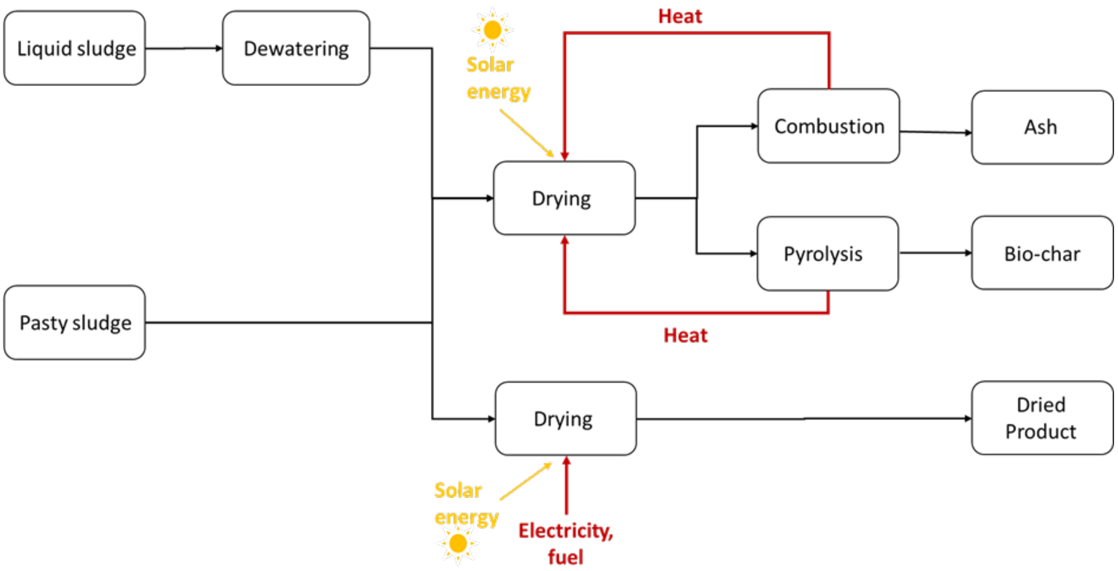

Figure 1. Faecal sludge treatment flow diagram

There is a wide number of sewage sludge drying technologies in the market, mostly from developed countries, which could be potentially used for faecal sludge. However, their adoption could be limited by the high investment that they represent, as the budget are usually more restraint in the faecal sludge sector. Therefore, it would be more convenient to develop drying technologies adapted to the faecal sludge context, which will require knowledge and insight on the drying properties of the material. The main problem resides in the fact that, in the faecal sludge sector, drying is still in a premature stage and presents wide areas to be explored. Information is available from other sectors where drying is in a more advanced stage, in particular in the case of sewage sludge that is a material with common characteristics than faecal sludge. The information and experience from the other sectors can provide an understanding of the process, lessons and good practices. Still, they cannot be transposed completely due to the inherent characteristics of faecal sludge. Besides, the physiochemical properties of faecal sludge widely vary according to the type of toilet, the geographical location, the habits of the users, among other factors. Therefore, the drying behaviour of a specific faecal sludge needs to be characterized for the design of tailored technologies. This study should be conducted in a holistic way that encompasses, apart from the loss of moisture aspects, the changes undergone by the material susceptible to influence the process.

If the reader is interested to learn more about sewage sludge drying, Chen, Lock Yue and Mujumdar (2002) present a collection of dewatering and drying technologies for sewage sludge. Moreover, Bennamoun, Arlabosse and Léonard (2013) published a comprehensive review on sewage sludge drying.

Faecal sludge drying fundamental aspects

This section presents the fundamental aspects of the faecal sludge drying process to take into consideration for the development, implementation, operation and improvement of technologies. These aspects involve the thermodynamics and kinetic aspect of the process, as well as the characteristics of the material along with the transformation.

If the reader is interested to learn about the drying fundamentals into more detail, Mujumdar and Devahastin (Mujumdar and Devahastin, 2000) describe the basic concepts of drying comprehensively.

Thermodynamic concepts

The thermodynamic aspects of a drying system are important to be understood as they can enable to determine the maximal moisture removal that can be achieved at given conditions, the required heat input, the binding strength of moisture, the rehydration abilities of the dried sludge and the thermal behaviour of the material.

i. Equilibrium moisture content

Drying is driven by a difference of concentration of water between the solid and the surrounding air. This difference in concentration is formally expressed as the difference in chemical potential or thermodynamic activity. During drying, moisture is transferred from the moist solid to the surrounding air that has a lower thermodynamic activity. The evolution of the system stops after reaching the thermodynamic equilibrium, occurring when the water activity in the solid is equal to that from the air. The moisture content at the thermodynamic equilibrium is referred to as to moisture equilibrium content.

ii. Sorption isotherms

The sorption isotherms present the relationship of the equilibrium moisture content with the air relative humidity at a constant temperature. Figure 2 illustrates an example of sorption isotherms, where desorption curve corresponds to drying. The pattern of this curve can give an indication of the arrangement of the water molecules within the sludge, which depends on the temperature and the surface properties of the material.

The sorption isotherms enable to determine the minimum moisture content that can be achieved after drying at a given temperature and relative humidity. This approach can be particularly useful for drying at relatively low temperatures, where the air can hold a limited amount of vapour water, leading to elevated relative humidities. In the case of a high temperature drying process, its use becomes less relevant because the air can hold considerable more vapour water without leading to a substantial increase of relative humidity. Above 100ºC, the sorption isotherms cannot be applied any further because there is no limitation on the capacity of the air to hold vapour water molecules and thus, the concept of relative humidity is not valid.

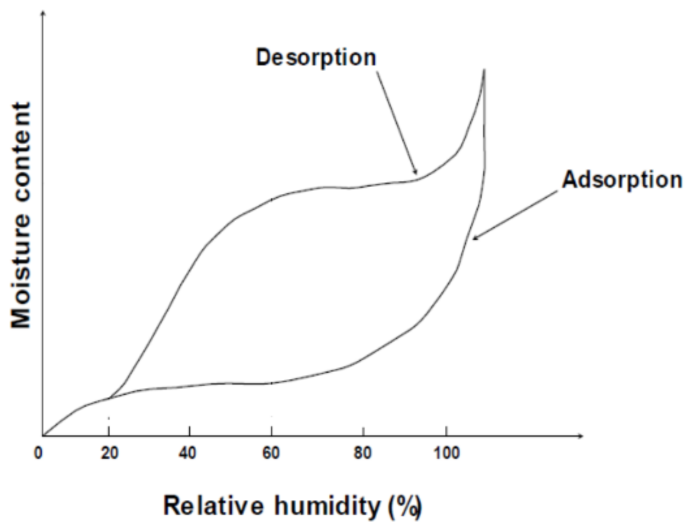

Figure 2. Sorption isotherms of a hygroscopic solid

iii. Hygroscopy

Hygroscopic materials can gain moisture after being dried if exposed to humid air. In contrast, non-hygroscopic materials cannot be rehydrated after drying at any conditions.

The hygroscopic material presents sorption isotherms with a desorption and adsorption components, as displayed in Figure 2. The desorption curve corresponds to the dehydration of the material, while the adsorption curve reflects the rehydration. The pattern of the adsorption and desorption curve can differ if the dehydration and rehydration follow different mechanisms.

It is of great importance to determine the hygroscopic characteristics of faecal sludge in order to understand the rehydration capabilities of the material. This aspect has important implications in the way to store the dried sludge, as important rehydration should be avoided because it can reduce the quality of the product and reactivate pathogens.

iv. Psychometry

The equilibrium moisture content depends on the thermodynamic properties of air, so it is very important to determine them. An important tool for this consists in the use of the psychrometrics chart (Figure 3), which displays the thermodynamic properties of an air-vapour mixture at constant pressure. The most relevant parameters relative to drying are as following:

- Absolute humidity, defined as the unit mass of vapour per unit mass of dry air;
- Relative humidity, defined as the ratio of the partial pressure of water vapour in the air to the vapour pressure of water at the same temperature;
- Dry-bulb temperature, which refers to the temperature of the air-vapour temperature.
- Wet-bulb temperature, which refers to the temperature of the wet material.

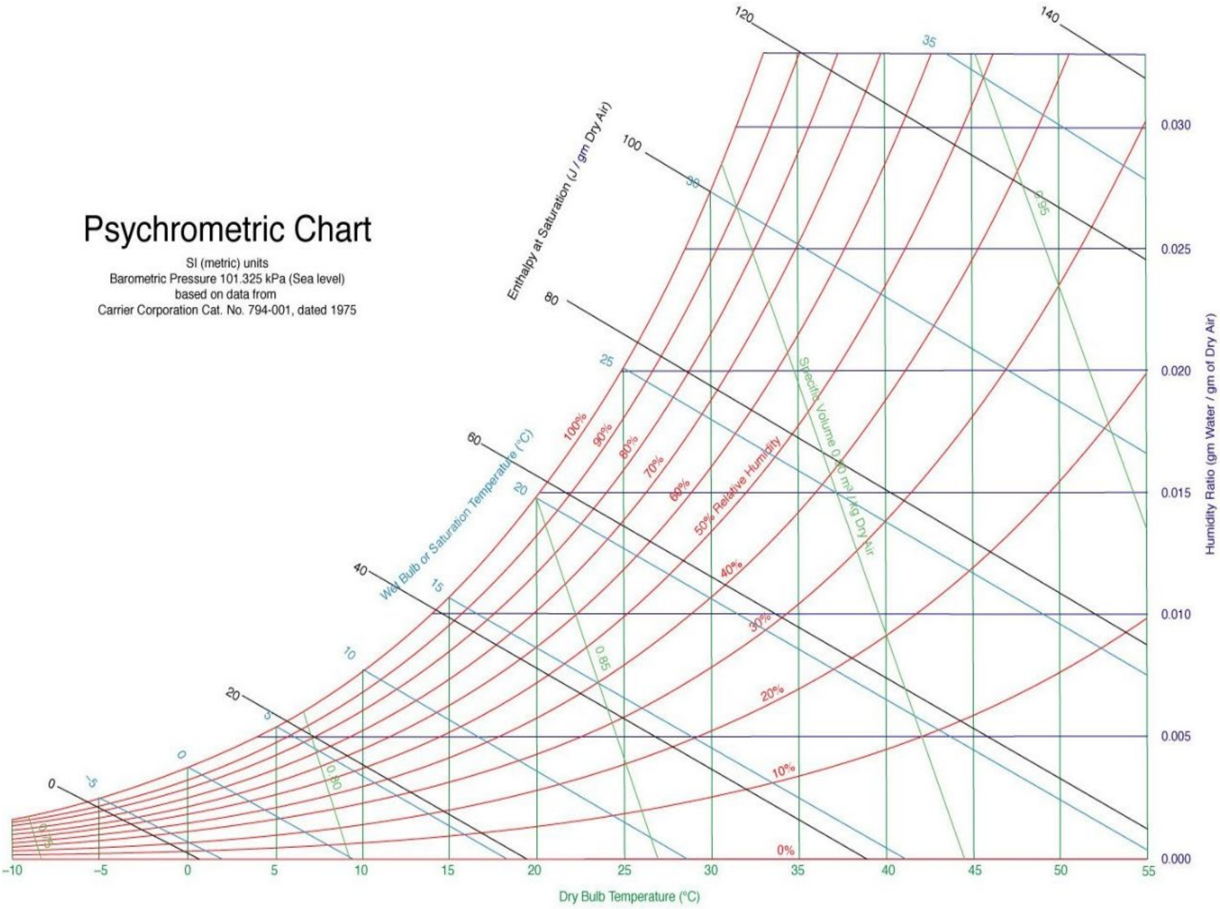

Figure 3. Psychometric chart of vapour water-air mixture (source: Carrier Corporation)

v. Thermodynamic water activity

The thermodynamic activity of water is defined as the ratio of the vapour pressure in a substance (liquid or solid) to the vapour pressure of pure water at the same temperature. This parameter is an indicator of the bonding strength of moisture with the dry solid structure. Two major types of moisture exist:

- Unbound moisture exerts the same equilibrium vapour pressure than that of pure water at the same temperature (thermodynamic activity equal to 1). This type of moisture is not linked to the solid matrix by any interaction and then behaves like water.

- Bound moisture exerts a vapour pressure lower than that of water at the same temperature (water activity lower than 1). This type of moisture is linked to the solid matrix biologically, physically or physically, and so it is usually more difficult to remove.

In the case of faecal sludge, moisture can be integrated into the sludge structure in different ways, as depicted in Figure 3. Moisture can be considered as unbound or free when it is not attached to the dry-bone structure, and then it can move freely within the sludge. Moisture is interstitial when it is trapped within clusters of particles and capillaries. Surface moisture is when it physically or chemically bound to the surface of the flocs. Intracellular moisture is contained inside cells.

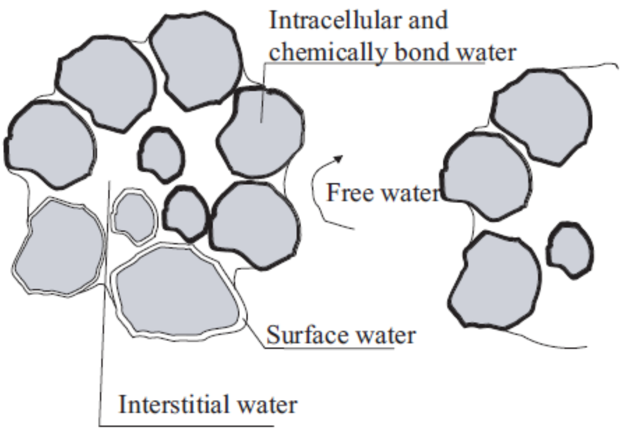

Figure 4. Different types of moisture in the sludge (Chen, Lock Yue and Mujumdar, 2002)

The determination of the distribution of the type of moisture in the sludge can provide valuable information about how drying will proceed. It can be postulated that bound moisture is more difficult to remove that unbound moisture. Therefore, sludge could be expected to dry faster at higher water activity than at lower values.

vi. Heat of drying

The distribution of the different types of moisture in the sludge also has an impact on the energy requirements. The evaporation of unbounded moisture is expected to demand a similar latent heat than pure water. In contrast, the energy demand will be higher for bound moisture that requires an extra energy input to break the physical, chemical and biological bounds.

Commonly, the latent heat of pure water vaporization is employed to estimate the heat required for drying. This approximation is correct during the evaporation of unbound moisture, but wrong for unbound moisture. Therefore, this could cause deviations with reality and underestimate the heat requirements of the overall process. It is therefore important to determine the heat of drying. This parameter can be calculated through the water activity from a Clausius-Clayperon derived equation (Vaxelaire, 2001).

vii. Thermal stability

During thermal drying, the heat provided for moisture evaporation can induce a thermal degradation of the material. This phenomenon can cause modifications of the dry-bone structure of the faecal sludge and a loss of material through volatilization, which can have an impact on the quality of sludge for its reuse. It is therefore important to characterize the conditions on which the sludge is thermally degraded.

Kinetics

The drying kinetics refers to the rate at which the process proceeds to attain the equilibrium moisture content. It is essential to ascertain how the kinetics vary as a function of the operating conditions for the development and improvement of drying technologies, setup of operation strategies and optimization of the system. The development of predictive models from the experimental kinetic data could be a useful tool for these purposes.

i. Drying curves

The drying curves exhibit the variation of moisture content as a function of time. The drying rate can be calculated from the derivative of the moisture content on dry basis or mass of sample with respect to time. An example of a drying curve with its corresponding drying rate is illustrated in Figure 5. To have more information about the determination of the drying curves, please refer to Chapter 4 from the Book of Standard Methods for Faecal Sludge Analysis.

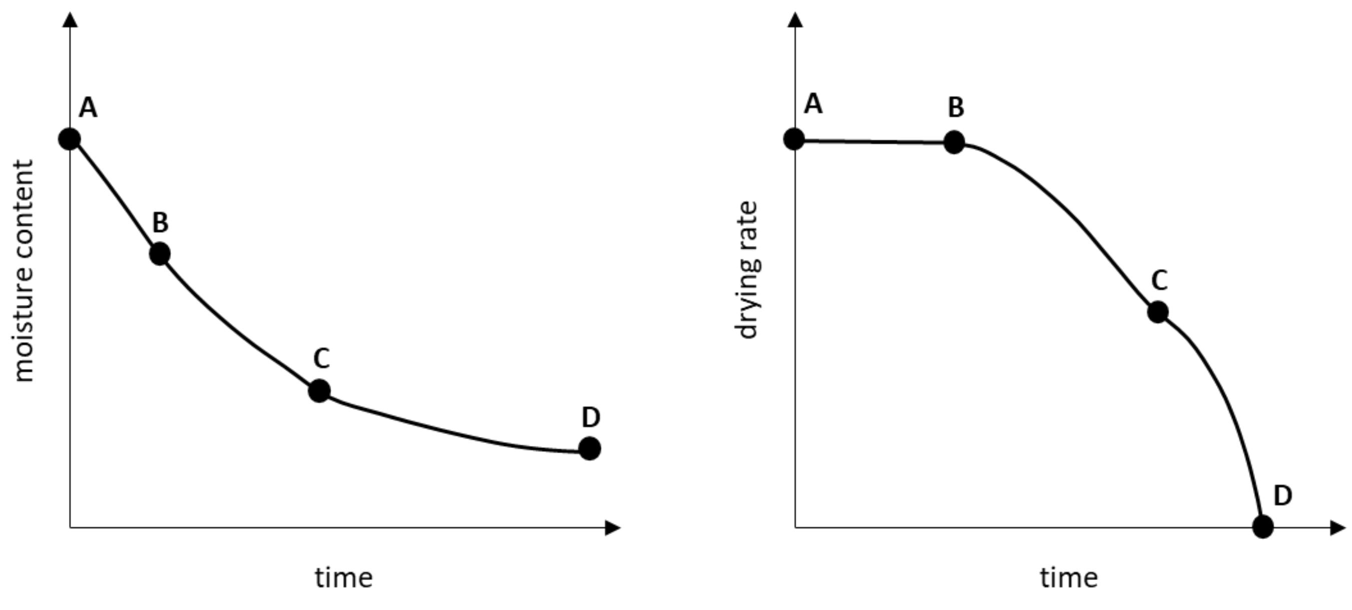

Figure 5. Drying curve (left) and its corresponding drying rate curve (right)

ii. Drying rate regimes

Typically, the kinetics are divided into three different phases:

(1) Constant rate period (segment AB from Figure 5), where the entire surface of the material is saturated in moisture and drying proceeds in steady-state. During this stage, the evaporated moisture leaving the surface is replaced immediately by moisture from inside the material, leading to a dynamic equilibrium between the internal and external mass transfers. The temperature of the material remains fairly constant at approximately the wet-bulb temperature.

(2) First falling rate period (segment BC from Figure 5), where the surface cannot be anymore maintained saturated in moisture and, in consequence, the drying rate declines. During this stage, the surface is partially saturated in moisture. Moreover, the temperature at the surface starts to increase from the wet to the dry-bulb temperature. The moisture content marking the beginning of the drying rate decline is named as critical moisture content (point B).

(3) Second falling rate period (segment CD from Figure 5), where the surface of the material is completely dried, leading to a further decrease in the drying rate. During this stage, an evaporation front progress towards the centre of the material and the dried areas of the material attains the final temperature.

In real cases, the three kinetics regimes not always occur. For example, a drying curve can start directly at the falling rate period, without a previous constant rate stage.

iii. Influence of the operating conditions

The drying kinetics depend on the factors influencing the heat and mass transfer rates. The kinetics are controlled exclusively by the external transfers during the constant rate period, and by the internal transfers during the second falling rate period. Both internal and external transfer influence the first falling period. The rate of the external transfers depends on the surrounding conditions (air temperature, humidity and velocity) and the bulk characteristics of the material (geometry, size), while the rate of the internal transfers depends on the internal characteristics of the material (temperature, porosity, size). Different mechanisms ensure the internal mass transfer of moisture from the core of the material towards the surface: liquid and vapour diffusion; moisture movement due to capillary and hydrostatic pressure differences.

The comprehension of the influence of the operating conditions on the drying kinetics is indispensable for the proper design, operation, control, optimization and improvement of drying systems. The experimental kinetic data obtained at different operating conditions could serve for the development of predictive kinetic models that could be subsequently inserted into a reactor model and process simulation software.

The determination of the critical moisture content could provide useful information about the duration of the constant rate period and the beginning of the falling rate period. This information could be translated into measures to optimize the process by changing the operating conditions between the kinetic regimes. For instance, if the critical moisture content is known, the air velocity could be set to maximize the external transfers during the constant rate period, in order to lead to faster drying. After reaching the critical moisture content, the air velocity could be reduced as its influence is theoretically much lower during the falling rate period, which will lead to savings in the energy consumption required to create an airflow stream.

Another example is intermittent drying, where the process is stopped after reaching the critical moisture content and resumed after allowing natural re-equilibration of the moisture within the sludge (de Lima *et al.*, 2016). This method is presumed to prolong the constant rate period, in which the drying rate is at its maximal value, and increase the efficiency of the system consequently.

iv. Properties of the material

During drying, the removal of moisture can provoke changes in the physicochemical, mechanical and properties of the material, which can influence the transfer phenomena and therefore the drying kinetics. Temperature can also play an important role in the modifications undergone by the material and affect the quality of the final product. These modifications have to be taken into account for a full comprehension of the drying process.

Morphological characteristics

The removal of moisture content leads to the re-arrangement of the dry bone structure and provokes morphological changes that can be perceived at the naked eye. In our best of knowledge, no investigations to characterize the morphological changes during drying have been carried out for faecal sludge. Nonetheless, an important number of publications about this topic can be found for sewage sludge, and part of the findings could be transposed to faecal sludge.

The loss of moisture in the solid during drying creates void spaces that are eventually occupied by the remaining material, leading to the contraction of the structure and the subsequent shrinkage. Shrinkage of the volume can range between 50 to 70% and occurs mainly during the constant rate period (Léonard *et al.*, 2002, 2004; Léonard, Blacher, Marchot, *et al.*, 2003; Léonard, Blacher, Pirard, *et al.*, 2003; Tao, Peng and Lee, 2005).

The fast depletion of moisture at the surface of the sludge can provoke the formation of a crust, also known as skin. Crust formation tends to occur at high heating rates that lead to fast moisture evaporation at the surface while the core of the material remains wet. The crust affects the drying process negatively as it constitutes a barrier for the migration of moisture from the sludge to the environment, reducing then the mass transfer rate and consequently slowing down the drying process.

The formation of cracks in the surface of the sludge can also occur during drying. Cracking takes place mainly during the falling rate period, with the cracks occupying from 30 to more than 50% of the volume. The cracks tend to enhance the mass transfer, and therefore increase the drying rate (Léonard *et al.*, 2002, 2004; Léonard, Blacher, Marchot, *et al.*, 2003; Léonard, Blacher, Pirard, *et al.*, 2003; Tao, Peng and Lee, 2005).

Mechanical properties

The change of faecal sludge consistency from a liquid slurry to granular solid during drying has important implications in the process. During this process, the mechanical properties of the sludge are modified. Faecal sludge and faeces are considered as a shear-thinning fluid whose rheological, viscoelastic and viscoplastic properties depend on the moisture content (Woolley, Buckley, *et al.*, 2014; Woolley, Cottingham, *et al.*, 2014; Septien *et al.*, 2018). Therefore, the viscosity of the material will vary during drying. All these aspects have to be taken into account for the design of the dryer. The feeding or conveying system from the dryer should be able to handle the viscosity variations along the process and the transformation of the sludge towards a solid. Moreover, the mechanical properties must be taken into account if the sludge is intended to be introduced into the dryer with a particular shape, e.g. pellets.

The change of phase from a suspension to a granular solid passes through a plastic phase characterized by a high stickiness of the sludge. During the sticky phase, the sludge can pose problems of clogging and fouling on the walls inside the dryer. The stickiness of faecal sludge requires then to be characterized and understood with insight, which will allow finding solutions to limit its occurrence and the severity of its effects.

Physiochemical properties

It is important to determine the physicochemical properties of the dried sludge for the evaluation of its reuse as an agricultural product, biofuel, or other. Drying can alter the chemical composition and physical properties of the sludge, which could have an impact on the quality of the dried sludge for its reuse or further processing. During drying, the solid structure of the sludge can be thermally degraded by the high temperatures, leading to the volatilization of organic and inorganic compounds. The loss of the volatilized material can diminish the nutrient and energy content of the material, reducing the quality of the dried sludge for reuse in agriculture or as a biofuel. In addition, the removal of moisture can increase the concentration of the nutrients and organic material in the sludge and can modify some physical properties.

Furthermore, the physical properties that influence the heating and moisture transport during drying, such as the density, thermal properties and radiative properties, should be determined in a process design perspective. As the physical properties may vary during drying, the impact of this variability should be included in the design and operation of the thermal dryer.

Other aspects

i. Disinfection

The primary goal of drying is to eliminate or reduce the biohazard characteristic of the sludge, by killing the pathogenic organisms present on it by the effect of moisture reduction and high temperatures. As it can be seen in Table 2, most bacteria cannot develop below a water activity of 0.91, including pathogens such as Escherichia Coli, Salmonella, Shigella and Vibrio Cholerae. This result implies that most of the pathogenic bacteria can be deactivated during drying if the sludge achieves a moisture content corresponding to a water activity lower than 0.91. Figure 6 shows how the deactivation time of common pathogens decreases strongly by increasing the temperature. The “safety zone”, where all the pathogens will be deactivated, can be achieved at 70ºC in a few minutes. The time to achieve the “safety zone” could be reduced to seconds by increasing the temperature above 70ºC, if the trends observed in Figure 6 are extrapolated.

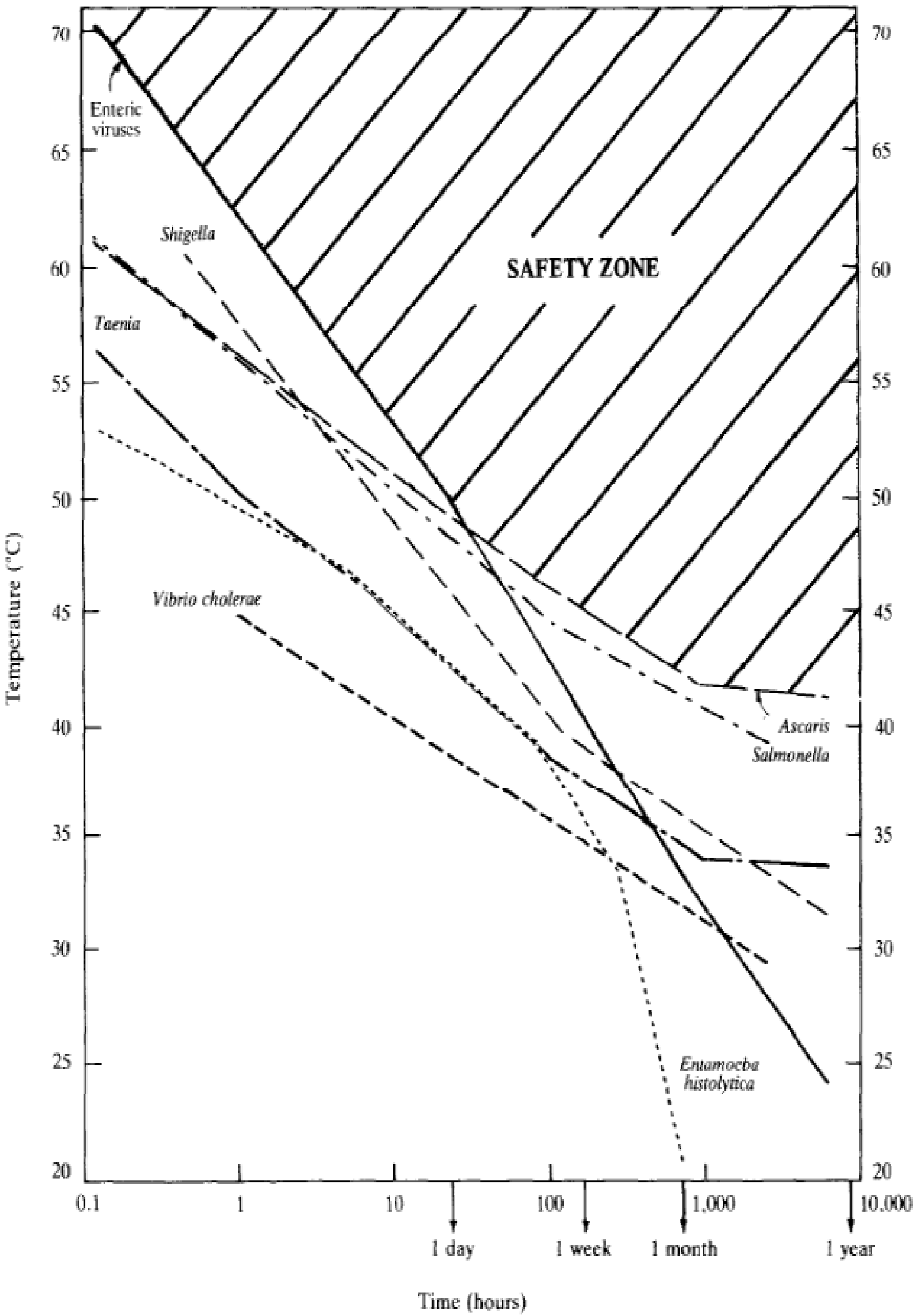

Figure 6. Temperature – time relation for the disinfection of pathogens (Feachem *et al.*, 1983)

Table 2. Minimum water activity for microbial and spore development (Mujumdar and Devahastin, 2000)

Pathogen	Water activity
Pseudomonas, Bacillus cereus spores	0.97
B. subtilis, C. botulinum spores	0.95
C. botulinum, Salmonella	0.93
Most bacteria	0.91
Most yeast	0.88
Aspergillus niger	0.85
Most moulds	0.80
Halophilic bacteria	0.75
Xerophilic fungi	0.65
Osmophilic yeast	0.62

ii. Dewaterability

Depending on the moisture boundedness within the sludge, the material will present different dehydration behaviour. Usually, the free or unbound moisture, interstitial moisture and part of the surface moisture (mainly when it is physically bounded) can be removed by dewatering through gravity and mechanical processes. The removal of chemically bound surface moisture and intracellular moisture usually requires thermal drying.

As stated previously, dewatering should be applied before drying to reduce the costs associated with the sludge dehydration. Therefore, it is of high relevance to determine the dewaterability of the sludge by measuring the amount of moisture that can be potentially removed through mechanical means. This information can additionally give access to a better understanding of the type of moisture interaction within the sludge.

iii. Gas emission

Faecal sludge drying can enhance the release of volatile organic compounds into the environment, which may cause unpleasant odours. The potential olfactory nuisances at the vicinity of the dryer could impose constraints for the implementation of a drying process (example: need to comply with regulations in regards to odour emission).

The gas emission during drying should be then characterized by identifying the type of released and quantifying their amounts as a function of the operating conditions. This data will enable to set odour management strategies, such as the implementation of gas treatment units, the pertinent selection of operating conditions to minimize the odour emission, the most appropriate location of the plant, among other points.

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Faecal sludge drying data

The data collected in this addendum is directly related to the drying process or has indirect implications on it. The data was collected from different institutions and is displayed into datasheets with relevant information about the feedstock and experimental conditions. The datasheets were categorized into eight groups: thermodynamics, kinetics, physiochemical properties, morphology, mechanical properties, dewaterability, disinfection, gas emission. Different types of faecal samples were involved on the generation of the data: fresh faeces and faecal sludge from various types of onsite sanitation facilities, among which ventilated improved pit (VIP) latrines, urine diversion dry toilets (UDDT), anaerobic baffled reactor (ABR) from a decentralized wastewater treatment plant (DEWAT). The datasheet can be found in the next section of this document.

This section collates and summarizes the information from the datasheets, and gives a brief explanation of the significance of the results.

i. Thermodynamics

The datasheets related to the thermodynamics aspects of drying included sorption isotherms, water activity, heat of drying and thermal stability data. The sorption isotherms provide the moisture content of the faecal sample at the thermodynamic equilibrium as a function of the air relative humidity at constant temperature. It also to determine the material hygroscopic properties. The water activity is a measure that gives an indication of the level of moisture boundedness within the material. The heat of drying quantifies the amount of energy required to dry the sample up to a given moisture content. The faecal matter thermal stability allows detecting the temperature range on which the sample dries and and the one on which it undergoes thermal degradation.

Overall, the equilibrium moisture content was low (> 30%wt) even at high relative humidities for the different faecal materials, suggesting that faecal matter can be dried to low moisture contents even in humid atmospheres (< 90%) at ambient temperature. The water activity tended to drop and the heat of drying to increase exponentially below a moisture content of around 30 - 40%, reflecting that moisture started to be tightly bound to the sludge from this point. The faecal materials shown to be hygroscopic as they can regain humidity after drying if they are placed in a humid atmosphere.

ii. Kinetics

The kinetics were studied in the datasheets through the drying curves, which display the evolution of moisture content as a function of time at different operating conditions (air temperature or irradiance, air velocity, relative humidity, sample size, etc).

It can be concluded that faecal matter drying kinetics are the most sensitive to the heat input (temperature in the case of convective drying, or irradiance for solar and infrared drying). The air velocity, relative humidity and sample size had a low to moderate influence on the drying kinetics.

iii. Physiochemical properties

The evolution of the physiochemical properties of the various faecal materials during drying was determined by measuring the composition, calorific value, density and thermal properties at different stages of drying. The radiative properties of the raw samples were also measured in order to evaluate if the faecal materials are suitable for radiative processes (solar and infrared drying).

The results demonstrated that the nutrient content, volatile solids content and calorific value in dry basis remained the same during drying at different conditions. However, the nitrogen chemical form changed during the process (decrease of ammonium, nitrates and nitrates), as well as the thermal properties and density. It was hypothesized that these changes were due to the loss of moisture combined with the increase of moisture boundedness along the process. Concerning the radiative properties, the faecal materials had a higher absorbance than reflectance, with an almost null transmissivity, in the visible light and near-infrared regions. This result implies that faecal matter is a suitable material for solar and infrared processes as most of the received radiation will be absorbed by the material for moisture removal.

iv. Morphology

The morphology of the faecal material along the process was studied by measuring the shrinkage and through visual inspections. The specific surface and porosity were measured for the faecal matter dried at different temperatures.

The major phenomena detected during drying was: shrinkage up to 70% reduction in volume, cracking and crusting of the surface at the last stages of drying, and change of colour of the material. The drying temperature did not exhibit any significant influence on the specific surface and porosity of the faecal materials.

v. Mechanical properties

The datasheets mechanical properties included the rheological, stickiness, and plastic properties at different moisture content and temperatures. The rheological properties were characterized by plotting the viscosity and shear stress as a function of the applied shear rate, as well as by the measurement of the loss and storage moduli, i.e. the viscous and elastic response of the material respectively, after short stimuli. The stickiness was studied through the determination of the cohesive and adhesive forces of the faecal materials. The plastic properties were investigated by measuring the plastic and liquid limits.

In summary, all faecal materials exhibited a shear thinning behaviour, meaning that the material viscosity decreased by shearing. At rest, the material exhibited a stronger elastic behaviour than viscous. Therefore, minimum shear stress needs to be applied to overcome the elastic deformation resistance for the material to start to flow. The decrease in the moisture content led to higher viscosities. Below a moisture content of 70 -60%wt, the faecal material lost its ability to flow. The faecal matters attained a peak of stickiness in the range of 60 to 40%wt moisture content, which could be seen by the highest values of the adhesive and cohesive forces. In general, the material cohesive forces were significantly higher than the adhesive ones, suggesting that the stickiness of the material within itself is higher than with surfaces. The faecal materials' liquid limit was located approximately at the moisture content level where the materials could no longer flow. The loss of the ability to flow of the faecal materials could be then correlated to the change of consistency from liquid to plastic. The plastic limit was found in the moisture content range from the sticky region, corroborating that faecal matter plastic and sticky behaviour are related to each other. Indeed, the sticky region marks the transition from a plastic sludge paste to a solid. The temperature modified the rheological and stickiness characteristics slightly by decreasing the viscosity, and increasing the adhesive and cohesive forces.

vi. Dewaterability

The dewaterability was assessed by measuring the extent of liquid that can be removed through centrifugation and by capillary suction time (CST) analysis. The results were correlated to the physiochemical characteristics of the faecal matter. The water activity of the solid residue after centrifugation was measured as well.

Faecal samples could be dewatered up to 60 – 70%wt depending on the source of the material. The liquid faecal samples with a moisture content higher than 85%wt presented a high dewaterability, whereas the samples with a thicker consistency (moisture content lower than 80%wt) exhibited moderate or poor dewaterability. The difference of dewaterability between the liquid and thick faecal materials could be due to the difference in unbound moisture content. Indeed, the liquid faecal samples could be dewatered to a further extent by their higher unbound moisture content. The water activity remained approximately equal to 1 before and after centrifugation. It can be then assumed that dewatering removed only unbound moisture under the explored conditions. The CST results could be correlated to the extra-polymer substances (EPS) concentration and electric conductivity (EC), but not for the volatile suspended solids (VSS). None correlation was found for the total solids content of the dewatered faecal material with the EPS concentration, EC and VSS content.

vii. Disinfection

The disinfection aspect of drying was studied by tracking the viability of Ascaris eggs with time in faecal materials at different moisture contents and exposed to different temperatures. Ascaris eggs was selected as the pathogen desinfection indicator due to its high resilience. In fact, if the Ascaris eggs are deactivated under certain conditions, it can be supposed that other pathogens will also be destroyed.

According to the datasheets, the Ascaris deactivation rate increased exponentially with temperature. The eggs viability was not affected after exposure to 40°C for 2 hours, whereas complete inactivation was achieved at 80°C after a few seconds. The Ascaris eggs viability was also considerably reduced by exposing the eggs to faecal matter with a moisture content below 40%wt for a few weeks. For wetter faecal materials, the Ascaris eggs viability remained barely the same with time. These results denote that drying at high temperatures (> 60°C) and to low moisture contents (< 40%wt) enhances the disinfection of the waste.

viii. Gas emission

The gas emission was examined by measuring the composition of the exhaust gas during faecal matter drying.

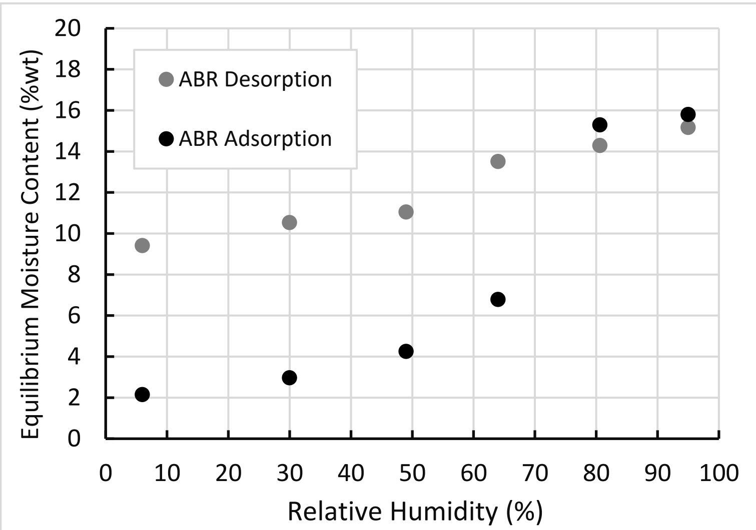
Apart from vapour water, other compounds were identified in the gas exhaust from the drying process, such as organic materials, carbon dioxide, carbon monoxide, nitrogen oxides, sulphure dioxide, ammonia and aerosols.

THERMODYNAMICS

General information	
Type of data	Sorption isotherms
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Saturated salt solution setup
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Temperature: ambient (~20°C) ○ Relative humidity (RH): 6, 30, 49, 64, 81 and 95%
Sample form in the dryer	~ 1.5 g of samples placed in silicon cupcake baking mould
Analysed parameters	Moisture content
Employed methods	Direct measurement by the moisture analyzer balance *PCE-MB Series* (SOP 8.7.1.5)
Publications	
-	

Data source files
https://www.dropbox.com/s/64gp2lb2fksolmq/2018-2019%20FS%20and%20Fresh%20faeces_Sorption%20Isotherms.xlsx?dl=0

Additional Notes
○ Samples placed inside a jar with a saturated salt solution to control the relative humidity to a given value ○ Employed salts: potassium hydroxide (6%RH), calcium chloride (30% RH), magnesium nitrate (49%RH), potassium iodide (64%RH), ammonium sulphate (80%RH), potassium nitrate (95% RH) ○ Equilibrium moisture content reached after the stabilization of the mass

Description of Data	
Equilibrium moisture content versus relative humidity (adsorption and desorption isotherms) 	Observations: ○ Higher equilibrium moisture contents for moisture desorption than adsorption (except at relative humidities higher than 80%) ○ Possible to achieve low moisture content (< 20%wt) at high relative humidities (< 95%) ○ Possible to regain slightly in moisture after drying if placed in environment with high relative humidity (hygroscopic behaviour)

General information	
Type of data	Sorption isotherms
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Saturated salt solution setup
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Temperature: ambient (~20°C) ○ Relative humidity (RH): 6, 30, 49, 64, 81 and 95%
Sample form in the dryer	~ 1.5 g of samples placed in silicon cupcake baking mould
Analysed parameters	Moisture content
Employed methods	Direct measurement by the moisture analyzer balance *PCE-MB Series* (SOP 8.7.1.5)
Publications	
-	

<table>
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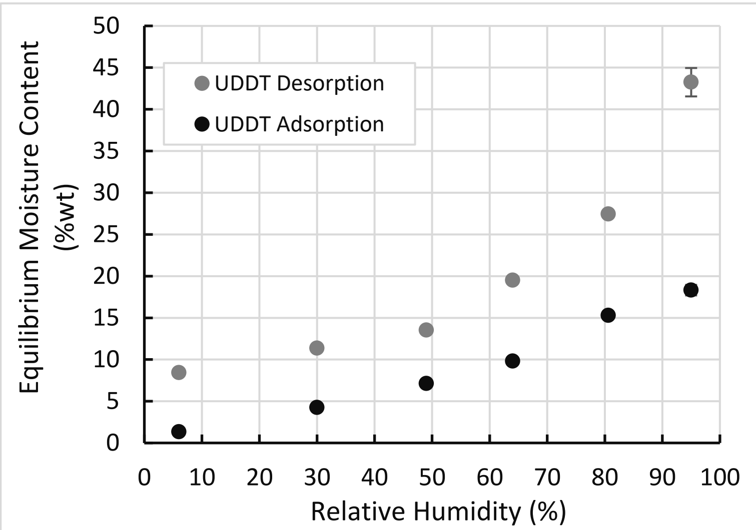
<tr><td colspan="2">https://www.dropbox.com/s/64gp2lb2fksolmq/2018-2019%20FS%20and%20Fresh%20faeces_Sorption%20Isotherms.xlsx?dl=0</td></tr>
<tr><td colspan="2"><u>Additional Notes</u></td></tr>
<tr><td colspan="2">
○ Samples placed inside a jar with a saturated salt solution to control the relative humidity to a given value
○ Employed salts: potassium hydroxide (6%RH), calcium chloride (30% RH), magnesium nitrate (49%RH), potassium iodide (64%RH), ammonium sulphate (80%RH), potassium nitrate (95% RH)
○ Equilibrium moisture content reached after the stabilization of the mass
</td></tr>
<tr><td colspan="2"><u>Description of Data</u></td></tr>
<tr><td><u>Equilibrium moisture content versus relative humidity (adsorption and desorption isotherms)</u>


</td><td><u>Observations:</u>
○ Higher equilibrium moisture contents for moisture desorption than adsorption
○ Possible to achieve low moisture content (< 30%wt) at high relative humidities (< 80%)
○ Possible for the sludge to regain slightly in moisture after drying if placed in environment with high relative humidity (hygroscopic behaviour)
</td></tr>
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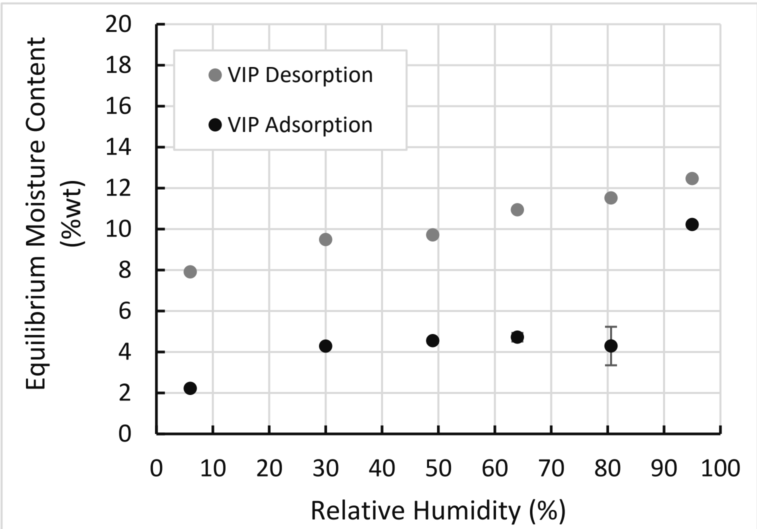
General information	
Type of data	Sorption isotherms
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 40%db
Ash content	~ 60%db
Presence of trash?	Yes (mainly hair extensions, plastic and rocks)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Saturated salt solution setup
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Temperature: ambient (~20°C) ○ Relative humidity (RH): 6, 30, 49, 64, 81 and 95%
Sample form in the dryer	~ 1.5 g of samples placed in silicon cupcake baking mould
Analysed parameters	Moisture content
Employed methods	Direct measurement by the moisture analyzer balance *PCE-MB Series* (SOP 8.7.1.5)
Publications	
-	

Data source files
https://www.dropbox.com/s/64gp2lb2fksolmq/2018-2019%20FS%20and%20Fresh%20faeces_Sorption%20Isotherms.xlsx?dl=0
Additional Notes
○ Samples placed inside a jar with a saturated salt solution to control the relative humidity to a given value ○ Employed salts: potassium hydroxide (6%RH), calcium chloride (30% RH), magnesium nitrate (49%RH), potassium iodide (64%RH), ammonium sulphate (80%RH), potassium nitrate (95% RH) ○ Equilibrium moisture content reached after the stabilization of the mass
Description of Data

Equilibrium moisture content versus relative humidity (adsorption and desorption isotherms)



Observations:

- Higher equilibrium moisture contents for moisture desorption than adsorption
- Possible to achieve low moisture content (< 20%wt) at high relative humidities (< 95%)
- Possible for the sludge to regain slightly in moisture after drying if placed in environment with high relative humidity (hygroscopic behaviour)

General information	
Type of data	Sorption isotherms
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Saturated salt solution setup
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Temperature: ambient (~20°C) ○ Relative humidity (RH): 6, 30, 49, 64, 81 and 95%
Sample form in the dryer	~ 1.5 g of samples placed in silicon cupcake baking mould
Analysed parameters	Moisture content
Employed methods	Direct measurement by the moisture analyzer balance *PCE-MB Series* (SOP 8.7.1.5)
Publications	
-	

Data source files

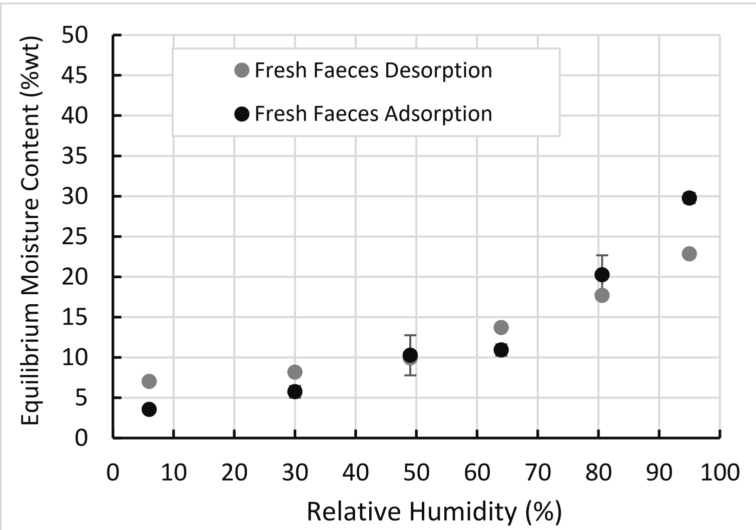
https://www.dropbox.com/s/64gp2lb2fksolmq/2018-2019%20FS%20and%20Fresh%20faeces_Sorption%20Isotherms.xlsx?dl=0

Additional Notes

- Fresh faeces collected from voluntary and anonymous donations from healthy young adults
- Samples placed inside a jar with a saturated salt solution to control the relative humidity to a given value
- Employed salts: potassium hydroxide (6%RH), calcium chloride (30% RH), magnesium nitrate (49%RH), potassium iodide (64%RH), ammonium sulphate (80%RH), potassium nitrate (95% RH)
- Equilibrium moisture content reached after the stabilization of the mass

Description of Data

Equilibrium moisture content versus relative humidity (adsorption and desorption isotherms)



Observations:

- Similar equilibrium moisture contents between moisture desorption and adsorption
- Possible to achieve low moisture content (< 30%wt) at high relative humidities (< 95%)
- Possible for the sludge to regain slightly in moisture after drying if placed in environment with high relative humidity (hygroscopic behaviour)

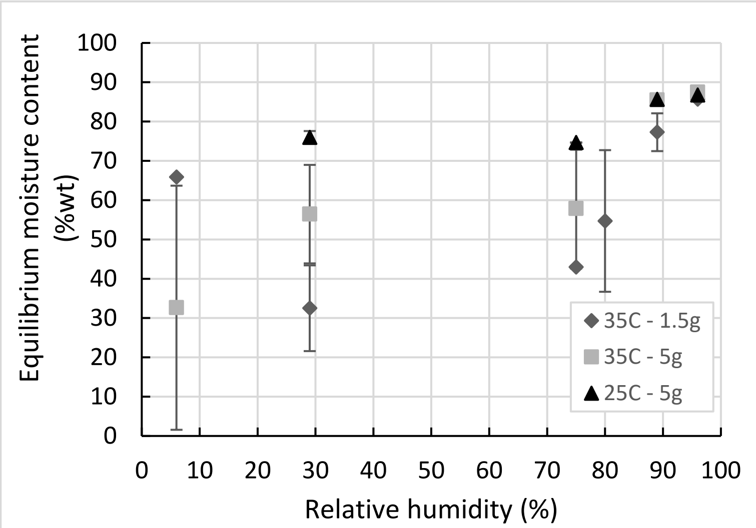
General information	
Type of data	Sorption isotherms
Place of experimentation	Civil and Water Engineering Department, Laval University, Quebec (Canada)
Dates of the experiments	2017
Feedstock	
Type of faecal material	Faecal sludge from share pit latrine
Location of collection	Quebec, Canada
Age before collection	1 or 2 years
Moisture content	~ 98 %wt
Total solids content	~ 2 %wt
Volatile solids content	~ 80 %wt
Ash content	~ 20 %wt
Presence of trash?	Yes (plastics, menstrual hygiene product, toilet paper)
Pre-treatment	Removal of trash
Experimental Procedure	
Drying experimental setup	Saturated salt solution setup
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Temperature: 25°C, and 35°C ○ Relative humidity (RH) at 25°C: 29, 75, 89, 97% ○ RH at 35°C: 6, 29, 75, 89, 97%
Sample form in the dryer	1.5 and 5 g of samples placed in weighing tray
Analysed parameters	Moisture content
Employed methods	Static gravimetric analysis from the sample mass loss
Publications	
Bourgault, C., Lessard, P., Remington, C., & Dorea, C. C. (2019). Experimental determination of moisture sorption isotherm of fecal sludge. *Water*, *11*(2), 303. Bourgault, C. (2018). Characterization and quantification of faecal sludge from pit latrines. PhD thesis. University of Laval, Canada.	

Data source files
https://www.dropbox.com/s/mochav67q0gf0ul/2017%20VIP%20sludge%20Moisture%20Sorption%20Isotherms_Laval%20University.xlsx?dl=0

Additional Notes
○ Samples placed inside a jar with a saturated salt solution to control the relative humidity to a given value ○ Employed salts: sodium hydroxide (6%RH), calcium chloride (29%RH), sodium chloride (75%RH), potassium chloride (89%RH), potassium sulphate (97%RH) ○ Equilibrium moisture content measured after the stabilization of the mass (2 to 4 weeks, depending on the sample)

Description of Data

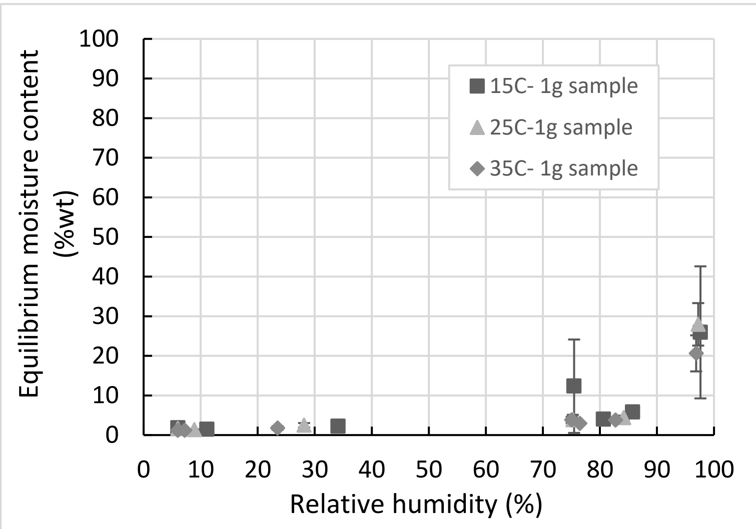
Equilibrium moisture content versus relative humidity at 25 and 35°C (desorption isotherm)



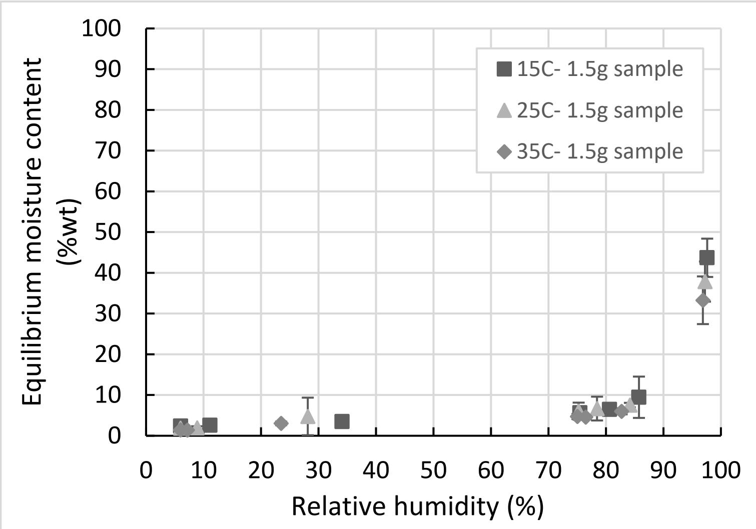
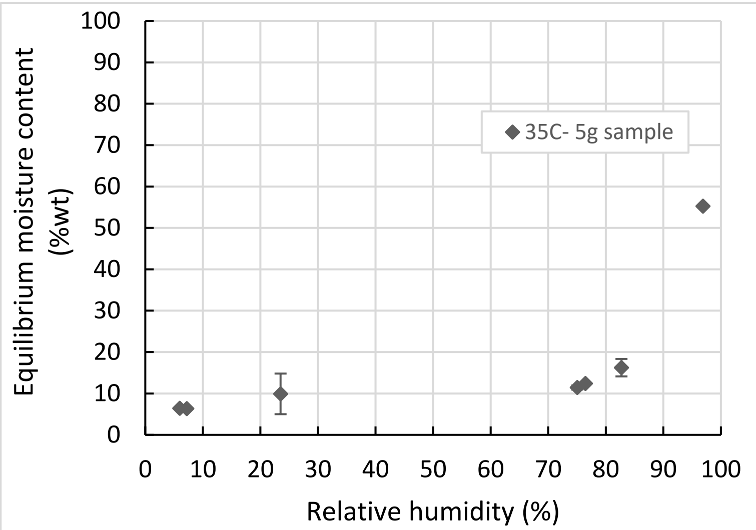
Observations:

- ○ Decrease of equilibrium moisture by decreasing the relative humidity in the range 75 to 96% RH
- ○ Below 75% RH, not clear decrease of the equilibrium moisture content due to the high variability of the results
- ○ Not clear effect of temperature and mass of sample

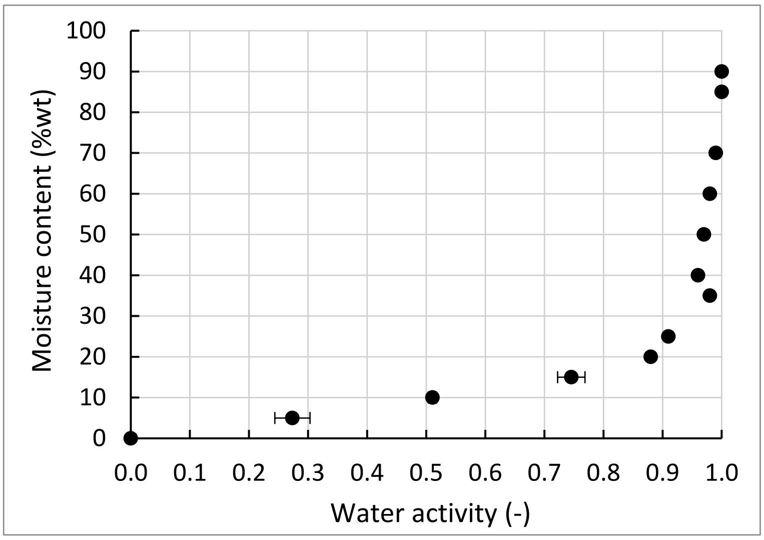
General information	
Type of data	Sorption isotherms
Place of experimentation	Public Health & Environmental Engineering Laboratory, University of Victoria, Victoria, (Canada)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Victoria, BC
Age before collection	A few days
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Saturated salt solution setup
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Temperature: 15°C, 25°C, and 35°C ○ Relative humidity (RH) at 15°C: 6, 11, 34, 75, 80, 85, 97% ○ RH at 25°C: 6, 9, 28, 75, 78, 84, 97% ○ RH at 35°C: 6, 7, 23, 75, 76, 83, 97%
Sample form in the dryer	1, 1.5, and 5 g of samples placed in weighing tray
Analysed parameters	Moisture content
Employed methods	Static gravimetric analysis from the sample mass loss
Publications	
Remington, C., Bourgault, C., & Dorea, C. (2020). Measurement and modelling of moisture sorption isotherm and heat of sorption of fresh feces. *Water, 12*(2), 323. doi:10.3390/w12020323	

<table>
<tr><td colspan="2">Remington, C. (2019). Countering the Porcelain Dream: Key Findings from an Evaluation of the Global Nitrogen Cycle, a Fundamental Characterization of Fresh Faeces, and a Campus Composting Toilet. MSc thesis. University of Victoria, Canada.</td></tr>
<tr><td colspan="2"><u>Data source files</u></td></tr>
<tr><td colspan="2">https://www.dropbox.com/s/hv4i7wb6uigk4di/2018-2019%20Human%20faeces%20Moisture%20Sorption%20Isotherms_University%20of%20Victoria.xlsx?dl=0</td></tr>
<tr><td colspan="2"><u>Additional Notes</u></td></tr>
<tr><td colspan="2">
○ Fresh faeces collected from voluntary and anonymous donations from healthy young adults
○ Samples placed inside a jar with a saturated salt solution to control the relative humidity to a given value
○ Employed salts: sodium hydroxide (6%RH), potassium hydroxide (7 - 11%RH), calcium chloride (23 - 34%RH), sodium chloride (75%RH), ammonium chloride (76 - 80%RH), potassium chloride (83 - 85%RH), potassium sulphate (97%RH)
○ Equilibrium moisture content measured after the stabilization of the mass (2 to 4 weeks, depending on the sample)
</td></tr>
<tr><td colspan="2"><u>Description of Data</u></td></tr>
<tr><td><u>Equilibrium moisture content versus relative humidity at 15, 25 and 35°C for 1 g of sample</u>


</td><td><u>Observations:</u>
○ High variability of the equilibrium moisture content at 97%RH (probably because of the sorption isotherm tending to a vertical asymptote at 100%RH)
○ Fast drop of the equilibrium moisture content below 97%RH
○ Low equilibrium moisture content (< 20%) below 85%RH
○ Not effect of temperature
○ Similar pattern for the different mass of sample
</td></tr>
</table>

Equilibrium moisture content versus relative humidity at 15, 25 and 35ºC for 1.5 g of sample 	
Equilibrium moisture content versus relative humidity at 15, 25 and 35º for 5 g of sample 	

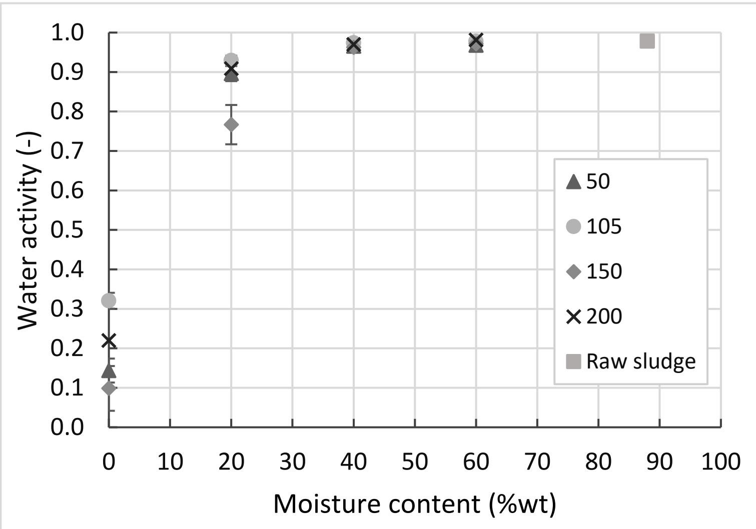
General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Moisture Analyser balance *PCE-MB Series*
Drying time	Until achieving 0, 5, 10, 15, 20, 25, 35, 40, 50, 55, 60, 70 and 85%wt moisture content
Operating conditions	Temperature: 100°C
Sample form in the dryer	1.5 g of sample on an 90 mm diameter aluminium crucible
Analysed parameters	Water activity
Employed methods	Use of water activity analyser *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files	
https://www.dropbox.com/s/ltlydxgp1xglrtz/2018-2019%20Moisture%20content%20as%20a%20function%20of%20Water%20activity.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Water activity as a function of moisture content 	Observations: ○ Water activity near 1 above 35%wt moisture content ○ Decrease of water activity below 35%wt moisture content

General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Water activity
Employed methods	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.	

Data source files
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0
Additional Notes
-
Description of Data

Water activity as a function of moisture content and temperature



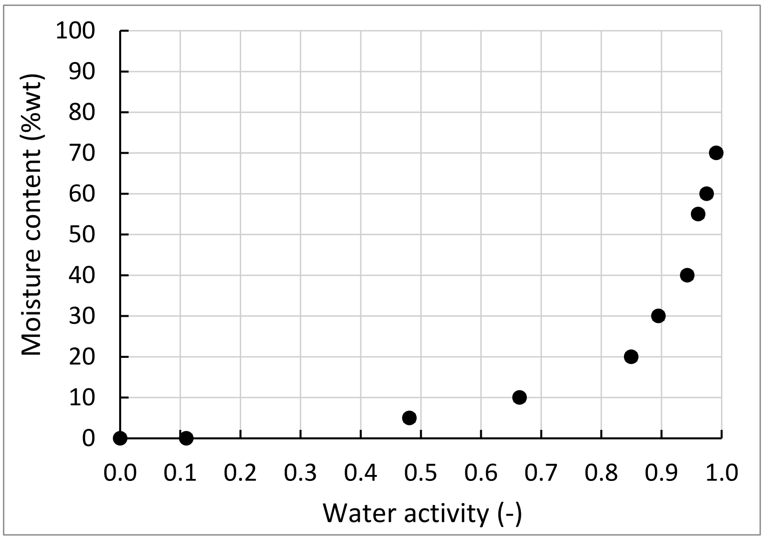
Observations:

- Water activity near 1 above 40%wt moisture content
- Decrease of water activity below 40%wt moisture content
- No effect of drying temperature

General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Moisture Analyser balance *PCE-MB Series*
Drying time	Until achieving 0, 5, 10, 20, 30, 40, 55, 60%wt moisture content
Operating conditions	Temperature: 100°C
Sample form in the dryer	1.5 g of sample on an 90 mm diameter aluminium crucible
Analysed parameters	Water activity
Employed methods	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files
https://www.dropbox.com/s/ltlydxgp1xglrtz/2018-2019%20Moisture%20content%20as%20a%20function%20of%20Water%20activity.xlsx?dl=0
Additional Notes
-
Description of Data

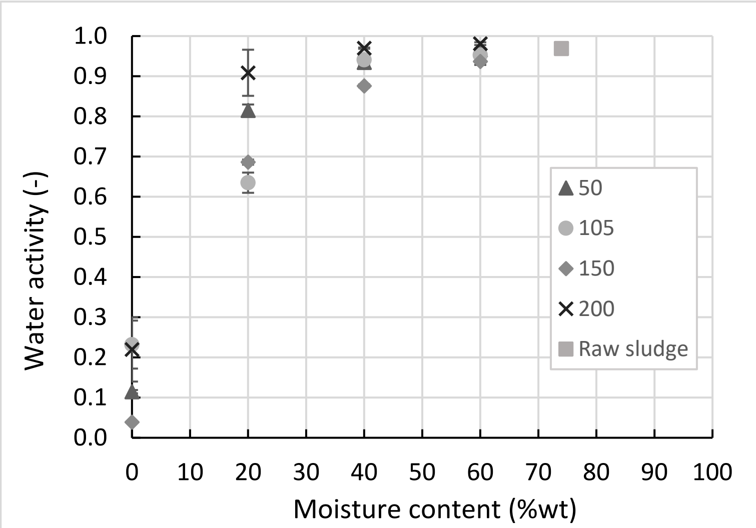
Water activity as a function of moisture content



Observations:

- Decrease of water activity as sludge dried (faster below 40%wt)

General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Water activity
Employed methods	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (8.8.3.3)
Publications	
Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.	

Data source files	
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Water activity as a function of moisture content and temperature 	Observations: ○ Water activity near 1 above 40%wt moisture content ○ Decrease of water activity below 40%wt moisture content ○ No effect of drying temperature

General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Moisture Analyser balance *PCE-MB Series*
Drying time	Until achieving 20, 30, 40, 50, 60, 70, 80, 90%wt moisture content
Operating conditions	Temperature: 105°C
Sample form in the dryer	1.5 g of sample on an 90 mm diameter aluminium crucible
Analysed parameters	Water activity at ambient (~22°C) and 40°C
Employed methods	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
-	

Data source files

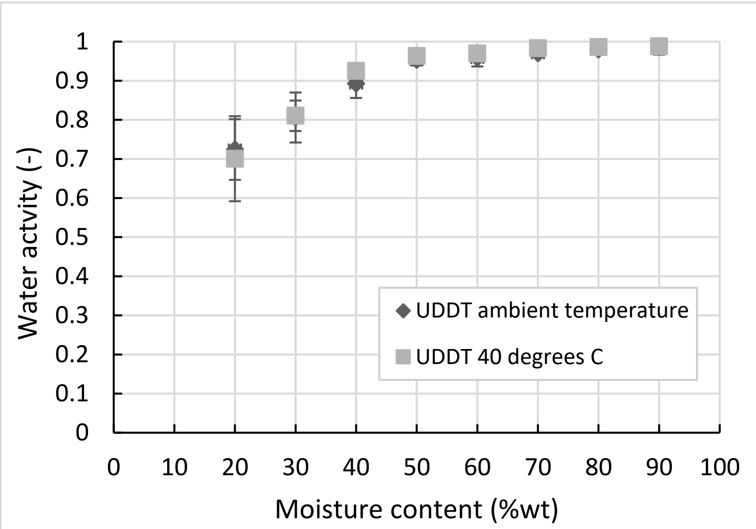
https://www.dropbox.com/s/tw20fkfiokv0bdo/2019-2020%20Water%20activity%20as%20a%20function%20of%20moisture%20content.xlsx?dl=0

Additional Notes

-

Description of Data

Water activity as a function of moisture content at different temperature



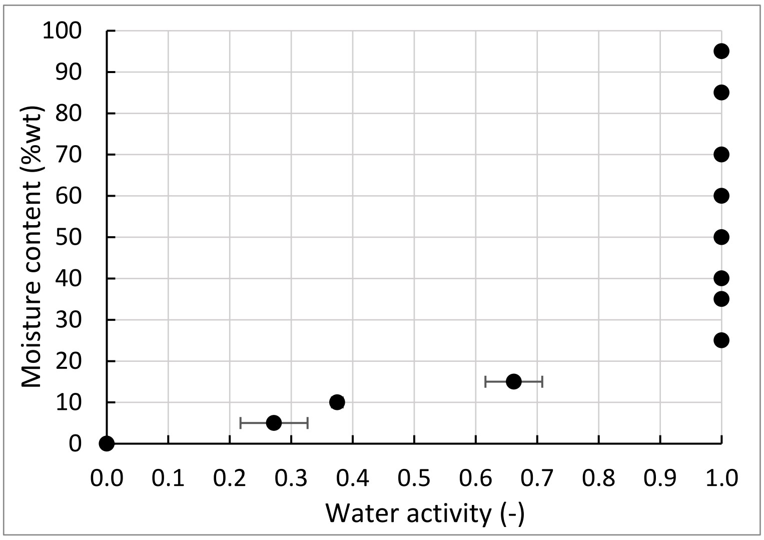
Observations:

- Water activity constant around 1 above a 50%wt moisture content
- Decrease of water activity below 50%wt moisture content
- No effect of temperature in water activity

General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	~ 65%db
Ash content	~ 35%db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Moisture Analyser balance *PCE-MB Series*
Drying time	Until achieving 0, 5, 10, 15, 20, 25, 30, 35, 40, 50, 60, 70 and 85%wt moisture content
Operating conditions	Temperature: 100°C
Sample form in the dryer	1.5 g of sample on an 90 mm diameter aluminium crucible
Analysed parameters	Water activity
Employed methods	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files
https://www.dropbox.com/s/ltlydxgp1xglrtz/2018-2019%20Moisture%20content%20as%20a%20function%20of%20Water%20activity.xlsx?dl=0
Additional Notes
-
Description of Data

Water activity as a function of moisture content

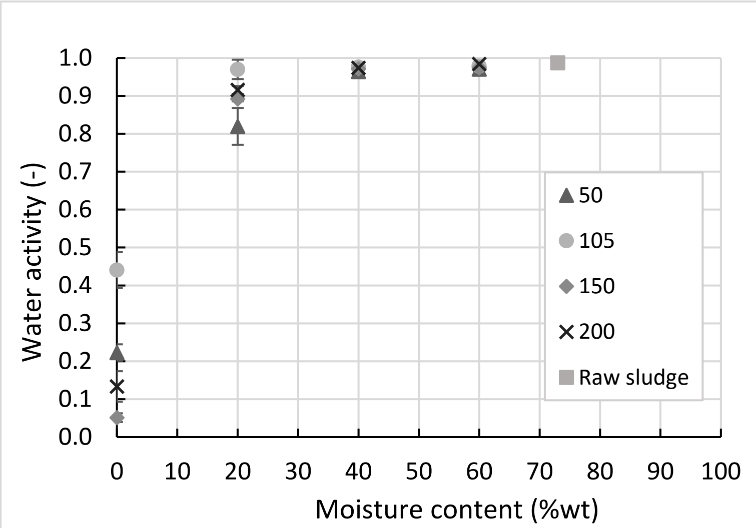


Observations:

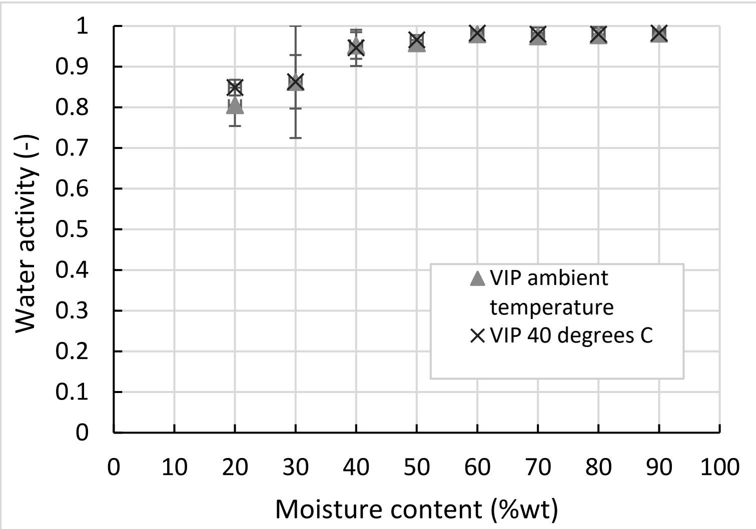
- Water activity near 1 above 20%wt moisture content
- Decrease of water activity below 20%wt moisture content

General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~75%wt
Total solids content	~25%wt
Volatile solids content	~40%db
Ash content	~60%db
Presence of trash?	Yes (mainly hair extensions, plastic and rocks)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Water activity
Employed methods	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.	

Data source files
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0
Additional Notes
-
Description of Data

Water activity as a function of moisture content and temperature	Observations:
	○ Water activity near 1 above 40%wt moisture content ○ Decrease of water activity below 40%wt moisture content ○ No effect of drying temperature

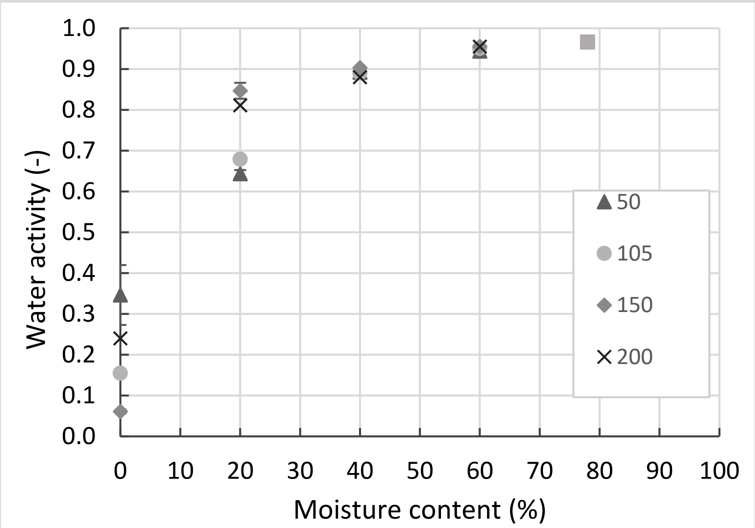
General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Moisture Analyser balance *PCE-MB Series*
Drying time	Until achieving 20, 30, 40, 50, 60, 70, 80, 90%wt moisture content
Operating conditions	Temperature: 105°C
Sample form in the dryer	1.5 g of sample on an 90 mm diameter aluminium crucible
Analysed parameters	Water activity at ambient (~22°C) and 40°C
Employed methods	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
-	

Data source files	
https://www.dropbox.com/s/tw20fkfiokv0bdo/2019-2020%20Water%20activity%20as%20a%20function%20of%20moisture%20content.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Water activity as a function of moisture content at different temperatures 	Observations: ○ Water activity constant around 1 above a 50%wt moisture content ○ Decrease of water activity below 50%wt moisture content ○ No effect of temperature in water activity

General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal, (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Water activity
Employed method	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
-	

Data source files
https://www.dropbox.com/s/vpa68hptk81v4e4/2019%20Fresh%20faeces%20tests_PRG.xlsx?dl=0
Additional Notes
Fresh faeces collected from voluntary and anonymous donations
Description of Data

Water activity as a function of moisture content and temperature



Observations:

- Water activity near 1 above 40%wt moisture content
- Decrease below 40%wt moisture content
- No effect of drying temperature

General information	
Type of data	Water Activity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Temperature: ambient (~ 20°C) ○ Relative humidity: ambient (~ 60%)
Sample form in the dryer	900 g of sample placed in 1 L plastic bucket
Analysed parameters	Water activity
Employed method	Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
-	

Data source files

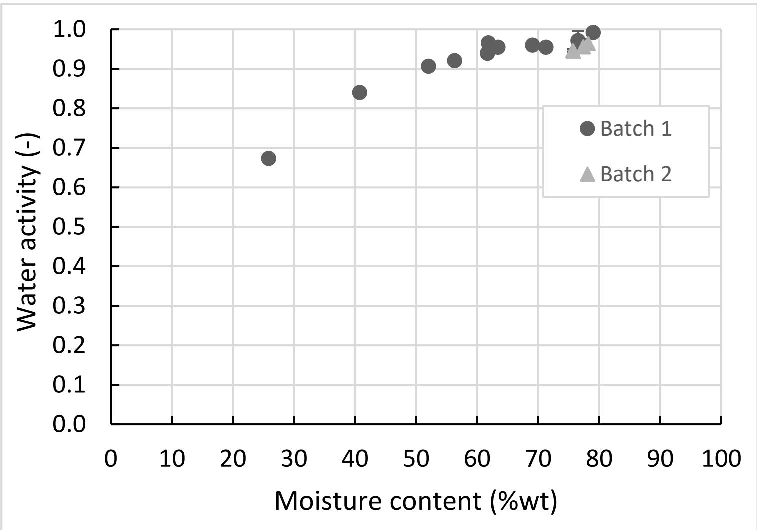
https://www.dropbox.com/s/xbv6su0jxsipiok/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20the%20open%20air_UKZN%20PRG.xlsx?dl=0

Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Containers with sample placed in a ventilated area
- Mesh placed at the opening of the container to avoid the development of maggots
- Samples from batch 1 analysed in a weekly basis for 16 weeks
- Samples from batch 2 analysed at days 0, 3, 5 and 7 during one week

Description of Data

Water activity as a function of moisture content for the samples from batch 1 and 2

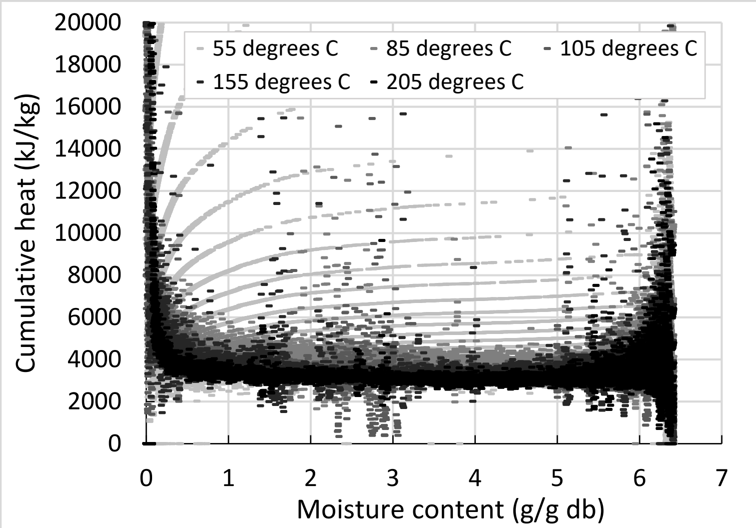


Observations:

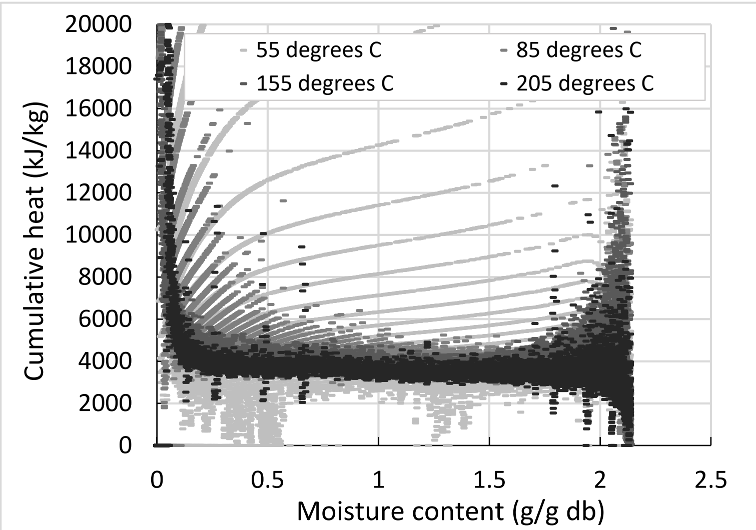
- Relatively constant water activity above 60%wt moisture content
- Decrease of water activity below 60%wt moisture content

General information	
Type of data	Heat of drying
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 85%wt
Total solids content	~ 15%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Drying time	~ 40 - 80 min
Operating conditions	o Set temperature: 55, 85, 105, 155 and 205°C o Heating rate: 10°C/min o Carrier gas: nitrogen o Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Heat of reaction and Moisture content
Employed method	Determined through the mass (1) and energy (2) variation measured by the STA
Publications	
-	

Data source files
https://www.dropbox.com/s/eypvydu2nyjolvg/Swansea%20Heat%20of%20drying%20tests_Faeces%20and%20Faecal%20sludge%20%282018-2020%29.xlsx?dl=0
Additional Notes
○ Faecal sludge couriered from South Africa ○ Considerable drying of the sample before reaching the set temperature at 105, 155 and 205°C
Description of Data

Cumulative heat per evaporated moisture versus moisture content as a function of temperature	Observations
	○ High fluctuation of the heat of drying at the beginning of the transformation (probably due to the stabilization of the process) ○ Heat of drying fairly constant or slightly increasing during most of process, ranging between about 3000 and 4000 kJ/kg ○ Exponential increase of the heat of drying below a moisture content of 1 g/g db ○ Heat of drying tending to a vertical asymptote at very low moisture content (~0.1 g/g db) ○ No trend observed as a function of the drying temperature ○ Heat of drying higher than latent heat of water vaporization (> 2260 kJ/kg)

General information	
Type of data	Heat of drying
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Drying time	~ 40 - 80 min
Operating conditions	o Set temperature: 55, 85, 105, 155 and 205°C o Heating rate: 10°C/min o Carrier gas: nitrogen o Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Heat of reaction and Moisture content
Employed method	Determined through the mass (1) and energy (2) variation measured by the STA
Publications	
-	

Data source files	
https://www.dropbox.com/s/eypvydu2nyjolvg/Swansea%20Heat%20of%20drying%20tests_Faeces%20and%20Faecal%20sludge%20%282018-2020%29.xlsx?dl=0	
Additional Notes	
○ Faecal sludge couriered from South Africa ○ Considerable drying of the sample before reaching the set temperature at 105, 155 and 205°C	
Description of Data	
Heat of drying versus moisture content as a function of temperature 	Observations ○ High fluctuation of the heat of drying at the beginning of the transformation (probably due to the stabilization of the process) ○ Heat of drying fairly constant or slightly increasing during most of process, ranging between about 7000 and 10000 kJ/kg ○ Exponential increase of the heat of drying below a moisture content of 0.5 g/g db ○ Heat of drying tending to a vertical asymptote at very low moisture content (~0.1 g/g db) ○ Apparent lower heating of drying at higher temperature ○ Heat of drying higher than latent heat of water vaporization (> 2260 kJ/kg)

General information	
Type of data	Heat of drying
Place of experimentation	Materials Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis (STA) *Perkin Elmer STA 6000*
Drying time	~ 40 - 80 min
Operating conditions	o Set temperature: 55 and 85, 105, 155 and 205°C o Heating rate: 10°C/min o Carrier gas: nitrogen o Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Heat of reaction and moisture content
Employed method	Determined through the mass (1) and energy (2) variation measured by the STA
Publications	
-	

Data source files

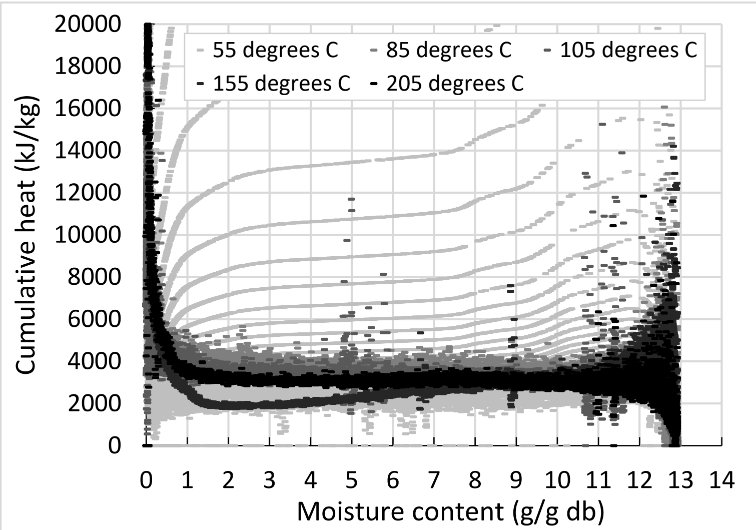
https://www.dropbox.com/s/eypvydu2nyjolvg/Swansea%20Heat%20of%20drying%20tests_Faeces%20and%20Faecal%20sludge%20%282018-2020%29.xlsx?dl=0

Additional Notes

- Faecal sludge couriered from South Africa
- Considerable drying of the sample before reaching the set temperature at 105, 155 and 205°C

Description of Data

Heat of drying versus moisture content as a function of temperature

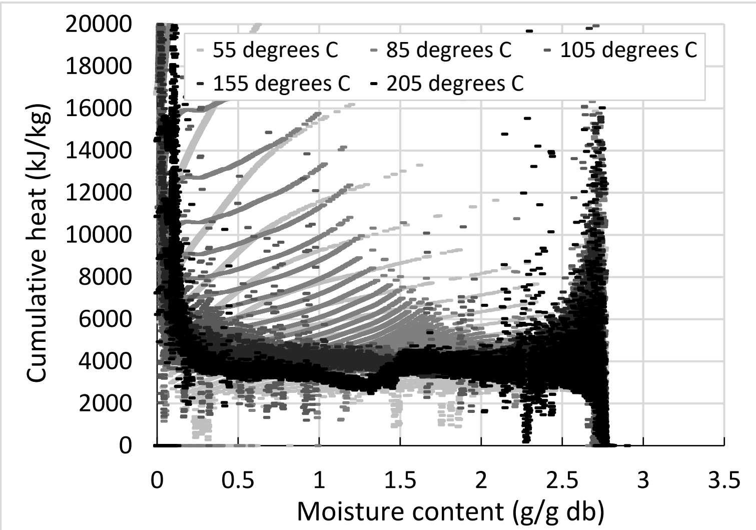


Observations

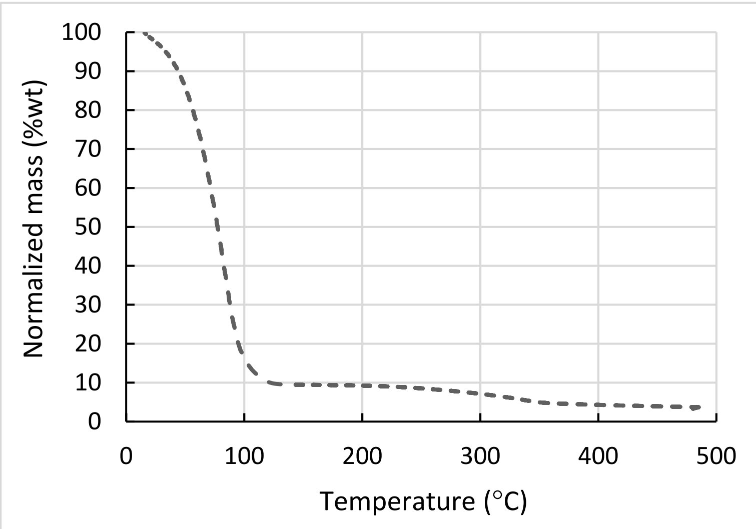
- High fluctuation of the heat of drying at the beginning of the transformation (probably due to the stabilization of the process)
- Heat of drying fairly constant during most of process, ranging between about 1500 and 2000 kJ/kg (except for 155°C)
- Exponential increase of the heat of drying below a moisture content of 2 g/g db
- Heat of drying tending to a vertical asymptote at very low moisture content (~0.1 g/g db)
- No trend observed as a function of the drying temperature
- Heat of drying close to the latent heat of water vaporization during most of the transformation (~ 2260 kJ/kg)

General information	
Type of data	Heat of drying
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Cranfield, UK
Age before collection	A few days
Moisture content	~ 60%wt
Total solids content	~ 40%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Drying time	~ 40 - 80 min
Operating conditions	○ Set temperature: 55, 85, 105, 155 and 205°C ○ Heating rate: 10°C/min ○ Carrier gas: nitrogen ○ Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Heat of reaction and Moisture content
Employed method	Determined through the mass (1) and energy (2) variation measured by the STA
Publications	
-	

Data source files
https://www.dropbox.com/s/eypvydu2nyjolvg/Swansea%20Heat%20of%20drying%20tests_Faeces%20and%20Faecal%20sludge%20%282018-2020%29.xlsx?dl=0
Additional Notes
○ Fresh faeces obtained from anonymous and voluntary donations ○ Considerable drying of the sample before reaching the set temperature at 105, 155 and 205°C
Description of Data

Heat of drying versus moisture content as a function of temperature	Observations
	○ High fluctuation of the heat of drying at the beginning of the transformation (probably due to the stabilization of the process) ○ Heat of drying fairly constant or slightly increasing during most of process, ranging between about 5000 and 10000 kJ/kg (except for 85°C) ○ Exponential increase of the heat of drying below a moisture content of 0.5 g/g db ○ Heat of drying tending to a vertical asymptote at very low moisture content (~0.7 g/g db) ○ No trend observed as a function of the drying temperature ○ Heat of drying higher than latent heat of water vaporization (> 2260 kJ/kg)

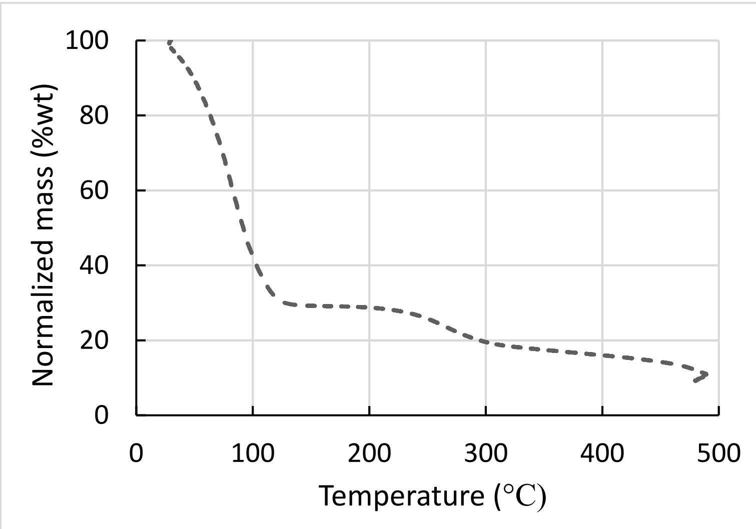
General information	
Type of data	Thermal stability
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Thermogravimetry analyser - differential thermal analyser *DTG-60A Shimadu*
Drying time	~ 35 min
Operating conditions	o Temperature: ramp from ambient temperature to 500°C o Heating rate: 5°C/min o Air flowrate: 50 mL/min
Sample form in the dryer	~ 70 mg sample on aluminium crucible (6 mm diameter × 5 mm height)
Analysed parameters	Mass
Employed method	Measurement by the *DTG-60A* instrument (SOP 8.8.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

<table>
<tr><td colspan="2">Septien, S., Getahun, S., Mirara, S., Makununika, B.S.N., Mugauri, T.R., Singh, A., Pocock, J., Inambao, F., Velkushanova, K., Buckley, C.A. (2019). Investigations of faecal sludge drying from on-site sanitation facilities. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.</td></tr>
<tr><td colspan="2"><u>Data source files</u></td></tr>
<tr><td colspan="2">https://www.dropbox.com/s/dr718ewj9s1k5h0/2018-2019%20Faecal%20sludge_Heat%20of%20drying%20and%20Dynamic%20Tests_PRG.xlsx?dl=0</td></tr>
<tr><td colspan="2"><u>Additional Notes</u></td></tr>
<tr><td colspan="2">○ Normalized mass at a given instance = mass at given instance / initial mass</td></tr>
<tr><td colspan="2"><u>Description of Data</u></td></tr>
<tr><td><u>Variation of mass with temperature</u>

</td><td><u>Observations:</u>
○ Large decrease of mass from ambient temperature to around 130°C (due to drying)
○ Second slight decrease of mass from 250°C to 350°C (probably due to a thermal degradation)</td></tr>
</table>

General information	
Type of data	Thermal stability
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal, South Africa
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilet (UDDT)
Location of collection	Durban, South Africa
Age before collection	1 - 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones and textiles)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Thermogravimetry analyser - differential thermal analyser *DTG-60A Shimadu*
Drying time	~ 35 min
Operating conditions	o Temperature: ramp from ambient temperature to 500°C o Heating rate: 5°C/min o Air flowrate: 50 mL/min
Sample form in the dryer	~70 mg sample on aluminium crucible (6 mm diameter × 5 mm height)
Analysed parameters	Mass
Employed method	Measurement by the *DTG-60A* instrument
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Septien, S., Getahun, S., Mirara, S., Makununika, B.S.N., Mugauri, T.R., Singh, A., Pocock, J., Inambao, F., Velkushanova, K., Buckley, C.A. (2019). Investigations of faecal sludge drying from on-site sanitation facilities. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.
Data source files
Additional Notes
Normalized mass at a given instance = mass at given instance / initial mass
Description of Data

Variation of mass with temperature



Experimental conditions:

- Temperature: from ambient to 500°C
- Heating rate: 5°C/min
- Airflow rate: 50 ml/min

Observations:

- Large decrease of mass from ambient temperature to around 130°C (due to drying)
- Second slight decrease of mass from 250°C to 350°C (probably due to a thermal degradation)

General information	
Type of data	Thermal stability
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal, South Africa
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated pit latrines
Location of collection	Durban, South Africa
Age before collection	3 – 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	~ 65%db
Ash content	~ 35%db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetry analyser - differential thermal analyser *DTG-60A Shimadu*
Drying time	~ 35 min
Operating conditions	○ Temperature: ramp from ambient temperature to 500°C ○ Heating rate: 5°C/min ○ Air flowrate: 50 mL/min
Sample form in the dryer	~70 mg sample on aluminium crucible (6 mm diameter × 5 mm height)
Analysed parameters	Mass
Employed method	Measurement by the *DTG-60A* instrument
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Septien, S., Getahun, S., Mirara, S., Makununika, B.S.N., Mugauri, T.R., Singh, A., Pocock, J., Inambao, F., Velkushanova, K., Buckley, C.A. (2019). Investigations of faecal sludge drying from on-site sanitation facilities. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

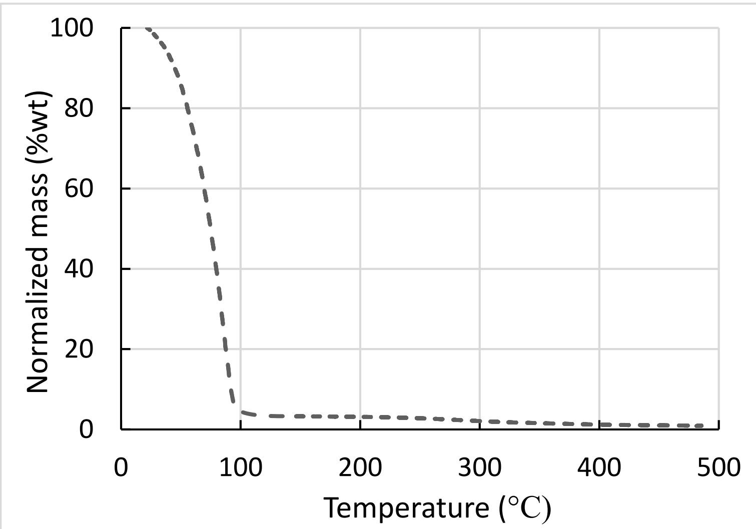
Data source files

Additional Notes

Normalized mass at a given instance = mass at given instance / initial mass

Description of Data

Variation of mass with temperature



Experimental conditions:

- Temperature: from ambient to 500°C
- Heating rate: 5°C/min
- Airflow rate: 50 ml/min

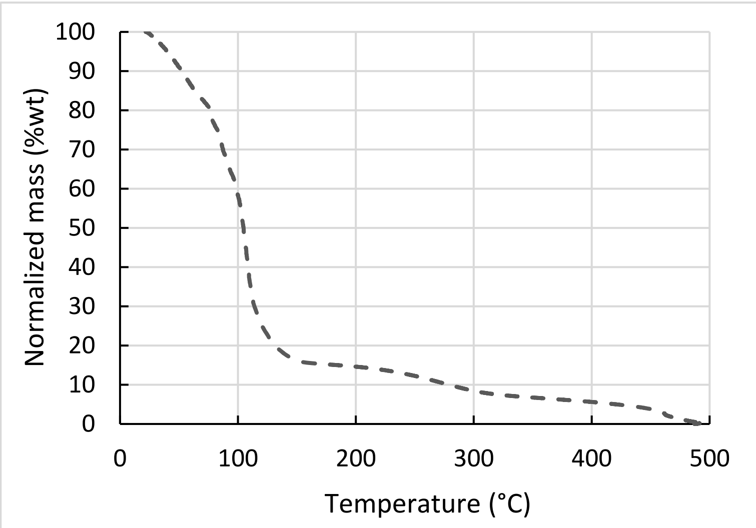
Observations:

- Large decrease of mass from ambient temperature to around 130°C (due to drying)
- Second slight decrease of mass from 250°C to 350°C (probably due to a thermal degradation)

General information	
Type of data	Thermal stability
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetry analyser - differential thermal analyser *DTG-60A Shimadu*
Drying time	~ 35 min
Operating conditions	o Temperature: ramp from ambient temperature to 500°C o Heating rate: 5°C/min o Air flowrate: 50 mL/min
Sample form in the dryer	~ 70 mg sample on aluminium crucible (6 mm diameter × 5 mm height)
Analysed parameters	Mass
Employed method	Measurement by the *DTG-60A* instrument (SOP 8.8.1.1)
Publications	

Data source files
https://www.dropbox.com/s/r185a7e9g4a8r2v/2018-2019%20Fresh%20faeces_Dynamic%20test_PRG.xlsx?dl=0

Additional Notes
○ Fresh faeces collected from voluntary and anonymous donations ○ Normalized mass at a given instance = mass at given instance / initial mass

Description of Data	
Variation of mass with temperature 	Observations: ○ Large decrease of mass from ambient temperature to around 160°C (due to drying) ○ Second slight decrease of mass from 220 to 330°C (probably due to a thermal degradation) ○ Third slight decrease from 440 to 500°C (probably due to further thermal degradation)

KINETICS

General information	
Type of data	Kinetics of convective drying
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Custom-design convective drying rig
Drying time	Until stabilisation of the sample mass
Operating conditions	o Air temperature: 40, 60 and 80°C o Air humidity: 0, 15 and 25% o Air velocity: 0.03, 0.06 and 0.12 cm/s
Sample form in the dryer	Pellets of 8, 10, 12 and 14 mm diameter
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)
Publications	
Makununika, B. S. N. (2016). Thermal drying of faecal sludge from VIP latrines and characterisation of dried faecal material. Master thesis. University of KwaZulu-Natal, Durban, South Africa.	

Data source files

Wet basis
https://www.dropbox.com/s/zmm55q2o47iedcp/Convective%20drying%20of%20VIP%20pellets%28wb%29_2014-2015.xlsx?dl=0

Dry basis
https://www.dropbox.com/s/4a3m2a6pi5e0vfc/Convective%20drying%20of%20VIP%20pellets%20%28db%29_2014-2015.xlsx?dl=0

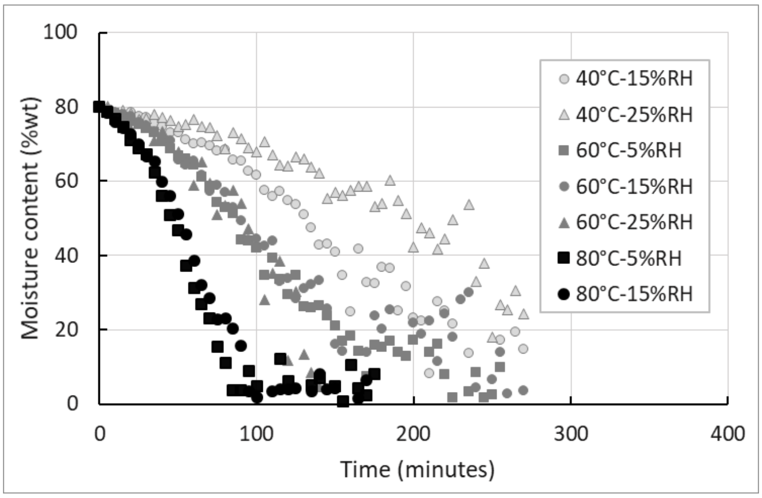
Additional Notes

-

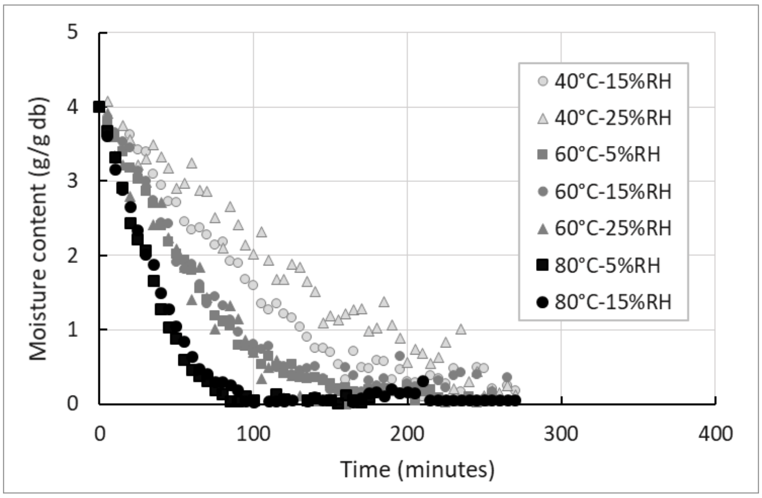
Description of Data

Moisture content as a function of temperature and relative humidity

Wet basis

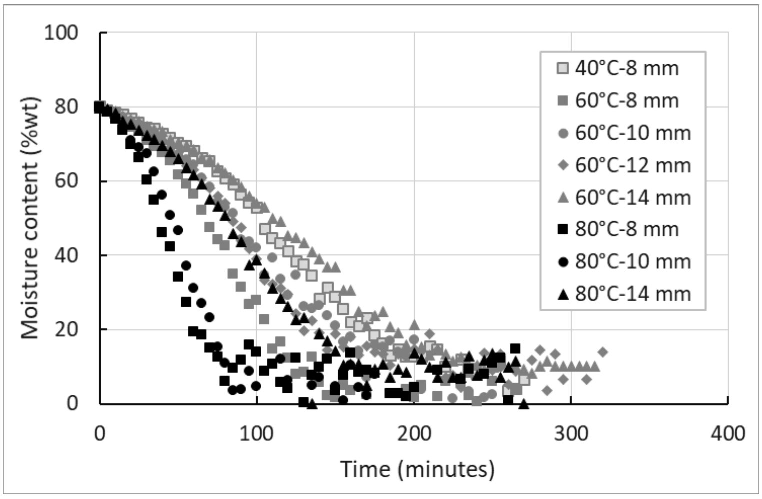
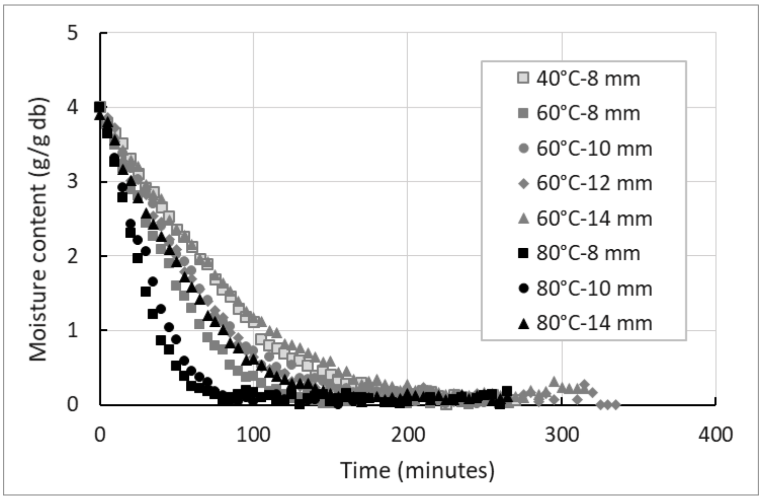


Dry basis



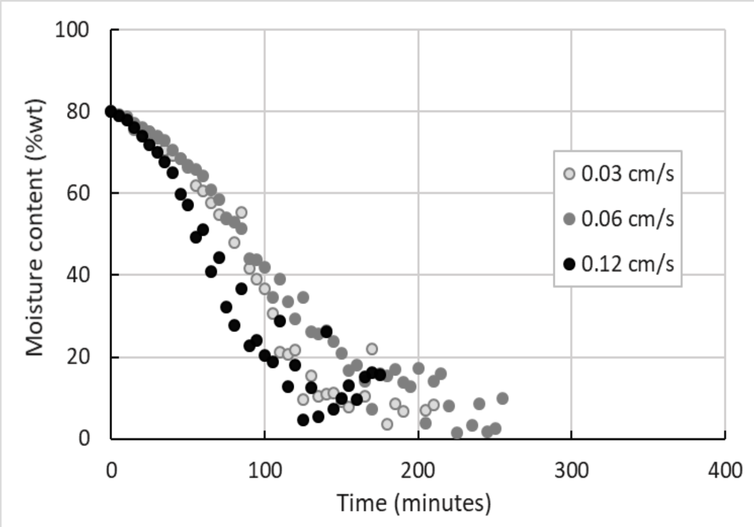
Observations

- Drying time varying between 100 and 250 min
- Faster drying at increasing drying temperature and decreasing relative humidity at 40°C
- No effect of relative humidity at 60 and 80°C

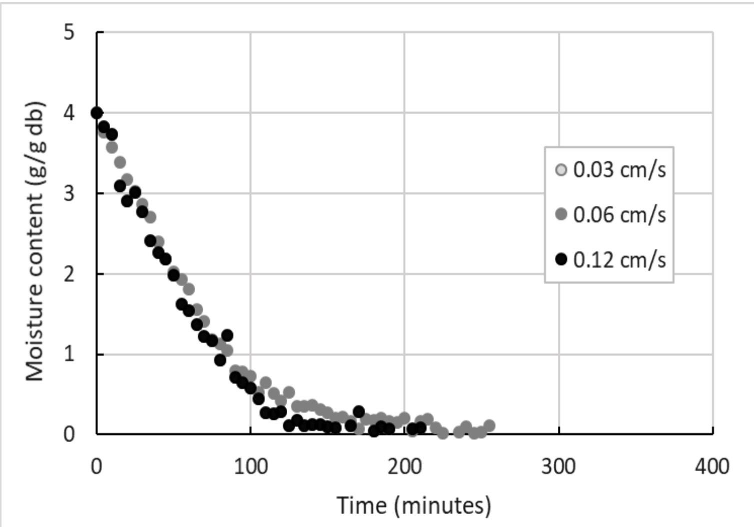
Moisture content versus time as a function of temperature and pellet diameter	Observations
Wet basis  **Dry basis** 	○ Drying time varying between 100 and 200 min ○ - Faster drying at increasing drying temperature and decreasing pellet diameter

Moisture content versus time as a function of air velocity

Wet basis



Dry basis



Observations

- Drying time around 150 min
- No significant effect of air velocity

General information	
Type of data	Kinetics of convective drying
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom-design convective drying rig
Drying time	Batch until complete drying
Operating conditions	○ Air temperature: 40, 60 and 80°C ○ Air humidity: 0, 15 and 25% ○ Air velocity: 0.03, 0.06 and 0.12 cm/s
Sample form in the dryer	Thin layer on a petri dish of 70 mm diameter and 4 mm height
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)
Publications	
Makununika, B. S. N. (2016). Thermal drying of faecal sludge from VIP latrines and characterisation of dried faecal material. Master thesis. University of KwaZulu-Natal, Durban, South Africa.	

Data source files

Wet basis
https://www.dropbox.com/s/9ohytucjwpa8ppb/Convective%20drying%20of%20VIP%20thin%20layer%20%28wb%29_2014-2015.xlsx?dl=0

Dry basis
https://www.dropbox.com/s/vzlykg6aah163eu/Convective%20drying%20of%20VIP%20thin%20layer%20%28db%29_2014-2015.xlsx?dl=0

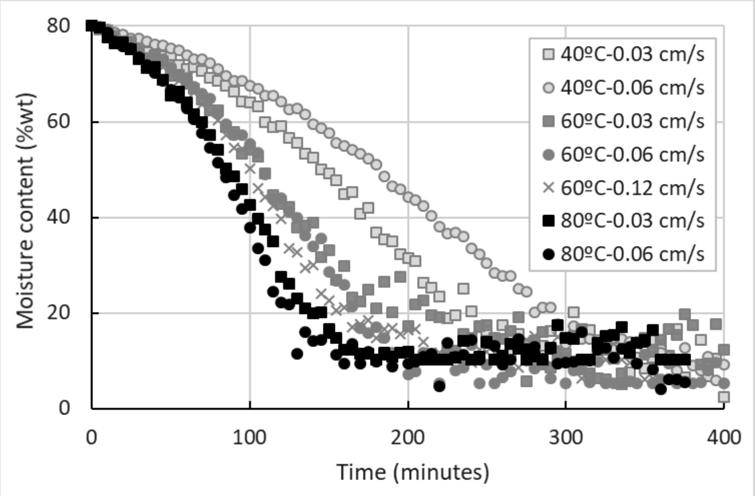
Additional Notes

-

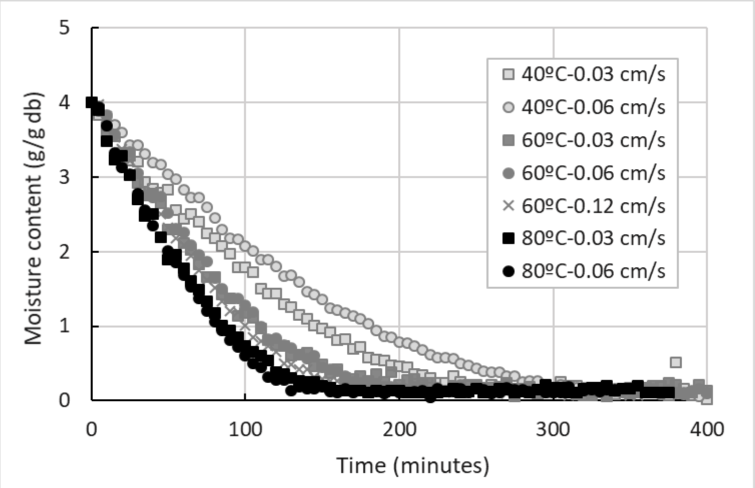
Description of Data

Moisture content as a function of temperature and air velocity

Wet basis



Dry basis



Observations

- Drying time varying between 150 and 300 min
- Faster drying at increasing drying temperature
- Slight faster drying at increasing air velocity

<table>
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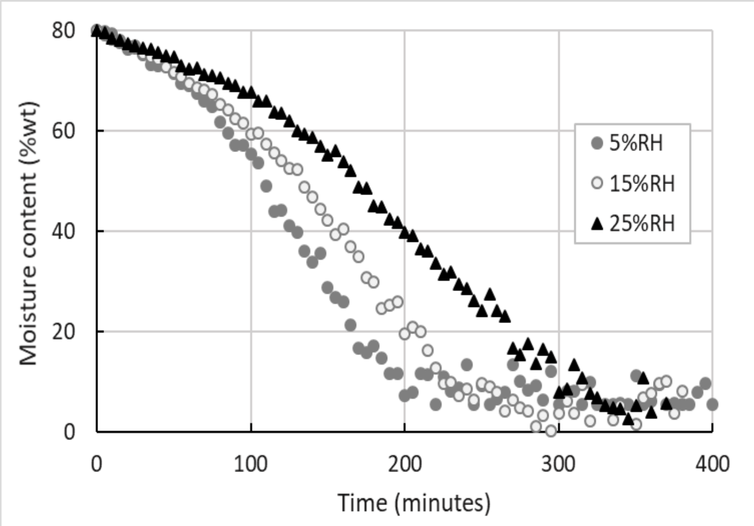
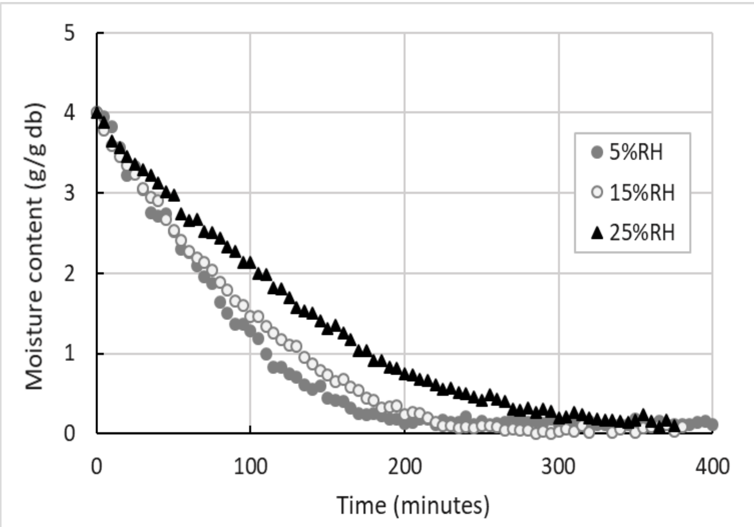
<td>

<u>Moisture content versus time as a function of relative humidity</u>

Wet basis



Dry basis



</td>
<td>

<u>Observations</u>

- Drying time varying between 200 and 300 min
- Faster drying at decreasing relative humidity

</td>
</tr>
</table>

General information	
Type of data	Kinetics of convective drying
Place of experimentation	Duke University, Center for WaSH-AID, Durham, MC
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durham, NC
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~20%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Aging (sample placed in container with urine and flush water for 4, 18, 24 and 48 h)
Experimental Procedure	
Drying experimental setup	Custom-design convective drying rig
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Air temperature: 40, 60 and 80°C ○ Air humidity: 5% ○ Air velocity: 0.03 cm/s
Sample form in the dryer	10 - 50 g of 9 mm thick sample in a 100 mm diameter petri dish
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

Data source files

https://www.dropbox.com/s/rzksa0gr6n5beez/Human%20Faeces%20convective%20drying%20kinetics%20and%20effects%20of%20conditioning%20data_Duke%20University%20%282018-2019%29%20.xlsx?dl=0

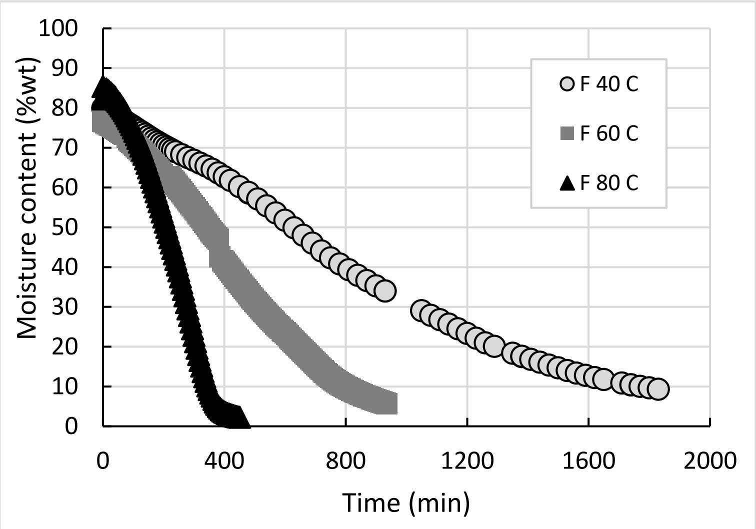
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations

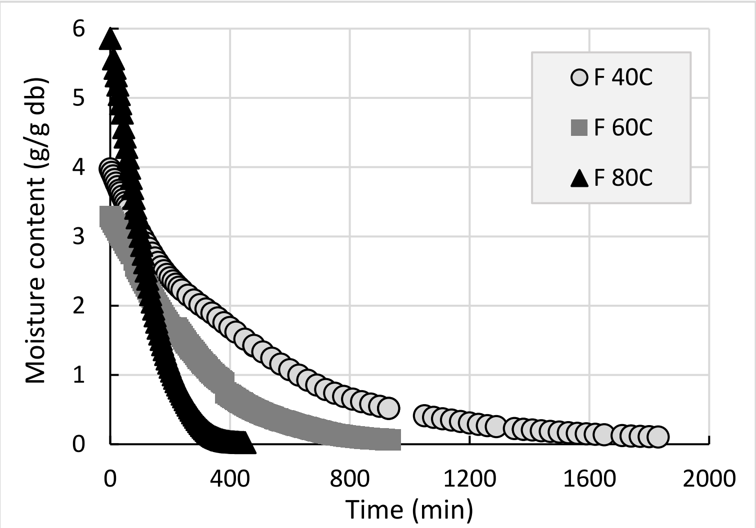
Description of Data

Moisture content as a function of temperature (samples without aging)

Wet basis



Dry basis

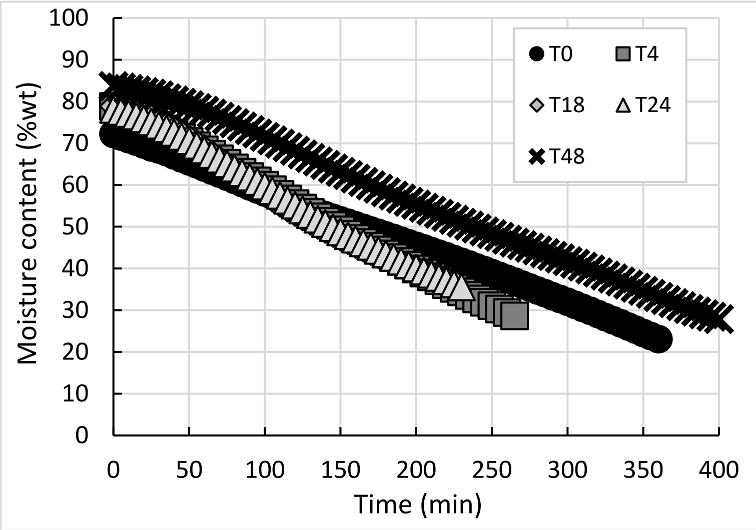


Observations

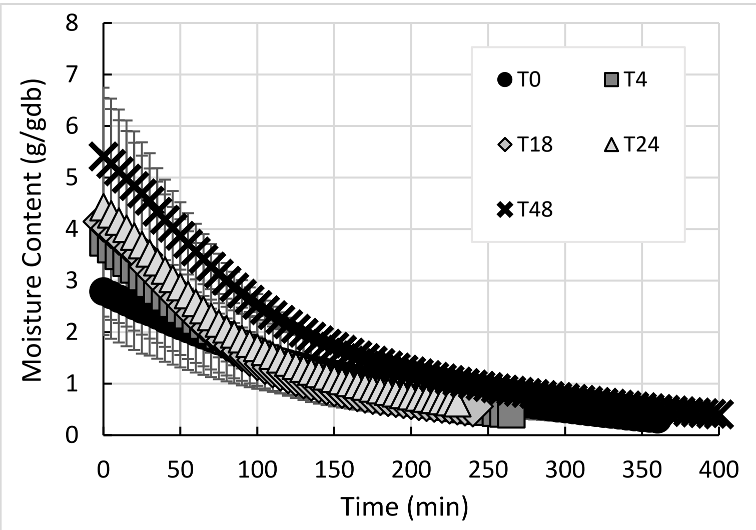
- Faster drying at increasing drying temperature

<u>Moisture content versus time as a function of aging time</u>

Wet basis



Dry basis



<u>Observations</u>

- Increase of the sample moisture content and drying rate with aging

General information	
Type of data	Kinetics of convective drying
Place of experimentation	RTI International, Research Triangle Park, North Carolina (USA)
Dates of the experiments	2016 - 2017
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	North Carolina, USA
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	N/A
Ash content	N/A
Presence of trash?	No
Pre-treatment	None
Experimental Procedure	
Drying experimental setup	Convection toaster oven
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Air temperature: 105, 120 and 150°C ○ Relative humidity: ambient ○ Air velocity: none
Sample form in the dryer	9 mm thick sample in a 100 m diameter petri dish
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
Hawkins BT, Sellgren KL, Cellini E, Klem EJD, Rogers T, Lynch B. Piascik JR, Stoner BR. Remediation of suspended solids and turbidity by improved settling tank design in a small-scale, free-standing toilet system using recycled blackwater. Water and Environment Journal, 2018.	

Sellgren KL, Gregory CW, Hunt MI, Raut AS, Hawkins BT, Parker CB, Klem EJD, Piascik JR, Stoner BR. Development of an electrochemical process for blackwater disinfection in a free-standing, additive-free toilet, RTI Press, 2017

Data source files

https://www.dropbox.com/s/tgg4sehv3xjlfhq/RTI%20International%20data_fresh%20faeces%20convective%20drying%20kinetics%20and%20shrinkage%20%282016-2017%29.xlsx?dl=0

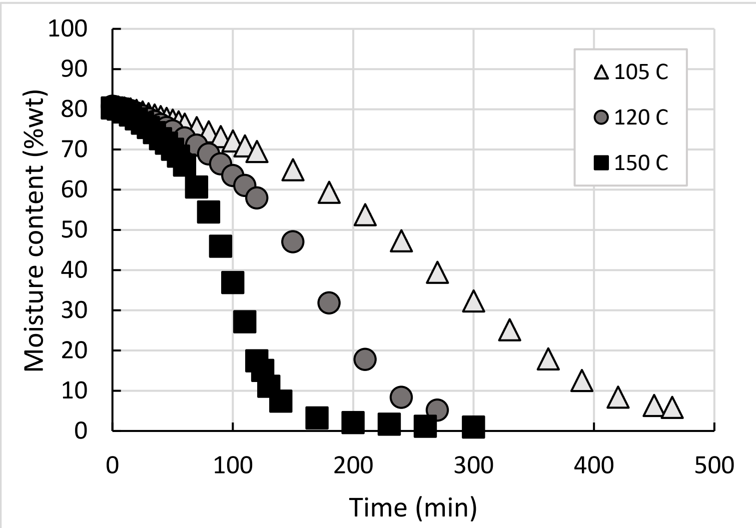
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations

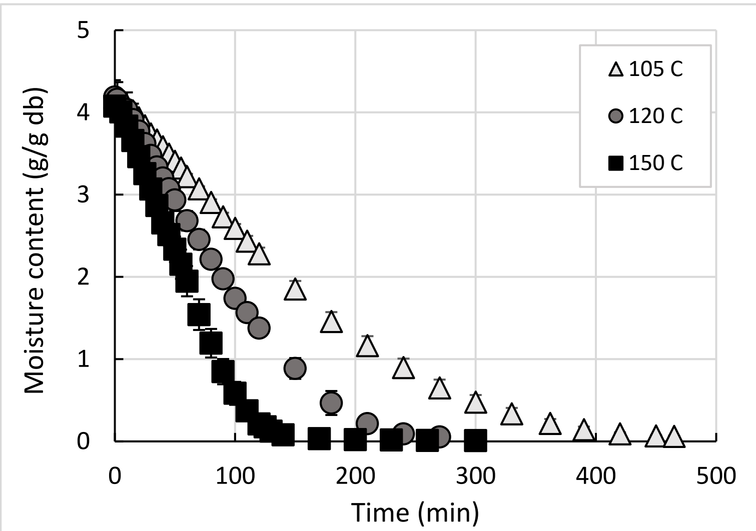
Description of Data

Moisture content as a function of temperature

Wet basis



Dry basis



Observations

- Faster drying at increasing drying temperature
- Crust formed on surface of fecal material at all temperatures

General information	
Type of data	Kinetics of infrared drying
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 70% db
Ash content	~ 30% db
Presence of trash?	Yes
Pre-treatment	o Screening to remove the large pieces of trash o Addition of 3%wt of sawdust for pellets formation
Experimental Procedure	
Drying experimental setup	Laboratory-scale medium infrared (MIR) dryer ('LaDePa')
Drying time	0, 4, 9, 13, 17, 25, 40 min
Operating conditions	o MIR emitters power: 3.0, 3.3, 3.5, 5.0 and 6.5 kW o Distance between the emitters and the sample: 50, 80 and 115 mm o Air stream flowrate: 11.1 and 18.3 m^3/min o Air humidity: ambient (70-80%)
Sample form in the dryer	Pellets of 8, 10, 12 and 14 mm diameter
Analysed parameters	Moisture Content
Employed methods	Weighing the sample before and after oven drying at 105°C for 24 h (SOP 8.7.1.1)

Publications

Mirara, S.W. (2017). Drying and Pasteurisation of VIP Latrine Faecal Sludge using a Bench Scale Medium Infrared Machine. Master thesis. University of KwaZulu-Natal, Durban, South Africa.
Septien, S., Singh, A., Mirara, S. W., Teba, L., Velkushanova, K., & Buckley, C. A. (2018). 'LaDePa'process for the drying and pasteurization of faecal sludge from VIP latrines using infrared radiation. South African journal of chemical engineering, 25, 147-158.

Septien, S., Mirara, S., Singh, A., Velkushanova, K., & Buckley, C. (2018). Characterisation of On-Site Sanitation Material and Products: VIP Latrines and Pour-Flush Toilets. WRC project final report. South Africa.

Data source files

https://www.dropbox.com/s/e6i0axdeejiacq3/Infrared%20drying%20of%20VIP%20pellets_2014-2015.xlsx?dl=0

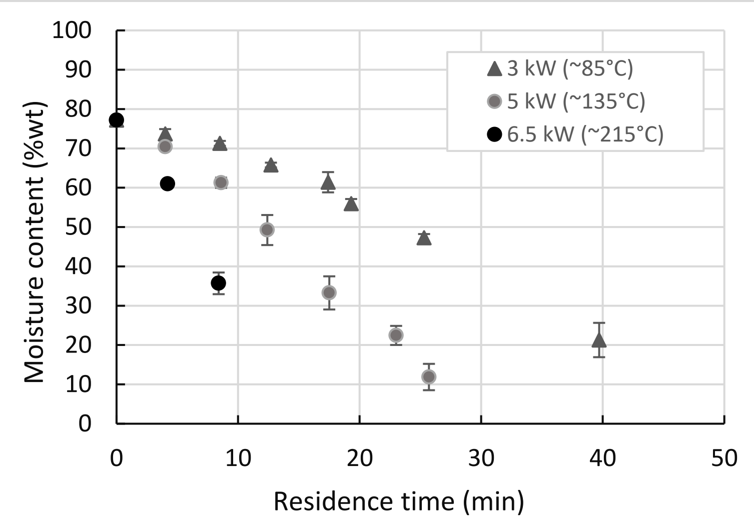
Additional Notes

- Some experiments using faecal sludge without sawdust addition and pre-dried sludge to approximately 70%wt moisture content

Description of Data

Moisture content versus residence time as a function of the MIR emitter power

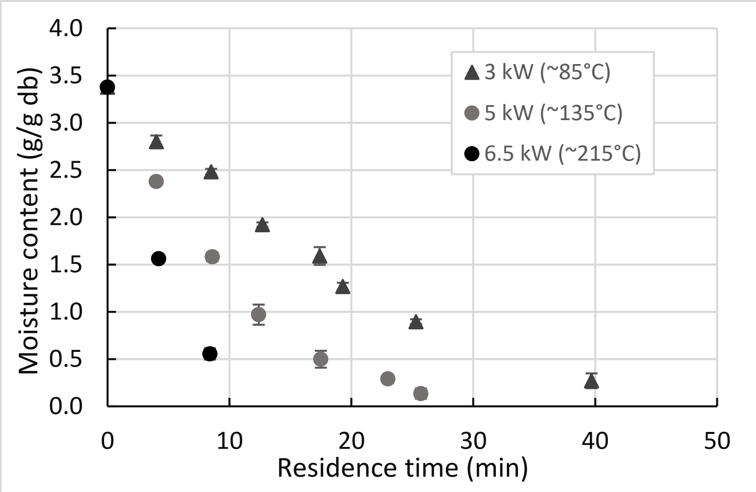
Wet basis



Observations:

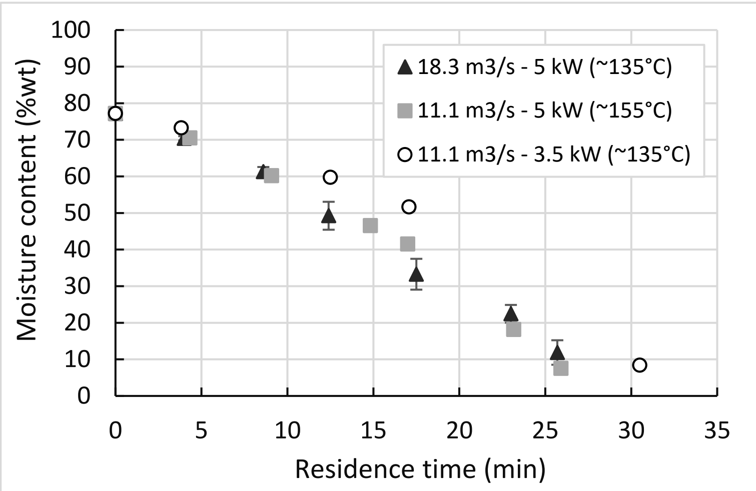
- Faster drying at higher MIR power

Dry basis

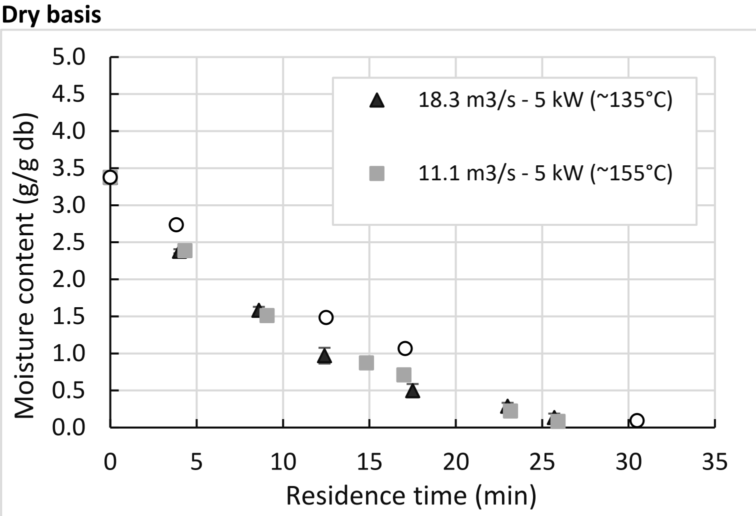


Moisture content versus residence time as a function of the MIR emitter power and air flowrate

Wet Basis



Dry basis

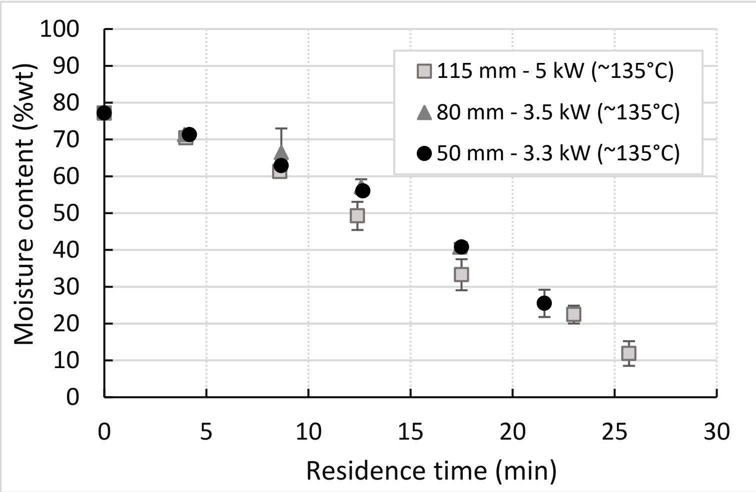


Observations:

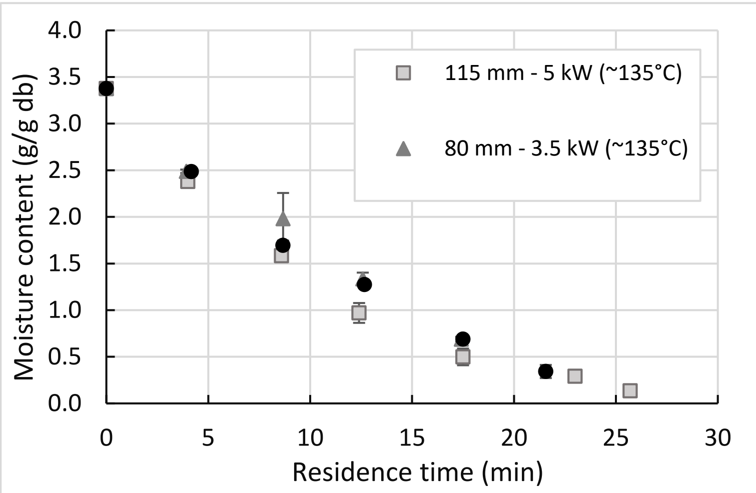
- Decrease of drying temperature by increasing the air flowrate (cooling effect)
- At fixed temperature, faster drying by increasing the air flowrate (but need to increase MIR power to compensate cooling effect)

Moisture content (wet and dry basis) versus residence time as a function of the MIR emitter power and height

Wet Basis



Dry Basis

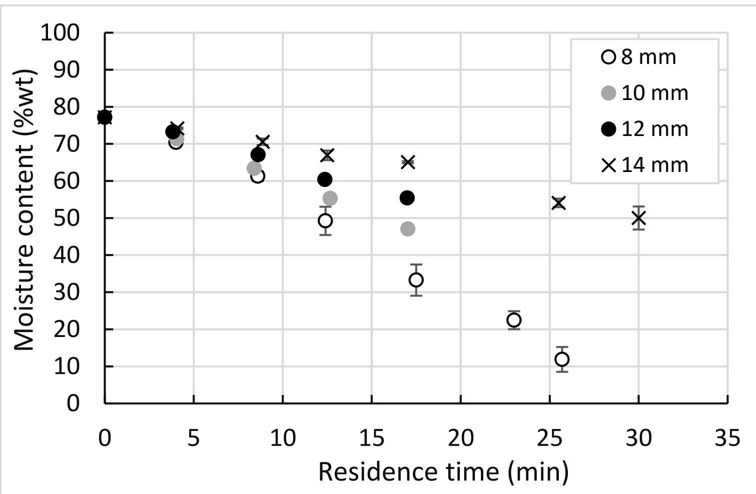


Observations:

- To maintain fixed temperature, need to increase the MIR power if the height of the emitter augmented
- At fixed temperature, same drying rate regardless the MIR emitter power and height

Moisture content versus residence time as a function of the pellet diameter

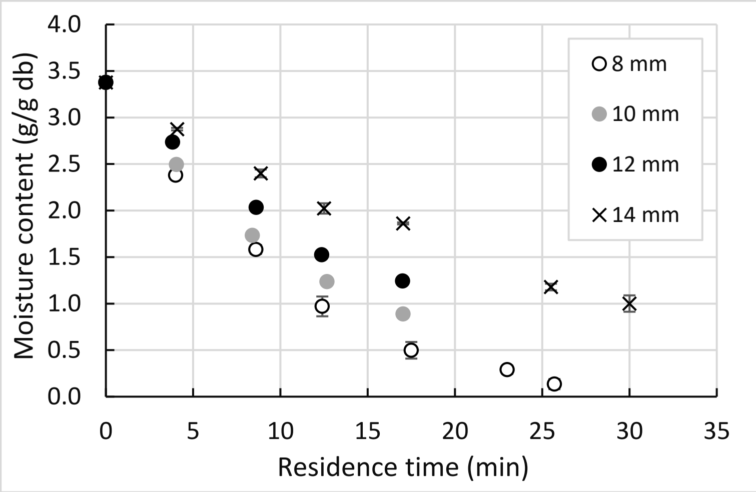
Wet Basis



Observations:

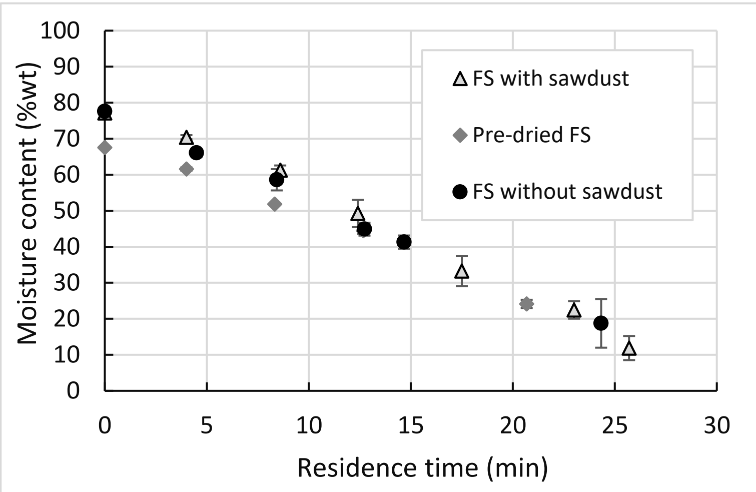
- Faster drying at lower pellet diameter

Dry Basis

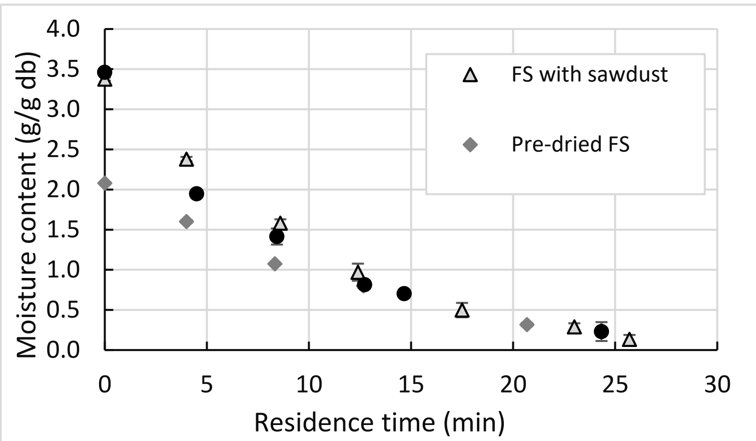


Moisture content versus residence time for the raw sludge, mixed with sawdust and pre-dried

Wet Basis



Dry Basis



Observations:

- No effect of the sludge pre-treatment on the drying rate

General information	
Type of data	Kinetics of solar thermal drying
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019-2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilet (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Custom-design solar thermal drying rig
Drying time	5 hours
Operating conditions	○ Irradiance: ~ 1000 W/m^2 (sunny conditions) ○ Air flowrate: 0.5 m^3/min (corresponding to an air velocity of 0.5 m/s) ○ Air temperature: ambient (~20°C), 40 and 80°C ○ Air humidity: ~10%
Sample form	~ 90 g of sample as a thin layer of 5 mm thickness and 110 mm diameter
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)

Publications
-

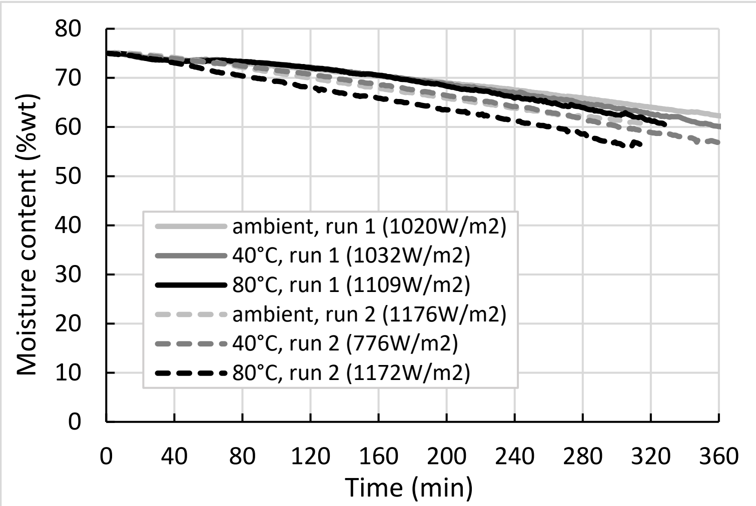
Data source files
https://www.dropbox.com/s/hmthsylq3z6hq1e/2019-2020%20UD%20sludge%20solar%20drying%20at%20different%20temps.xlsx?dl=0

Additional Notes
○ The measured average irradiance included in the results below for each experiment

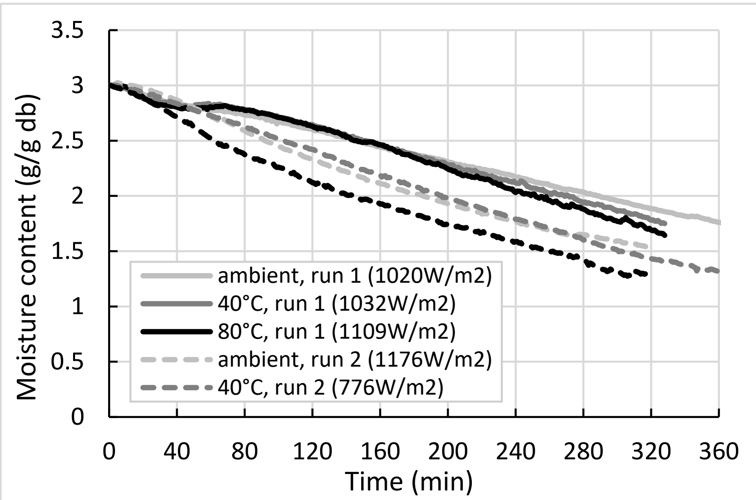
Description of Data

Moisture content versus time as a function of the air temperature

Wet basis



Dry basis



Observations:

- Similar drying rate between the different air temperatures

General information	
Type of data	Kinetics of solar thermal drying
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2017 - 2018
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Custom-design solar thermal drying rig
Drying time	3 to 5 hours
Operating conditions	o Irradiance: from 75 to 1000 W/m^2 (from overcast to sunny conditions) o Air flowrate: 0.5 m^3/min (corresponding to an air velocity of 0.5 m/s) o Air temperature: ambient (~20°C) o Air humidity: ~10%
Sample form in the dryer	Thin layer of 5 and 10 mm thickness and 60 mm diameter
Analysed parameters	Moisture content
Employed methods	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)

Publications

Septien, S., Mugauri, T.R., Singh, A., & Inambao, F. (2019). Drying of Faecal Sludge using Solar Thermal Energy. WRC project final report.

Mugauri, T.R. (2019). Drying of Faecal Sludge from Ventilated-Improved Pit Latrines (VIP Latrines) using Solar Thermal Energy. Master thesis. University of KwaZulu-Natal, Durban, South Africa.

Septien, S., Mugauri, T.R., Singh, A., & Inambao, F. (2018). Solar drying of faecal sludge from pit latrines in a bench-scale device. 41st WEDC conference proceedings, Nakuru, Kenya.

Septien, S., Mugauri, T.R., Singh, A., & Inambao, F. (2018). Solar Drying of Faecal Sludge from On-Site Sanitation Facilities. 5th Southern Africa Solar Energy Conference proceedings, Durban, South Africa.

Data source files

https://www.dropbox.com/s/n2qp26y3zilt1ev/Solar%20thermal%20drying%20of%20VIP_2017-2018.xlsx?dl=0

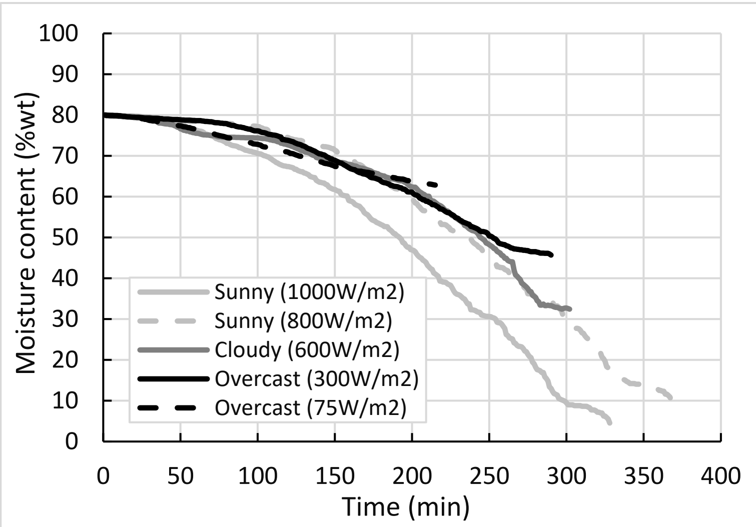
Additional Notes

- Control experiment: sample placed at the open-air
- The measured average irradiance included in the results below for each experiment

Description of Data

Moisture content versus time as a function of the weather conditions

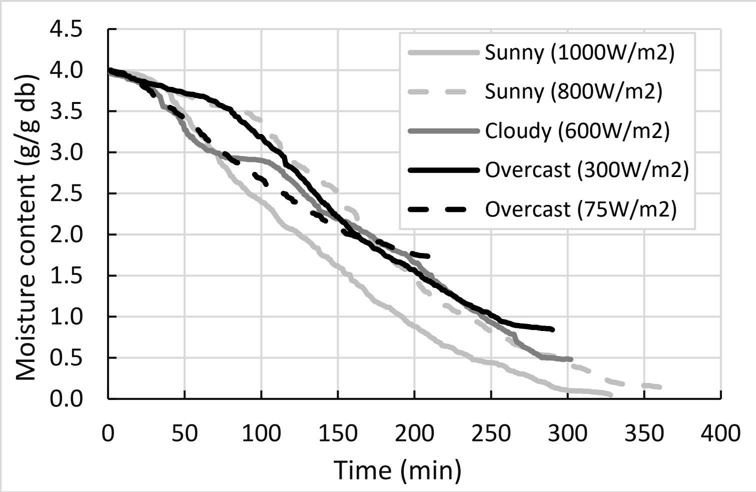
Wet Basis



Observations

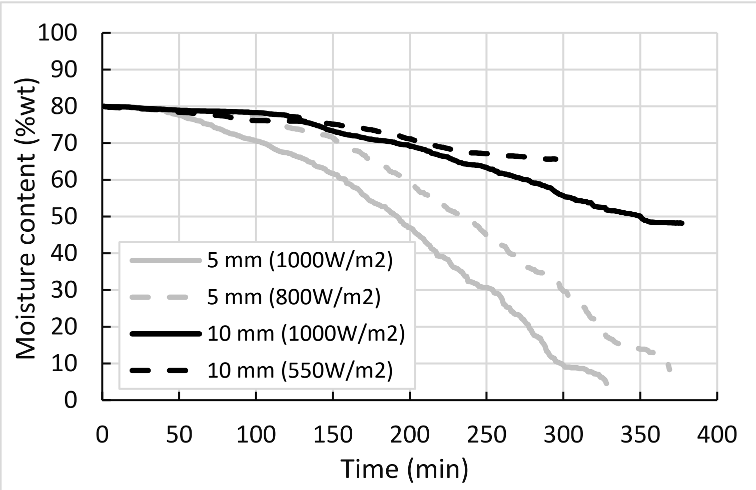
- Faster drying at sunny conditions (1000 W/m^2)

Dry Basis

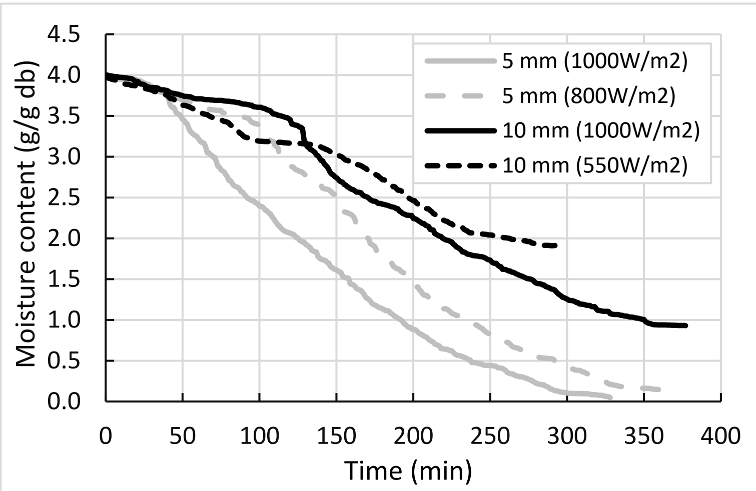


Moisture content versus time as a function of thickness of the thin layer

Wet Basis



Dry Basis

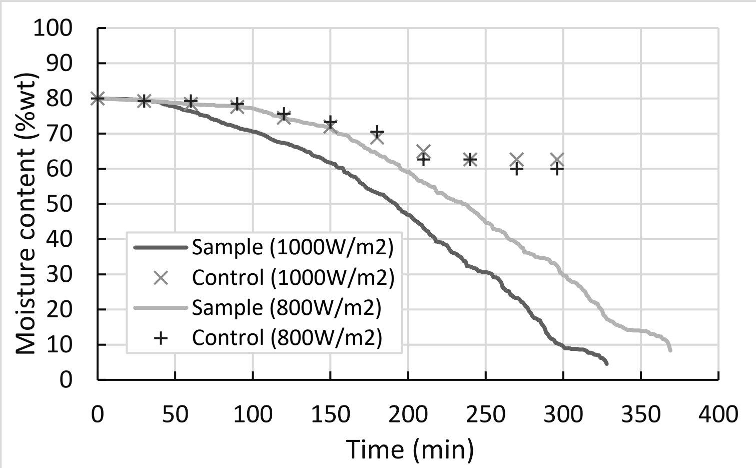


Observations

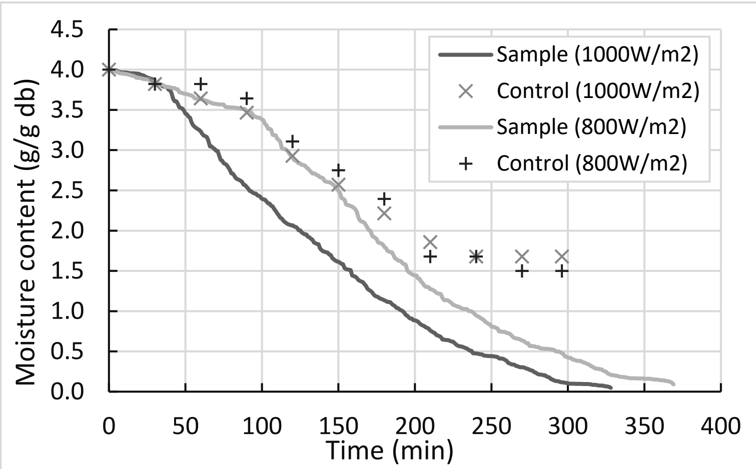
- Faster drying of the sludge thin layer of 5 mm

Moisture content versus time inside the solar drier and the control (sample placed at the open air) during sunny conditions

Wet Basis



Dry Basis

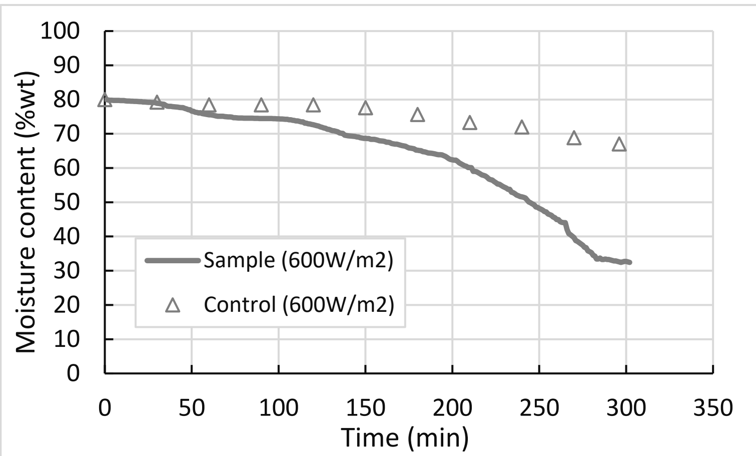


Observations

- Faster drying of the sample inside the solar dryer

Moisture content versus time inside the solar drier and the control (sample placed at the open air) during cloudy conditions

Wet Basis



Observations

- Faster drying of the sample inside the solar dryer

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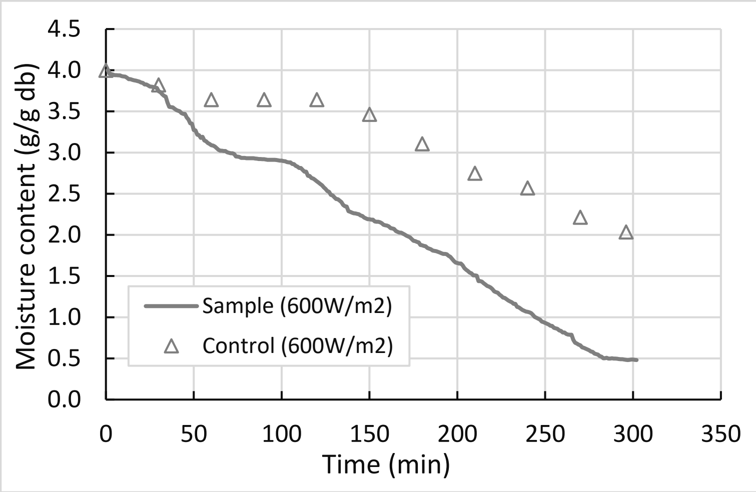
Dry Basis



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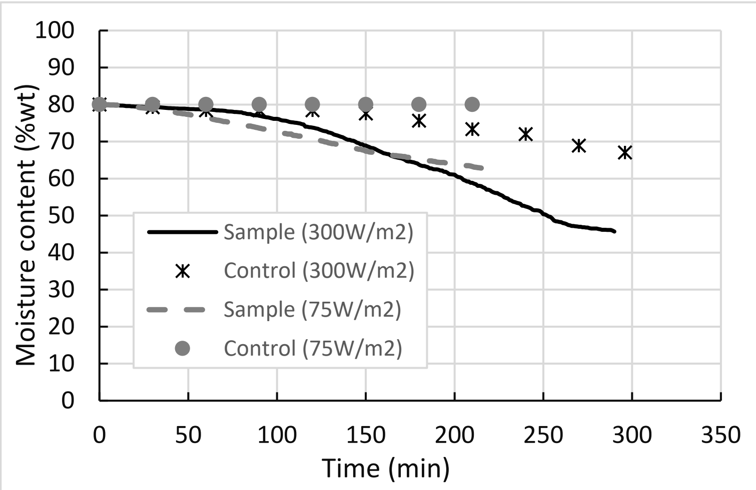
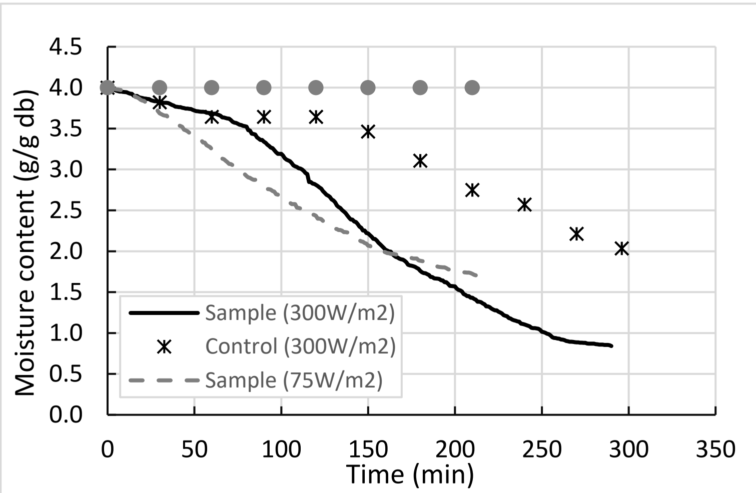
<u>Moisture content versus time inside the solar drier and the control (sample placed at the open air) during overcast conditions</u>

Wet Basis



Dry Basis



</td><td>

<u>Observations</u>

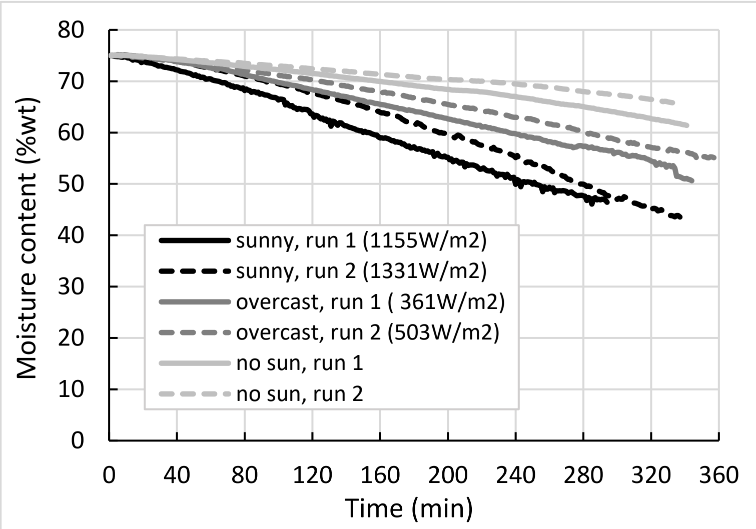
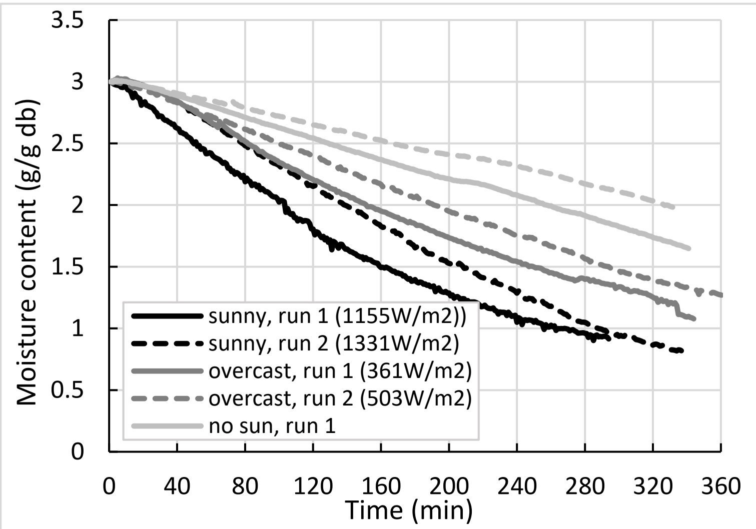
- Faster drying of the sample inside the solar dryer

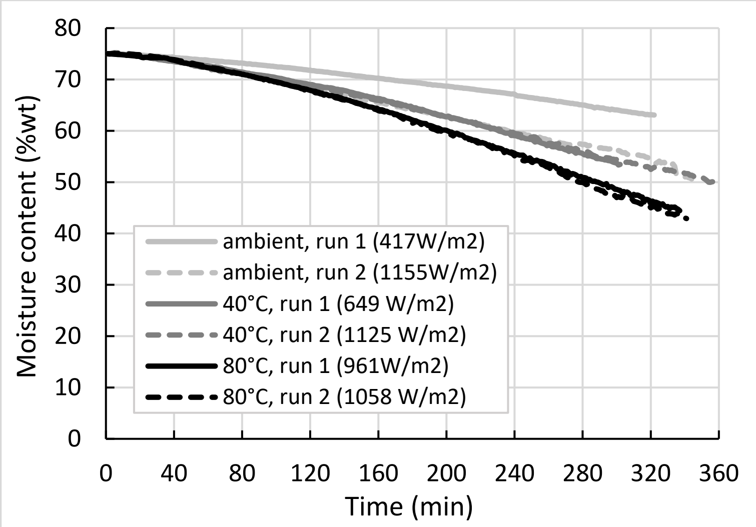
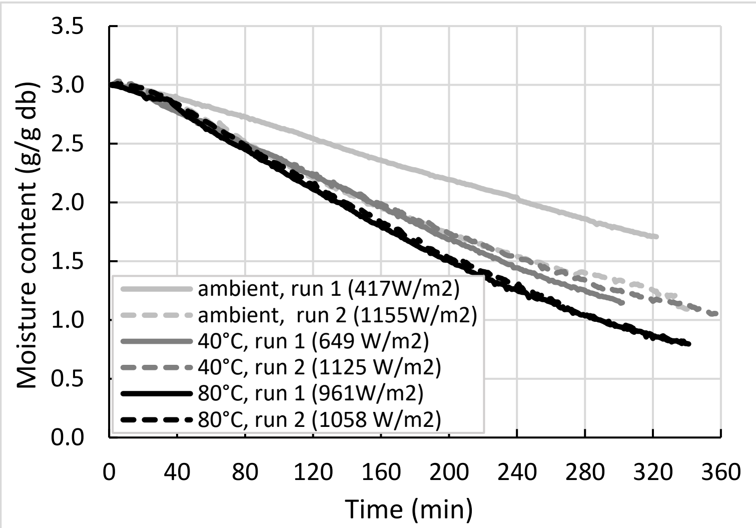
</td></tr>
</table>

General information	
Type of data	Kinetics of solar thermal drying
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Custom-design solar thermal drying rig
Drying time	5 hours
Operating conditions	o Irradiance: 300 – 1300 W/m^2 (from overcast to sunny conditions) o Air flowrate: 0.5 and 1 m^3/min (corresponding to an air velocity of 0.5 and 1 m/s) o Air temperature: ambient (~20°C), 40 and 80°C o Air humidity: ~10%
Sample form	~ 90 and 170 g of sample as a thin layer of 5 and 10 mm thickness respectively, and 110 mm diameter
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)

Publications
-
Data source files
Sunny and overcast weather conditions https://www.dropbox.com/s/z5hfymnuljctwsc/2019-2020%20VIP%20solar%20drying%20based%20on%20weather%20conditions.xlsx?dl=0 **Different temperatures at air velocity of 0.5 m/s** https://www.dropbox.com/s/7qksuoct2p05q3k/2019-2020%20Solar%20drying%20of%20VIP%205mm%20at%200.5m%20per%20sec%20.xlsx?dl=0 **Different temperatures at air velocity of 1.0 m/s** https://www.dropbox.com/s/kvpjzpjojb8zml5/2019-2020%20Solar%20drying%20of%20VIP%205mm%20at%201m%20per%20sec.xlsx?dl=0 **Ambient temperature and varying air velocities** https://www.dropbox.com/s/ngrboytch6am0p8/2019-2020%20VIP%20solar%20drying%20at%20varied%20air%20velocities%20%28ambient%20temp%29_UKZN.xlsx?dl=0 **Open drying** https://www.dropbox.com/s/reqvrb7s4ik4ofg/2019-2020%20VIP%20Open%20drying%20tests.xlsx?dl=0
Additional Notes
○ Control experiments: (1) sample placed at the open-air and (2) drying chamber covered by an opaque sheet to block the solar radiation to penetrate within it ○ The measured average irradiance included in the results below for each experiment

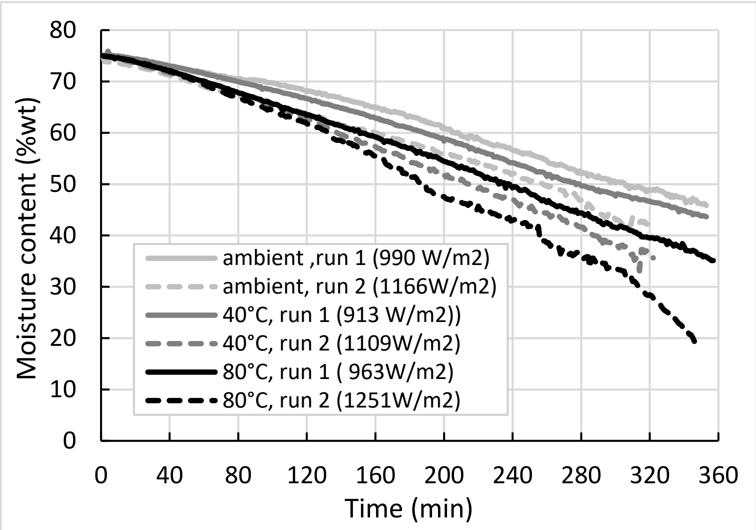
Description of Data

Moisture content versus time as a function of the weather conditions and comparison with control (2) (sample not exposed to the solar radiation)	Observations:
Wet basis  **Dry basis** 	○ Faster drying during sunny condition than overcast conditions ○ Slowest drying without irradiance (control (2)) ○ Faster drying at higher irradiance

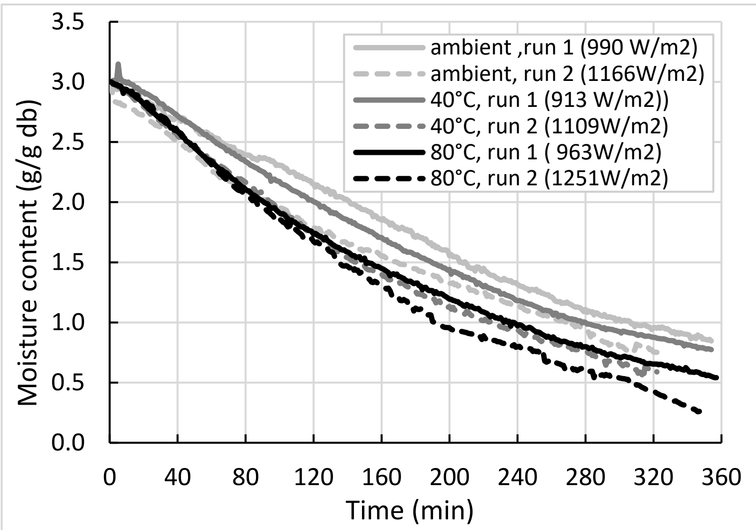
Moisture content versus time as a function of the air temperature at an air velocity of 0.5 m/s	Observations:
Wet basis  **Dry basis** 	○ Faster drying at 80°C ○ No significant difference between ambient temperature and 40°C

Moisture content versus time as a function of the air temperature at an air velocity of 1 m/s

Wet basis



Dry basis

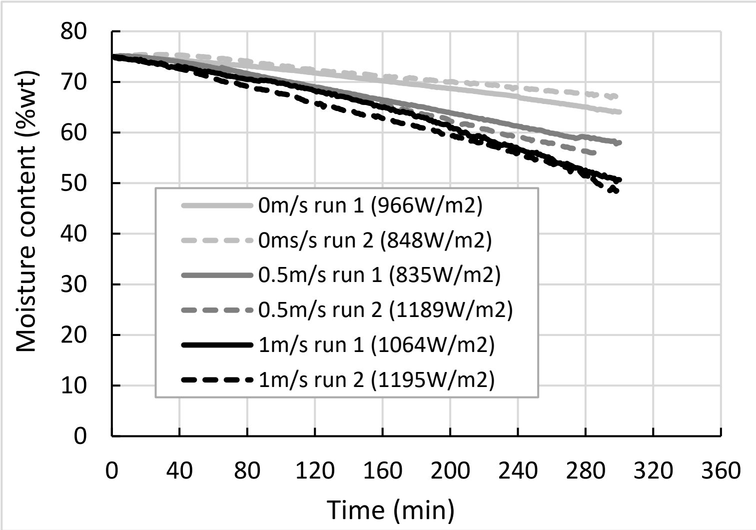


Observations:

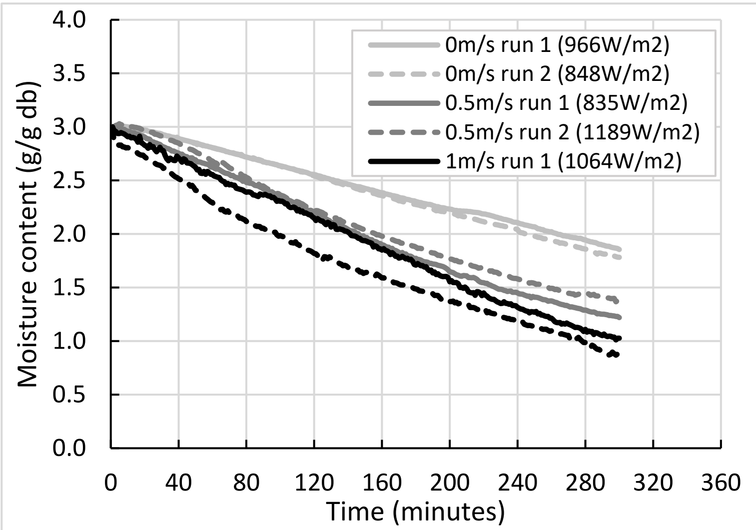
- Faster drying at 80°C than at ambient conditions, with 40°C as intermediate

Moisture content versus time as a function of the air velocity

Wet basis



Dry basis

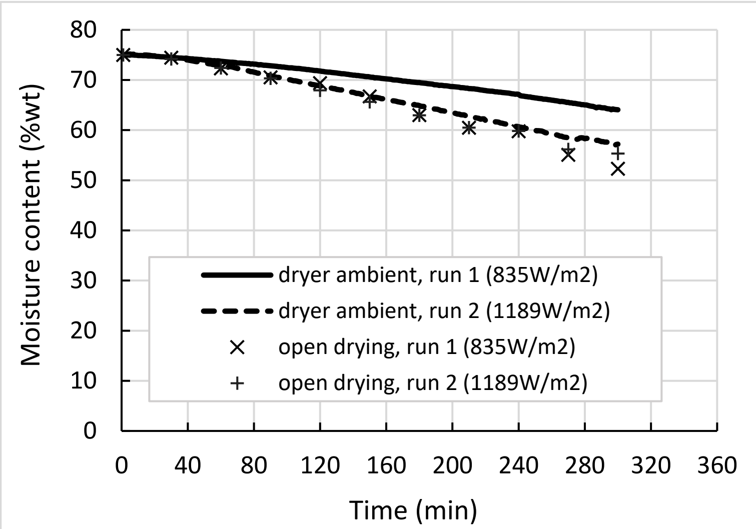


Observations:

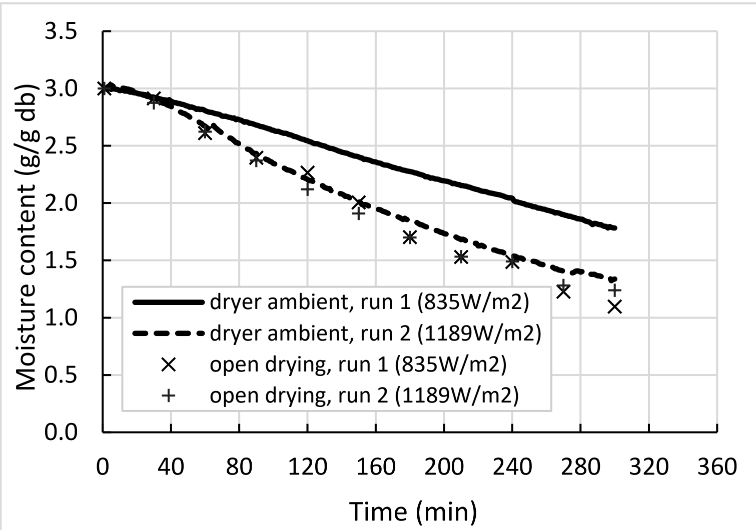
- Faster drying by increasing the air velocity (i.e. by increasing the air flowrate)

Moisture content versus time inside the solar drier and the control (sample placed at the open air) during sunny conditions

Wet basis



Dry basis

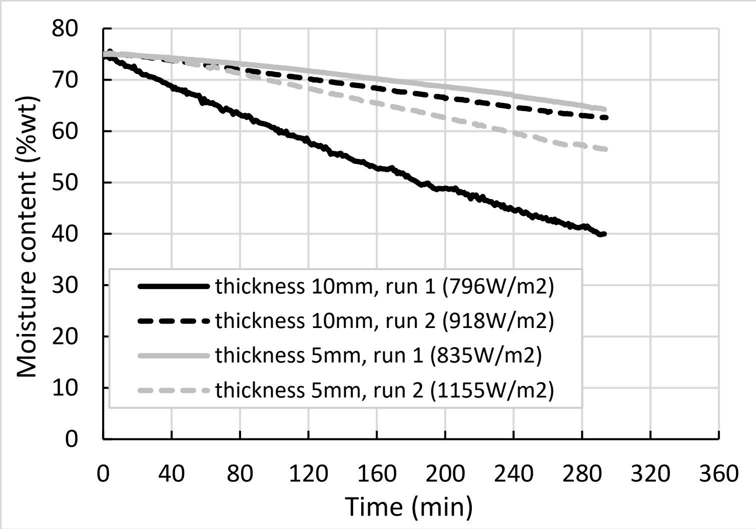


Observations:

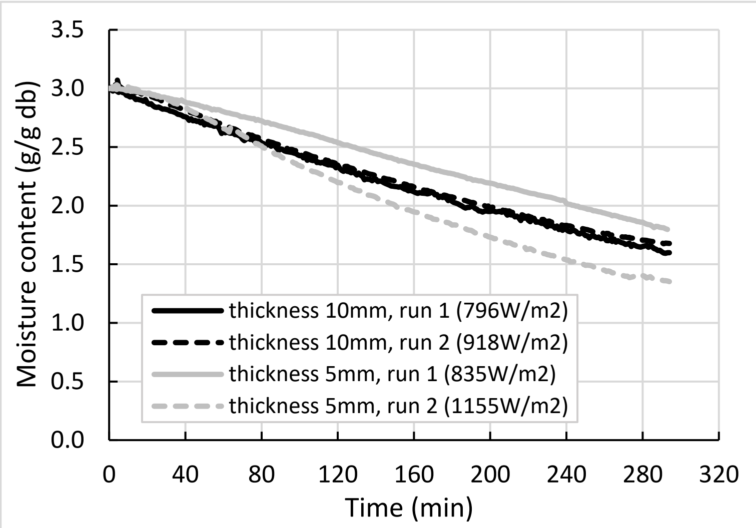
- Similar drying rate between the sample inside the drying chamber and the sample placed at the open air (control (1)) during the experiment with an average irradiance of 1189 W/m^2
- Faster drying for the open-air sample compared to the sample inside the drying chamber during the experiment with an average irradiance of 835 W/m^2 (probably due to the windy conditions on that day)

Moisture content versus time as a function of the sample thickness

Wet basis



Dry basis



Observations:

- No effect of the sludge thickness on the drying rate

General information	
Type of data	Isothermal kinetics in a thermogravimetric analyser
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Thermogravimetry - differential thermal analyser *SHIMADU DTG-60A*
Drying time	Until stabilisation of the sample mass
Operating conditions	o Temperature: 50, 100, 150 and 200°C o Heating rate: 50°C/min o Air flowrate: 50 mL/min
Sample form in the dryer	~ 70 mg sample on aluminium crucible of 6 mm diameter and 5 mm height
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)
Publications	
-	

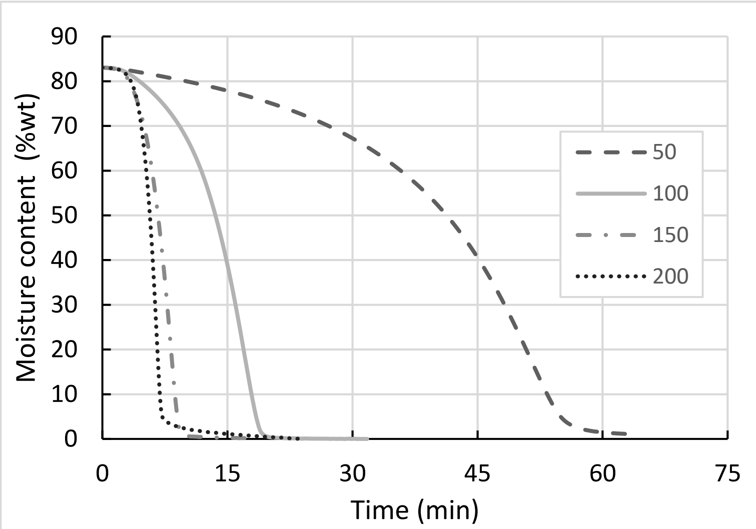
Data source files
https://www.dropbox.com/s/otzyeo7ze8rex9f/2018-2019%20ABR%20Isothermal%20Test_PRG.xlsx?dl=0

Additional Notes
-

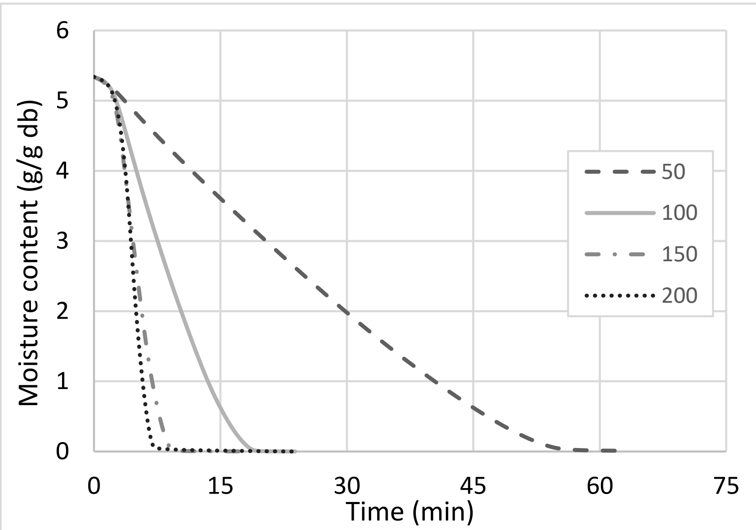
Description of Data

Moisture content versus time as a function of temperature

Wet basis



Dry basis



Observations:

- Faster drying by increasing temperature
- Strong influence of temperature on the drying rate below 150°C
- Weak effect of temperature above 150°C

General information	
Type of data	Isothermal kinetics in a thermogravimetry analyser
Place of experimentation	Bioenergy Lab, Cranfield Energy & Power, Cranfield University (United Kingdom)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 85%wt
Total solids content	~ 15%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser *PerkinElmer TGA 8000™*
Drying time	Until mass stabilisation
Operating conditions	○ Temperature: 55, 85, 105, 155 and 205°C ○ Heating rate: 10 and 100°C/min ○ Flow rate: 4 mL/min
Sample in the drier	~ 40 mg sample on a 3 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
Somorin T, Getahun S, Septien S et al. Isothermal drying characteristics and kinetics of human faecal sludges [version 1; peer review: awaiting peer review]. Gates Open Res 2020, 4:67	

Data source files

https://www.dropbox.com/s/6kwot2hnlj2c2o1/Cranfield%20University_ABR%20sludge%20TGA%20Isothermal%20kinetics%20%282018-2019%29.xlsx?dl=0

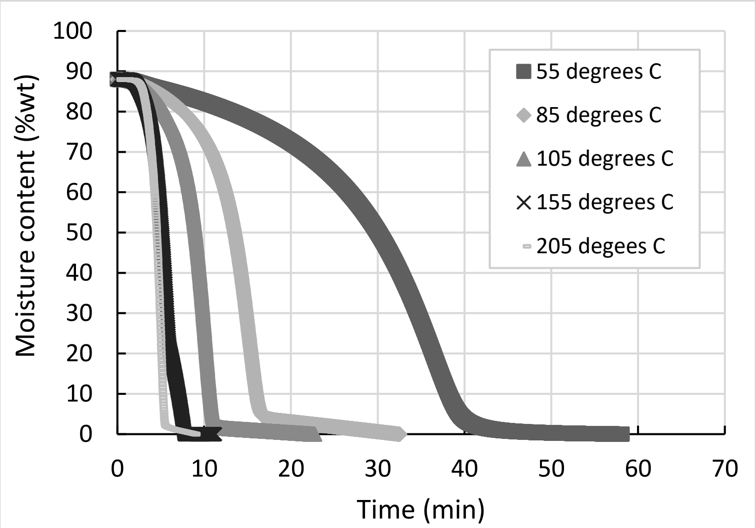
Additional Notes

- Faecal sludge couriered from South Africa

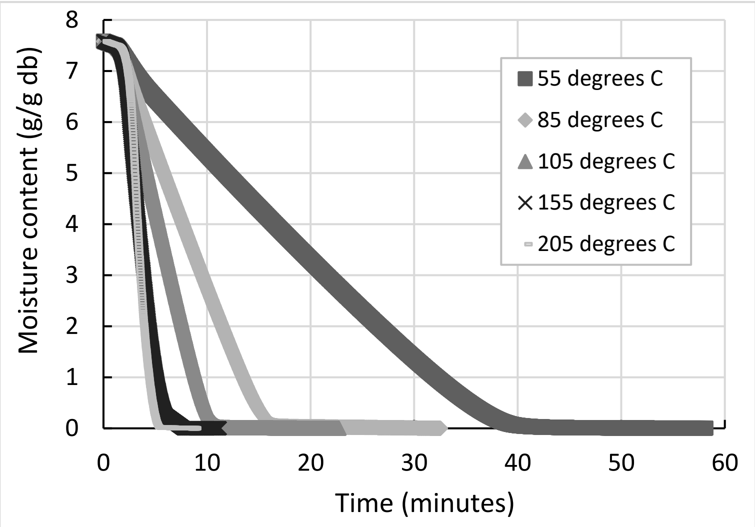
Description of Data

Moisture content versus time as a function of temperature at a heating rate of 100°C/min

Wet basis

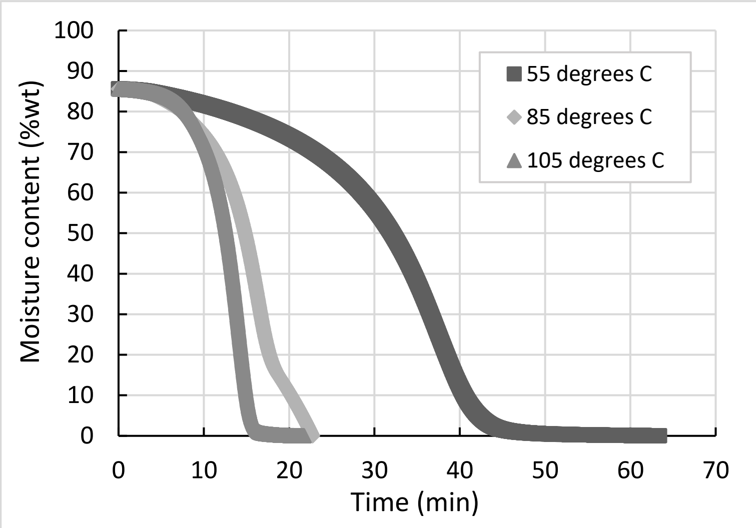
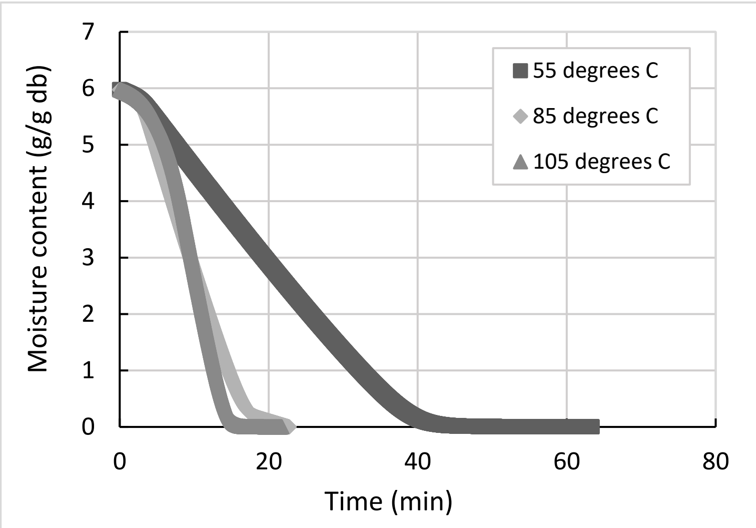


Dry basis



Observations:

- Faster drying by increasing temperature
- Considerable influence of temperature on the drying rate below 155°C
- Weak effect of temperature above 155°C

Moisture content versus time as a function of temperature at a heating rate of 10°C/min	Observations:
Wet basis 	○ Faster drying by increasing temperature
Dry basis 	

General information	
Type of data	Isothermal kinetics in a thermogravimetric analyser
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 85%wt
Total solids content	~ 15%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Drying time	~ 40 - 80 min
Operating conditions	○ Set temperature: 55, 85, 105, 155 and 205°C ○ Heating rate: 10°C/min ○ Carrier gas: nitrogen ○ Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

Data source files

Wet basis
https://www.dropbox.com/s/r2jsoyod36pte3a/Swansea%20University_Sludge%20TGA%20Isothermal%20kinetics_wet%20basis%20%282018-2020%29.xlsx?dl=0

Dry basis
https://www.dropbox.com/s/w1zkkuuu7z21hyj/Swansea%20University_Sludge%20TGA%20Isothermal%20Kinetics_dry%20basis%20%282018-2020%29.xlsx?dl=0
https://www.dropbox.com/s/w1zkkuuu7z21hyj/Swansea%20University_Sludge%20TGA%20Isothermal%20Kinetics_dry%20basis%20%282018-2020%29.xlsx?dl=0

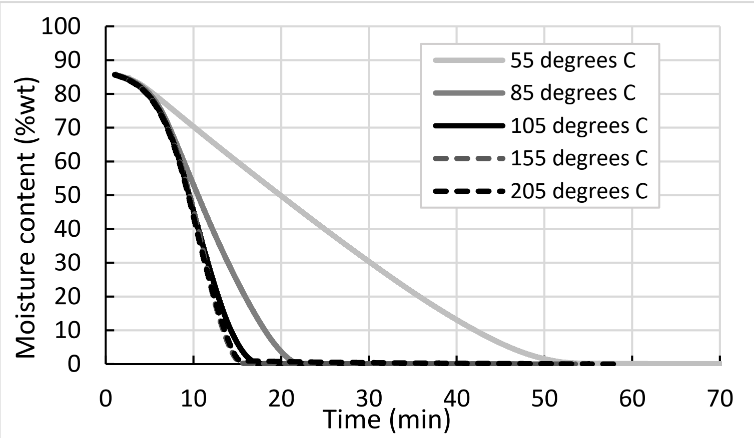
Additional Notes

- Samples couriered from South Africa
- Considerable drying of the sample before reaching the set temperature at 105, 155 and 205°C

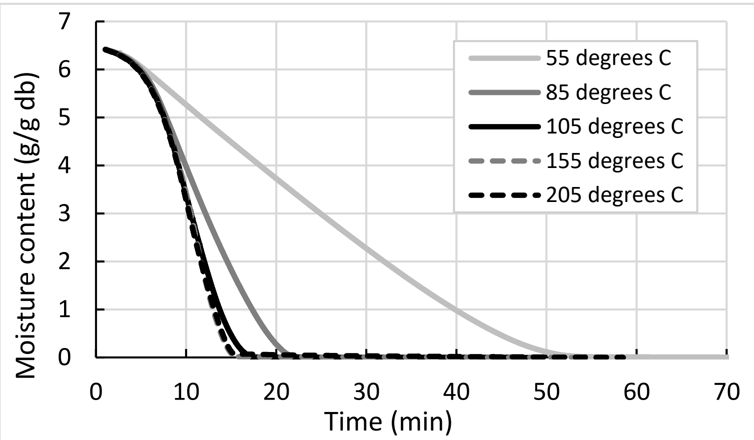
Description of Data

Moisture content versus time as a function of temperature

Wet basis



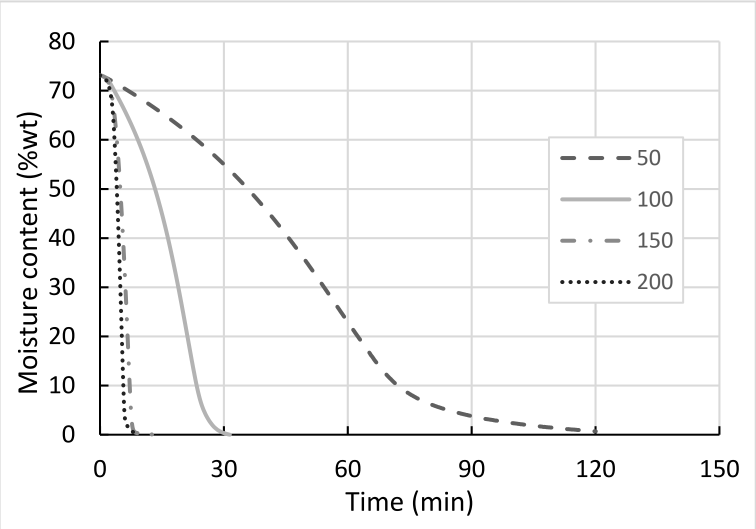
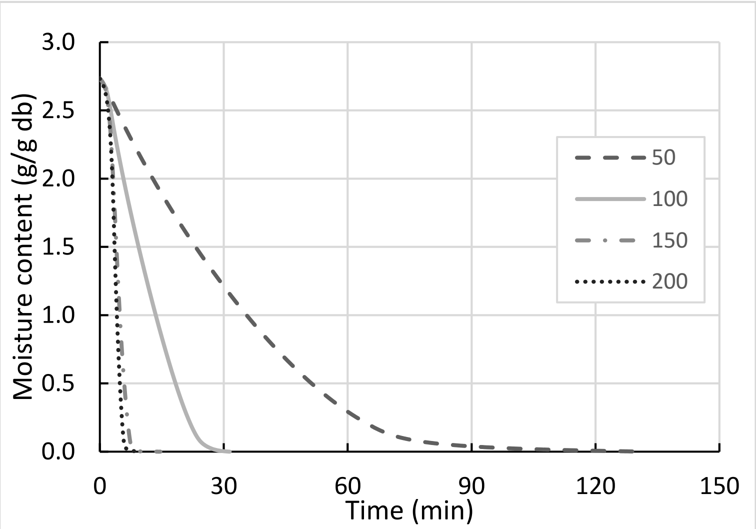
Dry basis



Observations

- Faster drying by increasing the temperature from 55 to 105°C
- Drying achieved before 20 minutes at temperatures above 85°C
- Same drying rate between 155 and 205°C (probably because major part of the drying occurred during the heating stage before reaching the final temperature)

General information	
Type of data	Isothermal kinetics in a thermogravimetric analyser
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Thermogravimetry - differential thermal analyser *SHIMADU DTG-60A*
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Temperature: 50, 100, 150 and 200°C ○ Heating rate: 50°C/min ○ Air flowrate: 50 mL/min
Sample form in the dryer	~ 70 mg sample on aluminium crucible of 6 mm diameter and 5 mm height
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)
Publications	

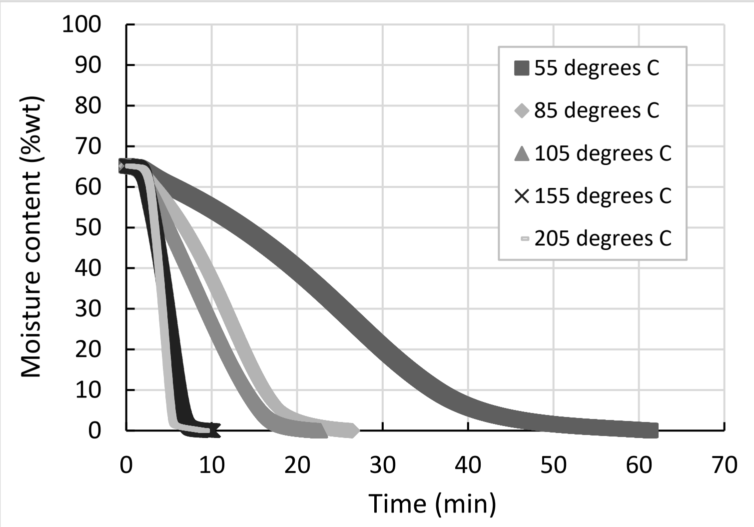
Data source files	
https://www.dropbox.com/s/2k2bhqr8kqjcaws/2018-2019%20UDDT%20Isothermal%20tests_PRG.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Moisture content versus time as a function of temperature **Wet basis**  **Dry basis** 	Observations: ○ Faster drying by increasing temperature ○ Strong influence of temperature on the drying rate below 150°C ○ Weak effect of temperature above 150°C

General information	
Type of data	Isothermal kinetics in a thermogravimetry analyser
Place of experimentation	Bioenergy Lab, Cranfield Energy & Power, Cranfield University (United Kingdom)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 50%wt
Total solids content	~ 50%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser *PerkinElmer TGA 8000™*
Drying time	Until mass stabilisation
Operating conditions	o Temperature: 55, 85, 105, 155 and 205°C o Heating rate: 100°C/min o Flow rate: 4 mL/min
Sample form	~ 40 mg sample on a 3 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
Somorin T, Getahun S, Septien S et al. Isothermal drying characteristics and kinetics of human faecal sludges [version 1; peer review: awaiting peer review]. Gates Open Res 2020, 4:67	

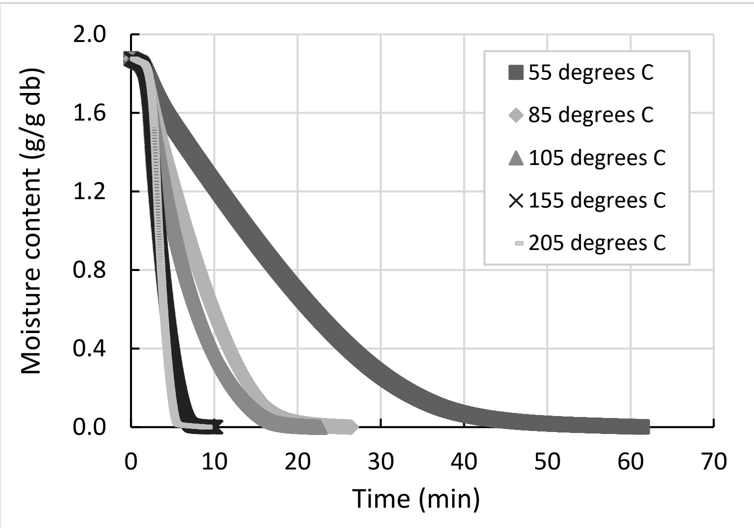
Data source files
https://www.dropbox.com/s/jbuwxf4hggk1vwz/Cranfield%20UDDT%20sludge_TGA%20Isothermal%20Kinetics%20%282018-2019%29.xlsx?dl=0
Additional Notes
○ Samples couriered from South Africa
Description of Data

Moisture content versus time as a function of temperature

Wet basis

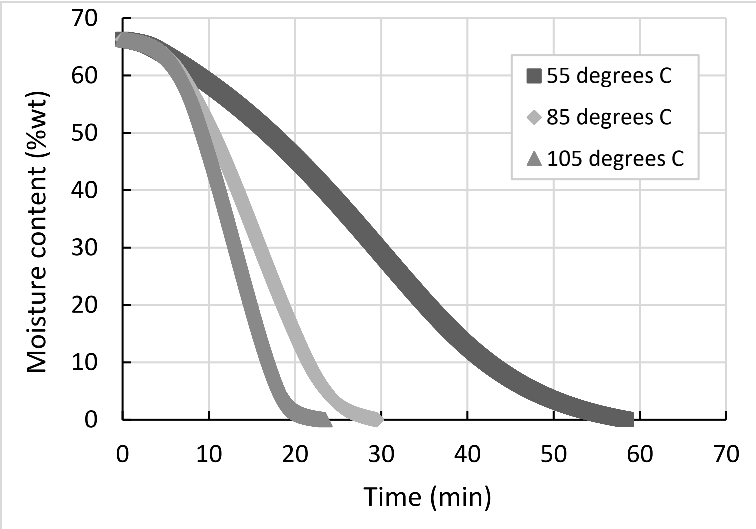
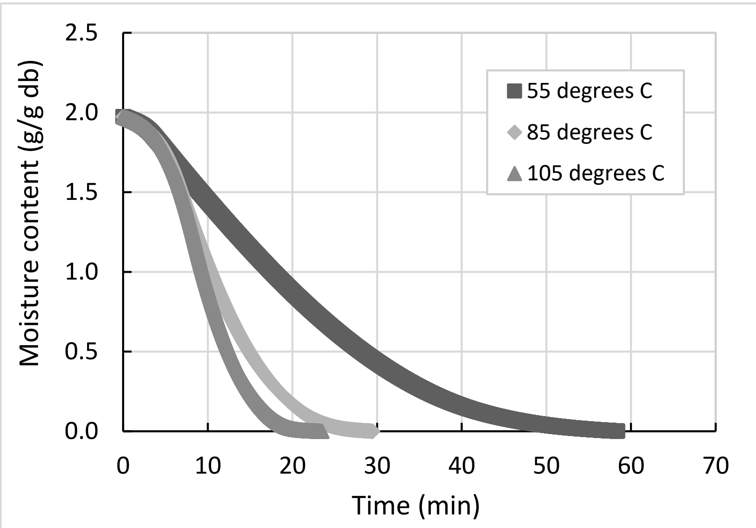


Dry basis



Observations:

- Faster drying by increasing temperature
- Considerable influence of temperature on the drying rate below 155°C
- Weak effect of temperature above 155°C

Moisture content versus time as a function of temperature at a heating rate of 10°C/min	Observations:
Wet basis  **Dry basis** 	○ Faster drying by increasing temperature

General information	
Type of data	Isothermal kinetics in a thermogravimetric analyser
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Drying time	~ 40 - 80 min
Operating conditions	o Set temperature: 55, 85, 105, 155 and 205°C o Heating rate: 10°C/min o Carrier gas: nitrogen o Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

Data source files

Wet basis
https://www.dropbox.com/s/r2jsoyod36pte3a/Swansea%20University_Sludge%20TGA%20Isothermal%20kinetics_wet%20basis%20%282018-2020%29.xlsx?dl=0

Dry basis
https://www.dropbox.com/s/w1zkkuuu7z21hyj/Swansea%20University_Sludge%20TGA%20Isothermal%20Kinetics_dry%20basis%20%282018-2020%29.xlsx?dl=0

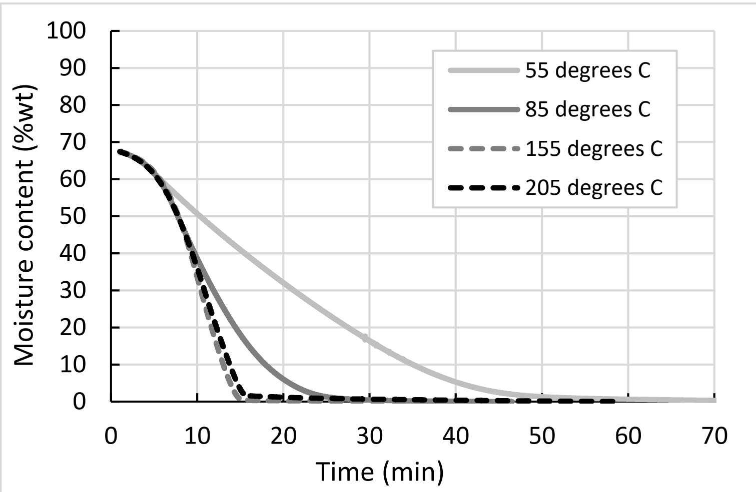
Additional Notes

- Samples couriered from South Africa
- Considerable drying of the sample before reaching the set temperature at 105, 155 and 205°C

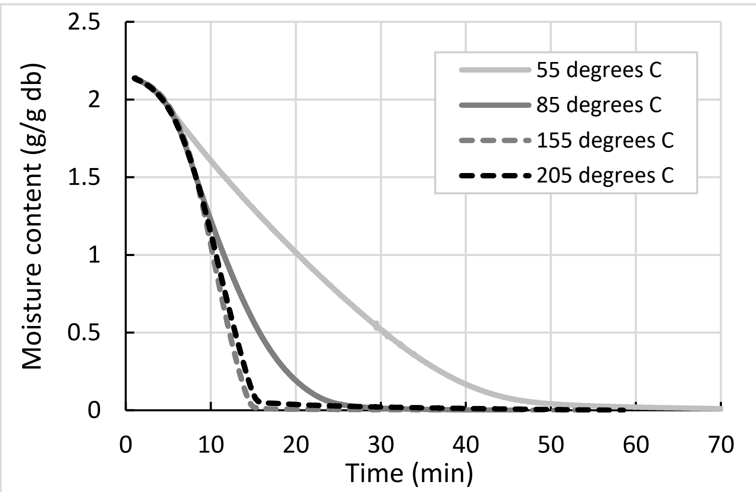
Description of Data

Moisture content versus time as a function of temperature

Wet basis



Dry basis



Observations

- Faster drying by increasing the temperature from 55 to 155°C
- Drying achieved before 20 minutes at temperatures above 155°C
- Same drying rate between 155 and 205°C (probably because major part of the drying occurred during the heating stage before reaching the final temperature)

General information	
Type of data	Isothermal kinetics in a thermogravimetric analyser
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	~ 65%db
Ash content	~ 35%db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetry - differential thermal analyser *SHIMADU DTG-60A*
Drying time	Until stabilisation of the sample mass
Operating conditions	o Temperature: 50, 100, 150 and 200°C o Heating rate: 50°C/min o Air flowrate: 50 mL/min
Sample form in the dryer	~ 70 mg sample on aluminium crucible of 6 mm diameter and 5 mm height
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files

https://www.dropbox.com/s/khl5b44277bgqw2/2018-2019%20VIP%20Isothermal%20Tests_PRG.xlsx?dl=0

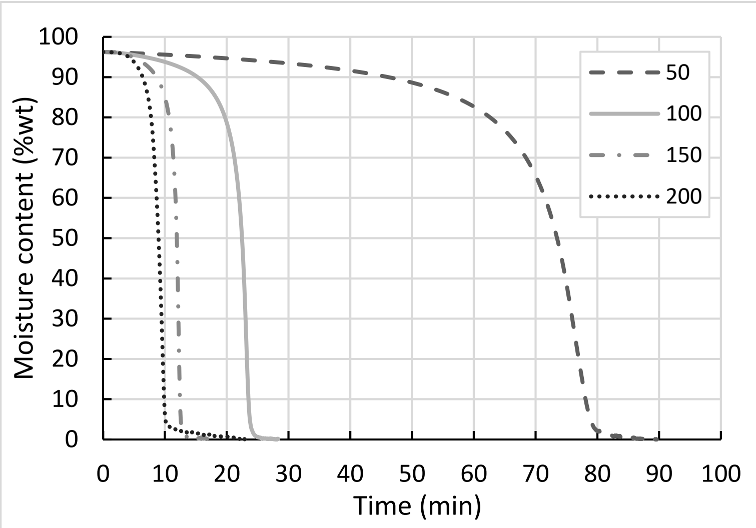
Additional Notes

-

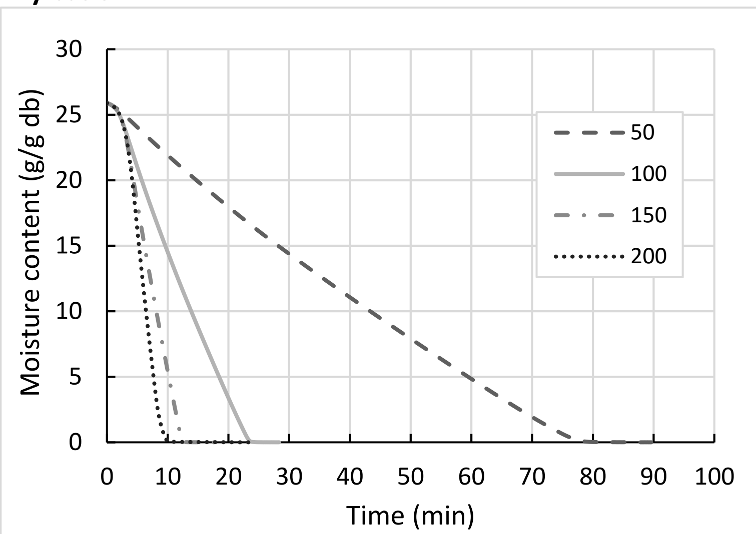
Description of Data

Moisture content versus time as a function of temperature

Wet basis



Dry basis



Observations:

- Faster drying by increasing temperature
- Strong influence of temperature on the drying rate below 150°C
- Weak effect of temperature above 150°C

General information	
Type of data	Isothermal kinetics in a thermogravimetry analyser
Place of experimentation	Bioenergy Lab, Cranfield Energy & Power, Cranfield University (United Kingdom)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser *PerkinElmer TGA 8000™*
Drying time	Until mass stabilisation
Operating conditions	○ Temperature: 55, 85, 105, 155 and 205°C ○ Heating rate: 100°C/min ○ Flow rate: 4 mL/min
Sample form	~ 40 mg sample on a 3 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
Somorin T, Getahun S, Septien S et al. Isothermal drying characteristics and kinetics of human faecal sludges [version 1; peer review: awaiting peer review]. Gates Open Res 2020, 4:67	

Data source files

https://www.dropbox.com/s/rhp4d3okk1sgaxb/Cranfield%20University%20VIP%20sludge_TGA%20Isothermal%20kinetics%20%282018-2019%29.xlsx?dl=0

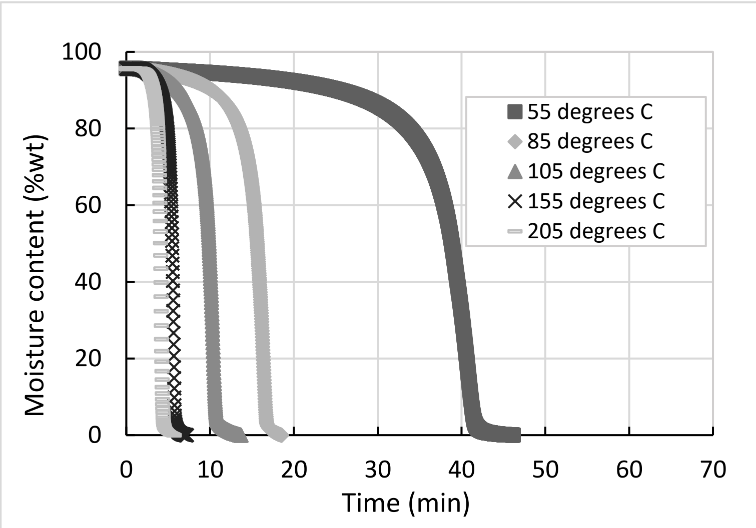
Additional Notes

- Faecal sludge couriered from South Africa

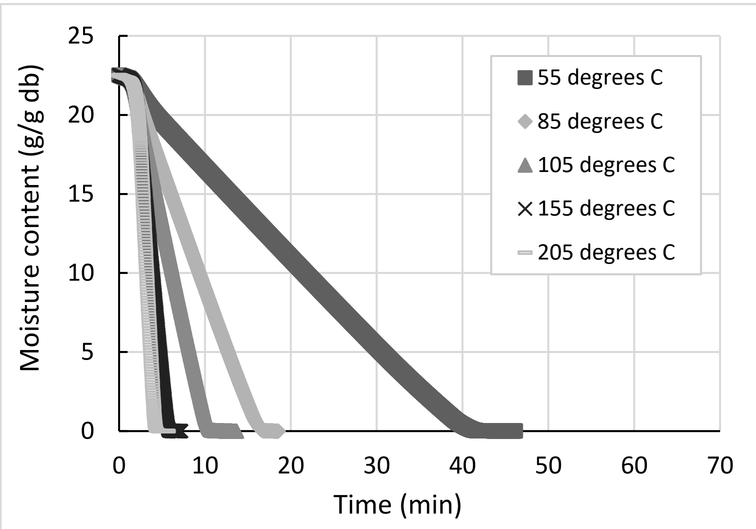
Description of Data

Moisture content versus time as a function of temperature

Wet basis



Dry basis

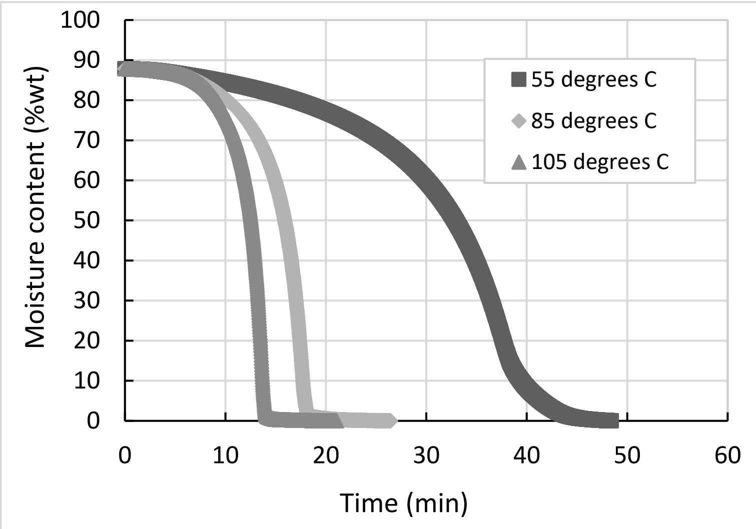


Observations:

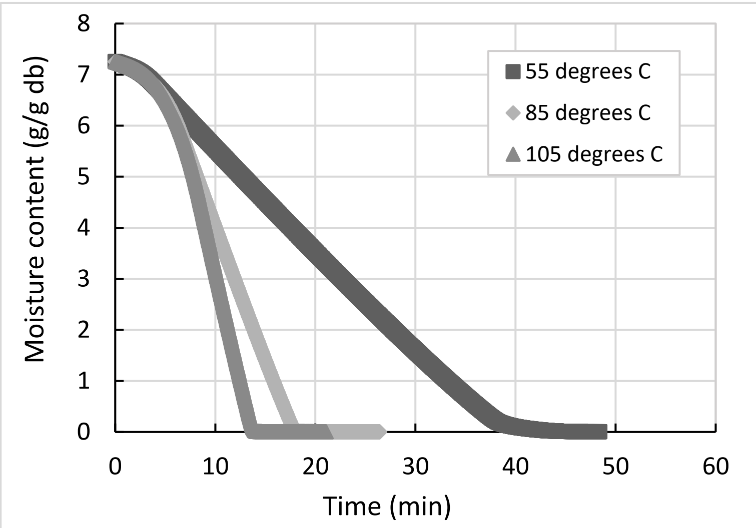
- Faster drying by increasing temperature
- Considerable influence of temperature on the drying rate below 155°C
- Weak effect of temperature above 155°C

Moisture content versus time as a function of temperature at a heating rate of 10°C/min

Wet basis



Dry basis



Observations:

- Faster drying by increasing temperature

General information	
Type of data	Isothermal kinetics in a thermogravimetric analyser
Place of experimentation	Materials Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Drying time	~ 40 - 80 min
Operating conditions	o Set temperature: 55, 85, 105, 155 and 205°C o Heating rate: 10°C/min o Carrier gas: nitrogen o Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

Data source files

Wet basis
https://www.dropbox.com/s/r2jsoyod36pte3a/Swansea%20University_Sludge%20TGA%20Isothermal%20kinetics_wet%20basis%20%282018-2020%29.xlsx?dl=0

Dry basis
https://www.dropbox.com/s/w1zkkuuu7z21hyj/Swansea%20University_Sludge%20TGA%20Isothermal%20Kinetics_dry%20basis%20%282018-2020%29.xlsx?dl=0

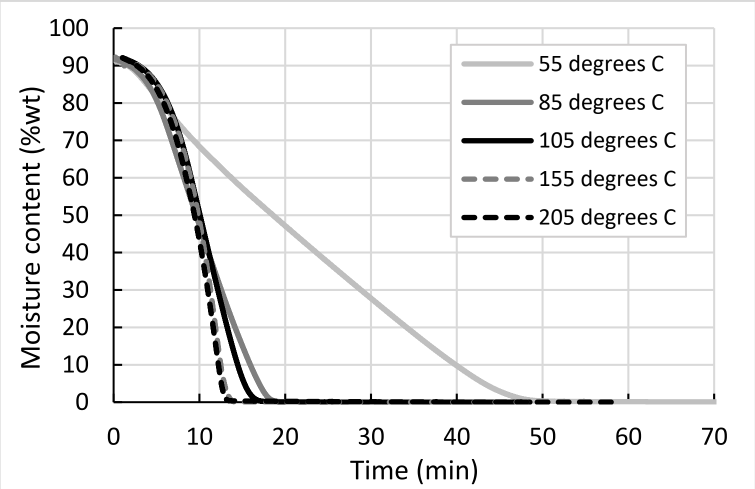
Additional Notes

- Faecal sludge couriered from South Africa
- Considerable drying of the sample before reaching the set temperature at 105, 155 and 205°C

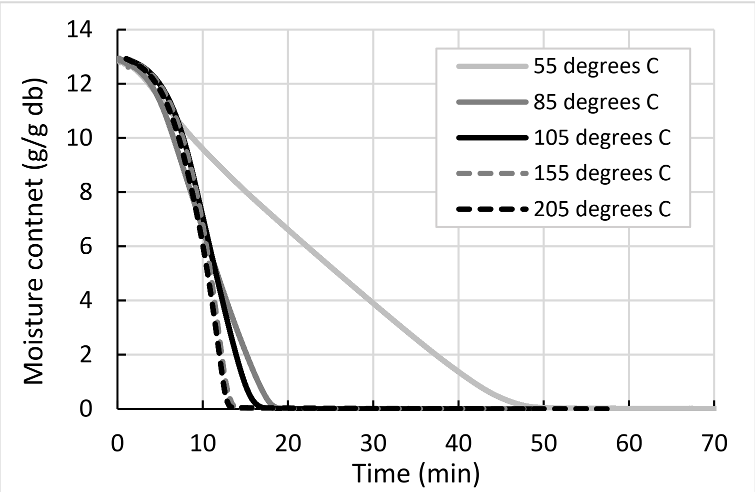
Description of Data

Moisture content versus time as a function of temperature

Wet basis



Dry basis



Observations

- Faster drying by increasing the temperature from 55 to 155°C
- Drying achieved before 20 minutes at temperatures above 85°C
- Same drying rate between 155 and 205°C (probably because major part of the drying occurred during the heating stage before reaching the final temperature)

General information	
Type of data	Isothermal kinetics in a thermogravimetric analyser
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetry - differential thermal analyser *SHIMADU DTG-60A*
Drying time	Until stabilisation of the sample mass
Operating conditions	○ Temperature: 50, 100, 150 and 200°C ○ Heating rate: 50°C/min ○ Air flowrate: 50 mL/min
Sample form in the dryer	~ 70 mg sample on aluminium crucible of 6 mm diameter and 5 mm height
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files

https://www.dropbox.com/s/l2yq6knth6gcw1g/2019%20Fresh%20faeces_Isotherm%20Tests_PRG.xlsx?dl=0

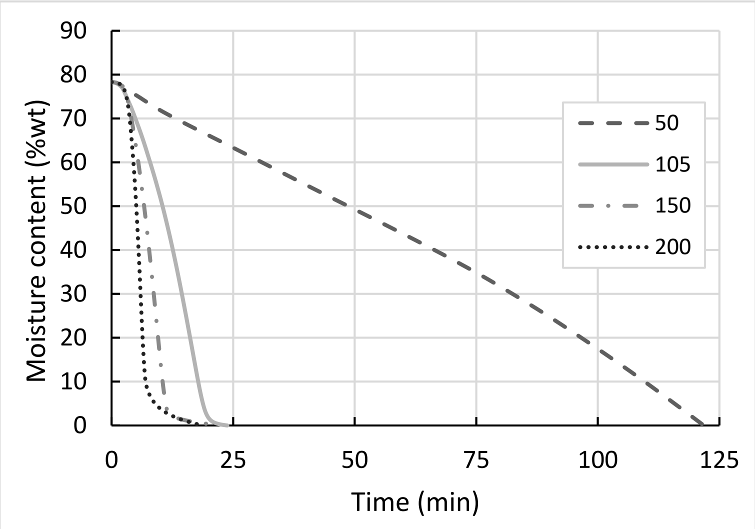
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations from healthy young adults

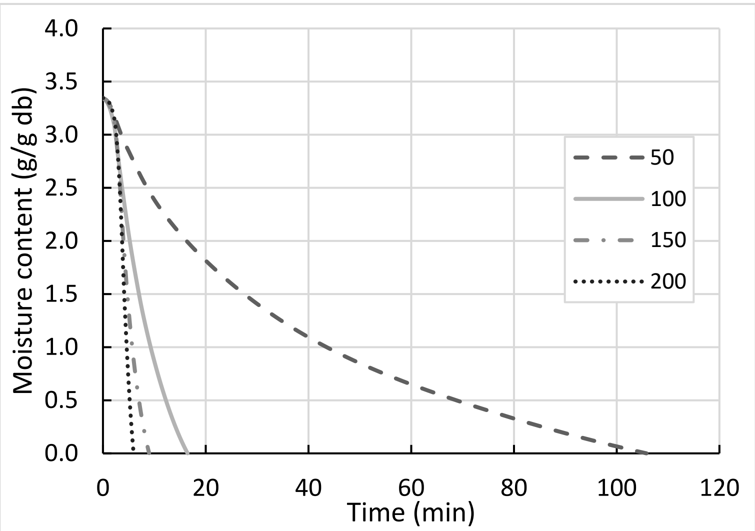
Description of Data

Moisture content vs time as a function of temperature

Wet basis



Dry basis



Observations:

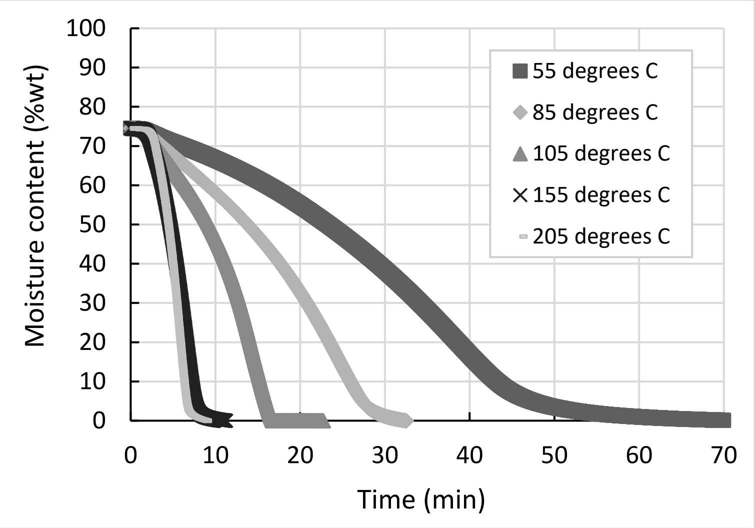
- Faster drying by increasing temperature
- Strong influence of temperature on the drying rate below 150°C
- Weak effect of temperature above 150°C

General information	
Type of data	Isothermal kinetics in a thermogravimetry analyser
Place of experimentation	Bioenergy Lab, Cranfield Energy & Power, Cranfield University (United Kingdom)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Cranfield, UK
Age before collection	A few days
Moisture content	~ 60%wt
Total solids content	~ 40%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser *PerkinElmer TGA 8000™*
Drying time	Until mass stabilisation
Operating conditions	○ Temperature: 55, 85, 105, 155 and 205°C ○ Heating rate: 10 and 100°C/min ○ Flow rate: 4 mL/min
Sample form	~ 40 mg sample on a 3 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
Somorin T, Getahun S, Septien S et al. Isothermal drying characteristics and kinetics of human faecal sludges [version 1; peer review: awaiting peer review]. Gates Open Res 2020, 4:67	

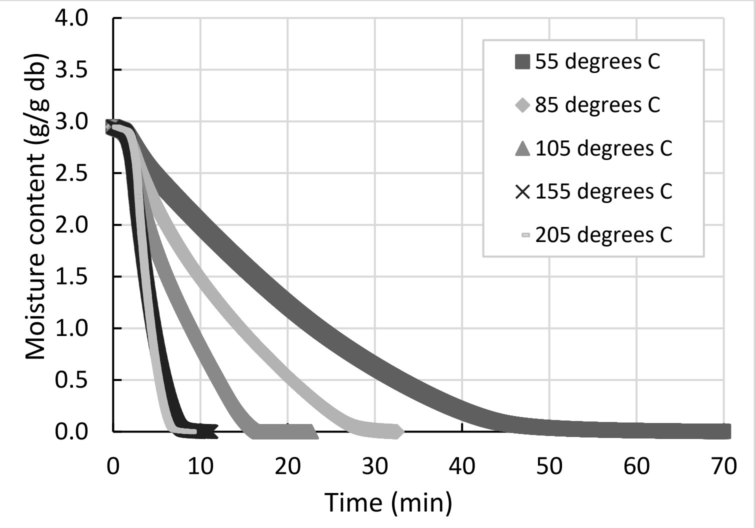
Data source files
https://www.dropbox.com/s/92scdrvv2psut3h/Cranfield%20Human%20Faeces_TGA%20Isothermal%20kinetics%20%282018-2019%29.xlsx?dl=0
Additional Notes
○ Fresh faeces collected from voluntary and anonymous donations
Description of Data

Moisture content versus time as a function of temperature

Wet basis



Dry basis

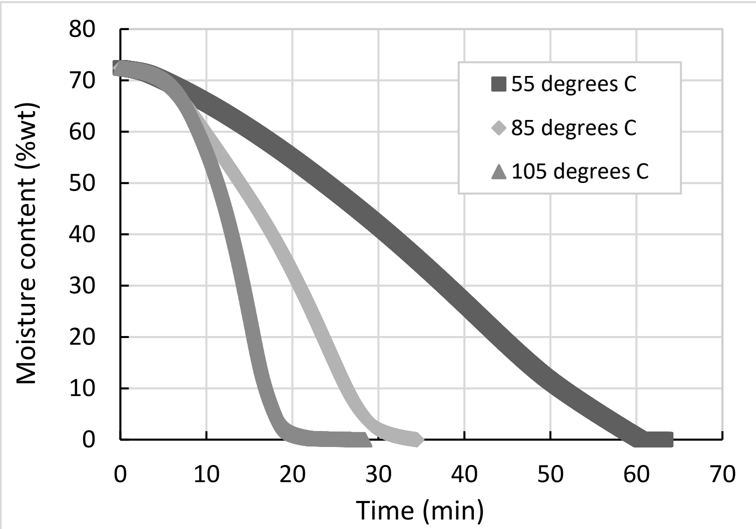


Observations:

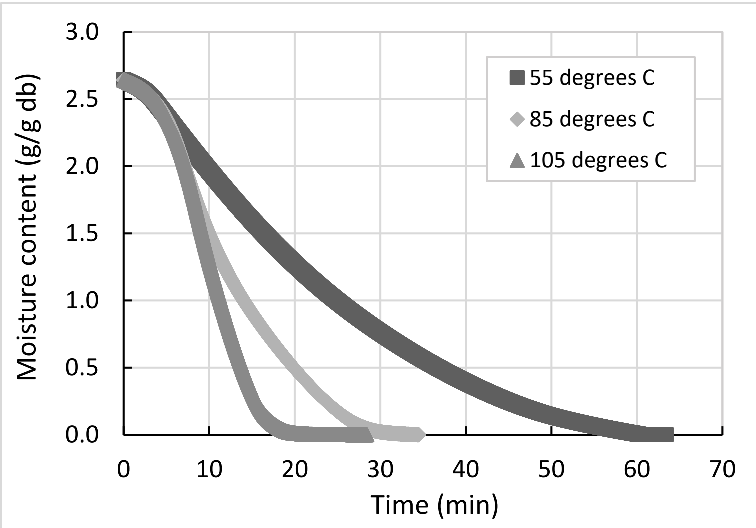
- Faster drying by increasing temperature
- Considerable influence of temperature on the drying rate below 155°C
- Weak effect of temperature above 155°C

Moisture content versus time as a function of temperature at a heating rate of 10°C/min

Wet basis



Dry basis



Observations:

- Faster drying by increasing temperature

General information	
Type of data	Isothermal kinetics in a thermogravimetric analyser
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Cranfield, UK
Age before collection	A few days
Moisture content	~ 60%wt
Total solids content	~ 40%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Drying time	~ 40 - 80 min
Operating conditions	○ Set temperature: 55, 85, 105, 155 and 205°C ○ Heating rate: 10°C/min ○ Carrier gas: nitrogen ○ Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

Data source files

Wet basis
https://www.dropbox.com/s/r2jsoyod36pte3a/Swansea%20University_Sludge%20TGA%20Isothermal%20kinetics_wet%20basis%20%282018-2020%29.xlsx?dl=0

Dry basis
https://www.dropbox.com/s/w1zkkuuu7z21hyj/Swansea%20University_Sludge%20TGA%20Isothermal%20Kinetics_dry%20basis%20%282018-2020%29.xlsx?dl=0

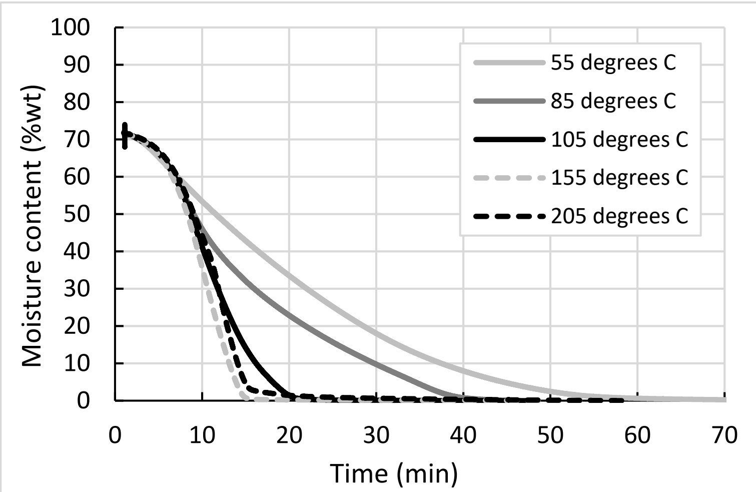
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Considerable drying of the sample before reaching the set temperature at 105, 155 and 205°C

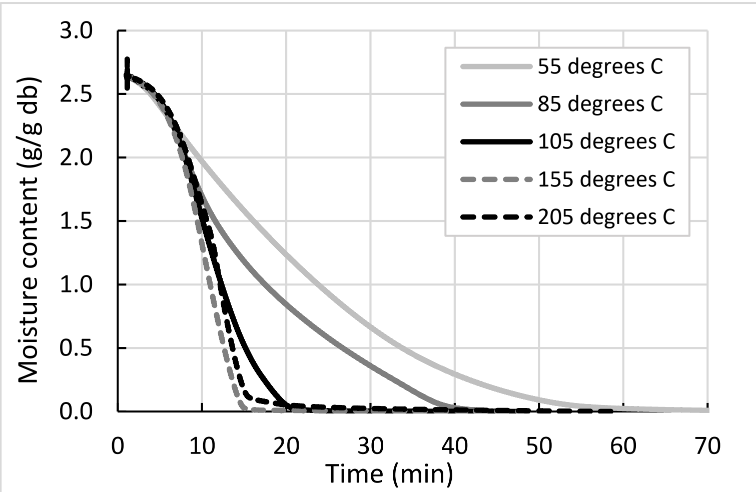
Description of Data

Moisture content as a function of time

Wet basis



Dry basis



Observations

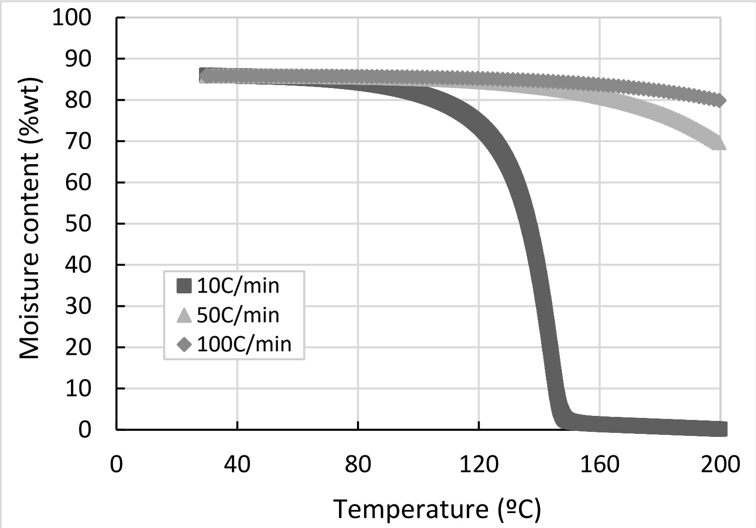
- Faster drying by increasing the temperature from 55 to 155°C
- Drying achieved before 20 minutes at temperatures above 105°C
- Same drying rate between 155 and 205°C (probably because major part of the drying occurred during the heating stage before reaching the final temperature)

General information	
Type of data	Non isothermal kinetics in a thermogravimetry analyser
Place of experimentation	Bioenergy Lab, Cranfield Energy & Power, Cranfield University (United Kingdom)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 85%wt
Total solids content	~ 15%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser *PerkinElmer TGA 8000™*
Drying time	~ 2, 4, 17 min
Operating conditions	○ Temperature: from ambient to 200°C ○ Heating rate: 10, 50 and 100°C/min ○ Flow rate: 4 mL/min
Sample form	~ 40 mg sample on a 3 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

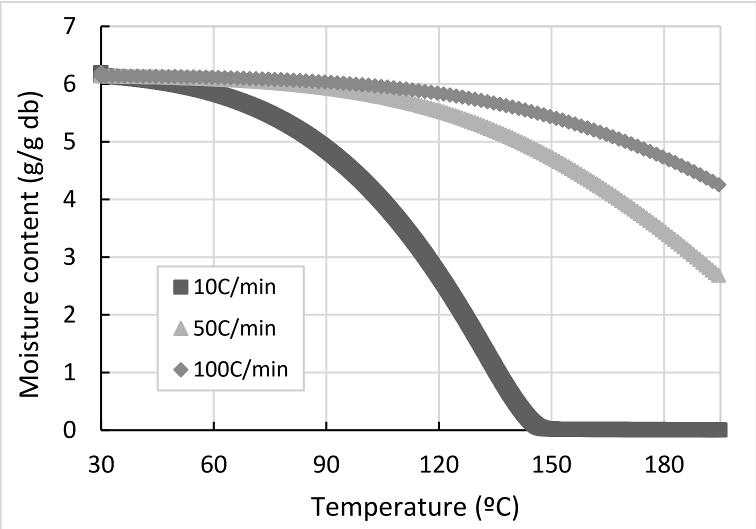
Data source files
https://www.dropbox.com/s/ttir3jkjp3aww6e/Cranfield%20University%20ABR%20sludge%20TGA%20Non-isothermal%20kinetics%20%282018-2019%29.xlsx?dl=0
Additional Notes
○ Faecal sludge couriered from South Africa
Description of Data

Moisture content versus temperature as a function of the heating rate

Wet basis



Dry basis



Observations:

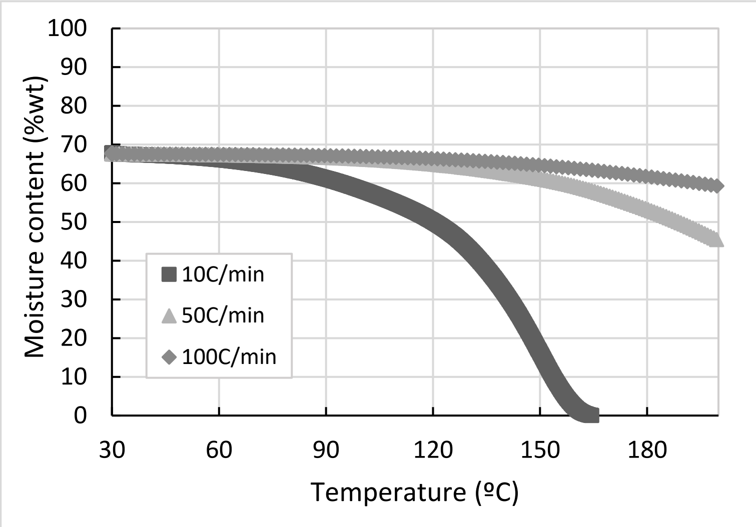
- Complete drying at a constant rate of 10°C/ min
- Incomplete drying at a constant rate of 50 and 100°C/ min (drying time too short to achieve complete dryness)

General information	
Type of data	Non-isothermal kinetics in a thermogravimetry analyser
Place of experimentation	Bioenergy Lab, Cranfield Energy & Power, Cranfield University (United Kingdom)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 50%wt
Total solids content	~ 50%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser *PerkinElmer TGA 8000™*
Drying time	Until temperature ramp reaching 200°C
Operating conditions	○ Temperature: from ambient to 200°C ○ Heating rate: 10, 50 and 100°C/min ○ Flow rate: 4 mL/min
Sample form	~ 40 mg sample on a 3 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

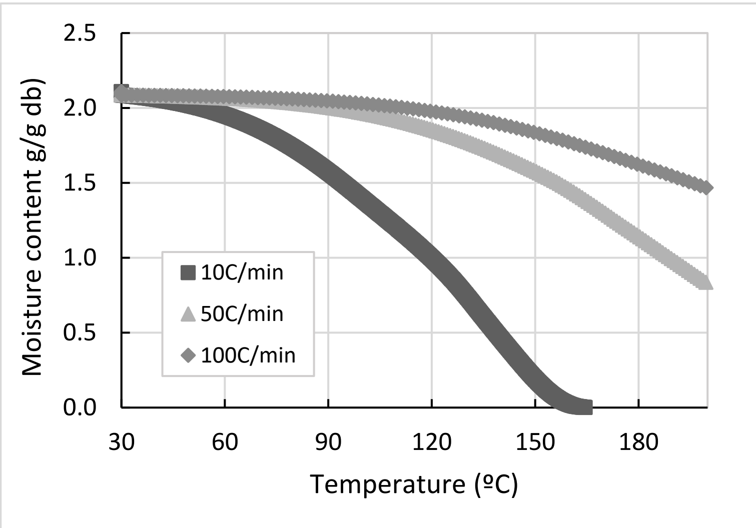
Data source files
https://www.dropbox.com/s/xjecvq6j7y7xove/Cranfield%20University%20UDDT%20sludge%20TGA%20Non-Isotherm%20Kinetics.xlsx?dl=0
Additional Notes
○ Faecal sludge couriered from South Africa
Description of Data

Moisture content versus temperature as a function of the heating rate

Wet basis



Dry basis



Observations:

- Complete drying at a constant rate of 10°C/ min
- Incomplete drying at a constant rate of 50 and 100°C/ min (drying time too short to achieve complete dryness)

General information	
Type of data	Non isothermal kinetics in a thermogravimetry analyser
Place of experimentation	Bioenergy Lab, Cranfield Energy & Power, Cranfield University (United Kingdom)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser *PerkinElmer TGA 8000™*
Drying time	~ 2, 4, 17 min
Operating conditions	○ Temperature: from ambient to 200°C ○ Heating rate: 10, 50 and 100°C/min ○ Flow rate: 4 mL/min
Sample form	~ 40 mg sample on a 3 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

Data source files

https://www.dropbox.com/s/i8wdz9vy8gw71e2/Cranfield%20University%20VIP%20sludge%20TGA%20Non-isothermal%20kinetics%20%282018-2019%29.xlsx?dl=0

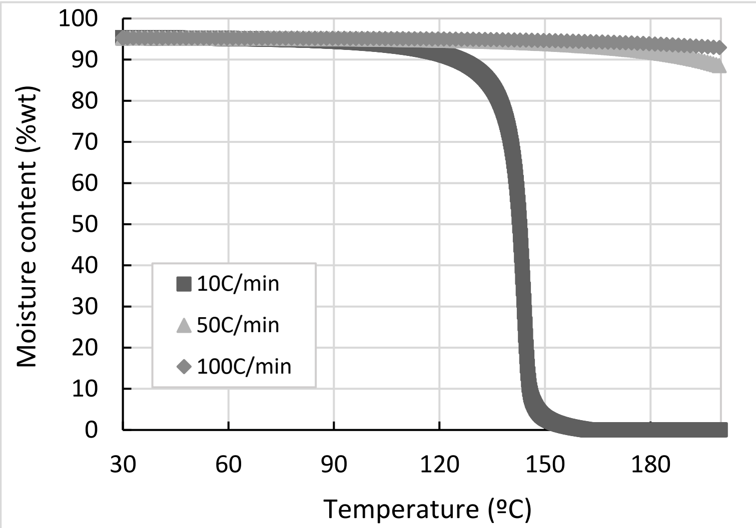
Additional Notes

- Faecal sludge couriered from South Africa

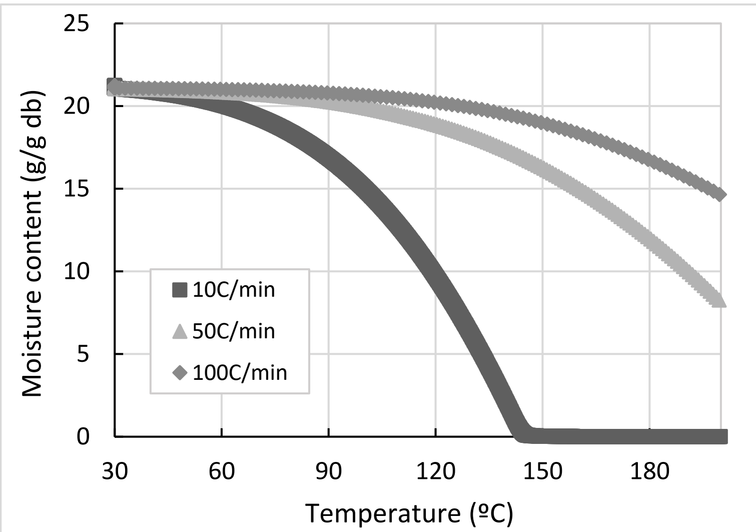
Description of Data

Moisture content versus temperature as a function of the heating rate

Wet basis



Dry basis



Observations:

- Complete drying at a constant rate of 10°C/ min
- Incomplete drying at a constant rate of 50 and 100°C/ min (drying time too short to achieve complete dryness)

General information	
Type of data	Non isothermal kinetics in a thermogravimetry analyser
Place of experimentation	Bioenergy Lab, Cranfield Energy & Power, Cranfield University (United Kingdom)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Cranfield, UK
Age before collection	A few days
Moisture content	~ 60%wt
Total solids content	~ 40%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser *PerkinElmer TGA 8000™*
Drying time	~ 2, 4, 17 min
Operating conditions	○ Temperature: from ambient to 200°C ○ Heating rate: 10, 50 and 100°C/min ○ Flow rate: 4 mL/min
Sample form	~ 40 mg sample on a 3 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation)
Publications	
-	

Data source files

https://www.dropbox.com/s/s89d7lhqk8bx5yn/Cranfield%20University%20Human%20Faeces%20TGA%20Non-isothermal%20kinetics%20%282018-2019%29.xlsx?dl=

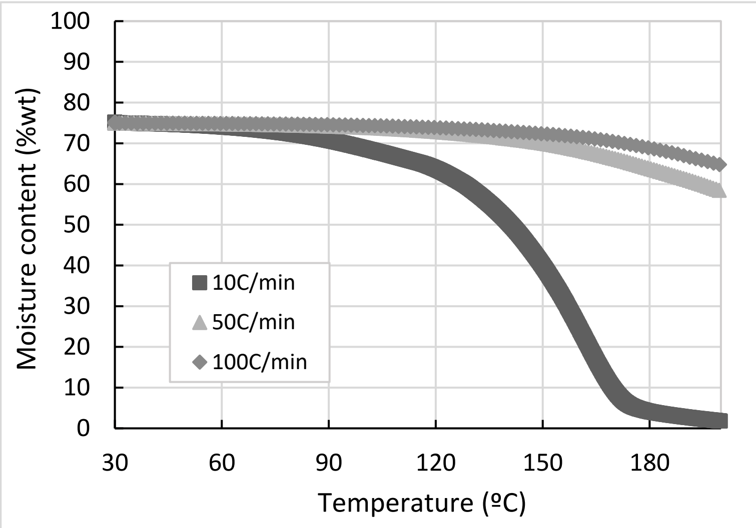
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations

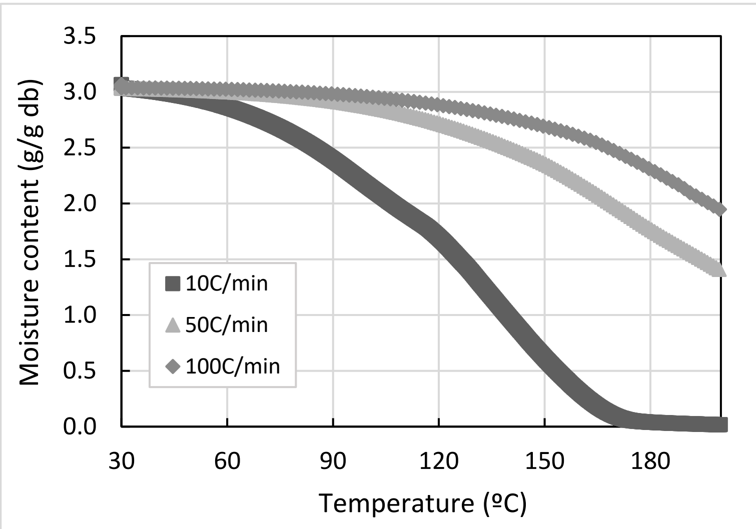
Description of Data

Moisture content versus temperature as a function of the heating rate

Wet basis



Dry basis



Observations:

- Complete drying at a constant rate of 10°C/ min
- Incomplete drying at a constant rate of 50 and 100°C/ min (drying time too short to achieve complete dryness)

General information	
Type of data	Kinetics in a moisture analyser balance
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Moisture analyser balance *PCE-MB Series*
Drying time	Until complete drying
Operating conditions	Temperature: 100°C
Sample form in the dryer	1.5 g of sample on an 90 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed methods	Direct measurement by moisture analyser balance *PCE-MB Series* (SOP 8.7.1.5)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files

https://www.dropbox.com/s/ahtih6apycqwx16/2018-2019%20Drying%20kinetics%20%28moisture%20analyser%29.xlsx?dl=0

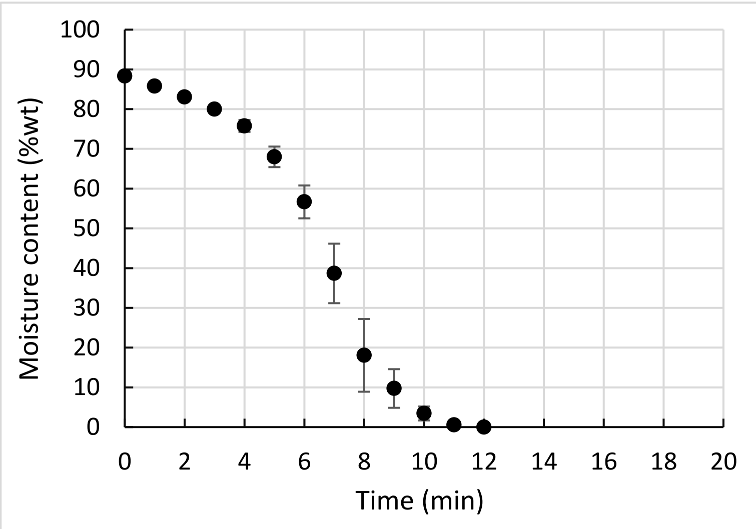
Additional Notes

-

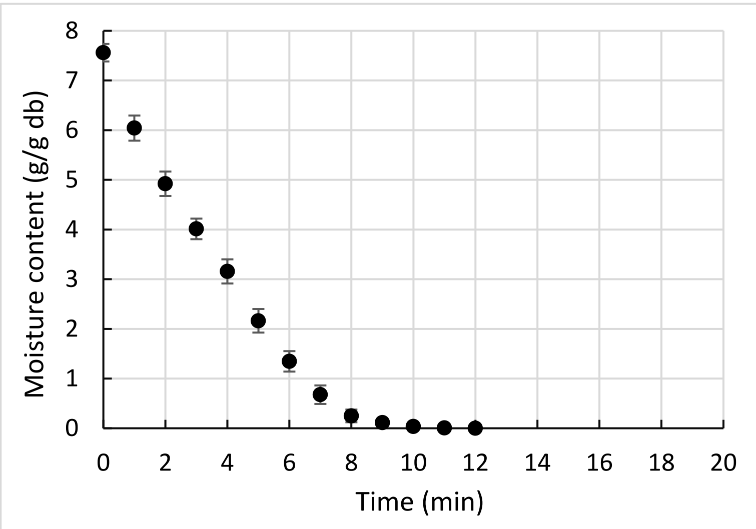
Description of Data

Moisture content versus time

Wet basis



Dry basis



Observations:

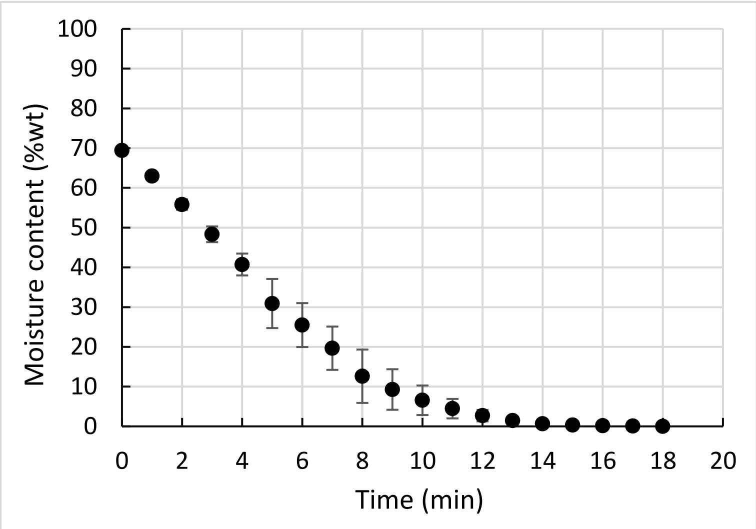
- Fast drying (less than 15 minutes)

General information	
Type of data	Kinetics in a moisture analyser balance
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Moisture Analyser balance *PCE-MB Series*
Drying time	Until complete drying
Operating conditions	Temperature: 100°C
Sample form in the dryer	1.5 g of sample on an 90 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed methods	Direct measurement by moisture analyser balance PCE-MB Series (SOP 8.7.1.5)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

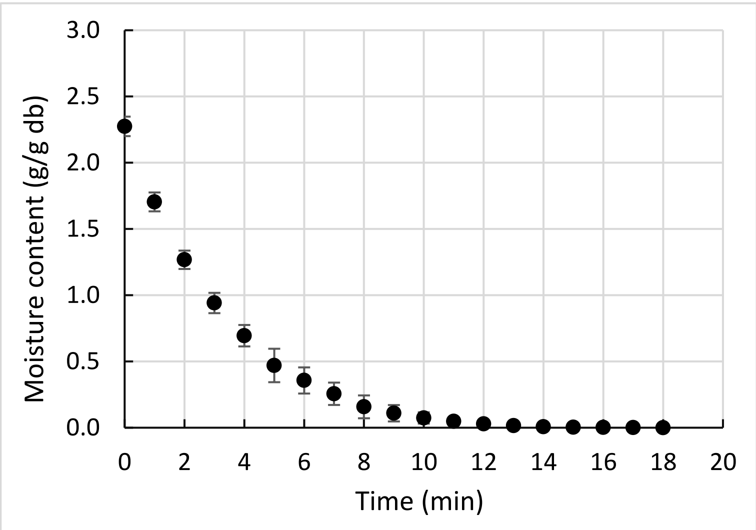
Data source files
https://www.dropbox.com/s/ahtih6apycqwx16/2018-2019%20Drying%20kinetics%20%28moisture%20analyser%29.xlsx?dl=0
Additional Notes
-
Description of Data

Moisture content versus time

Wet basis



Dry basis



Observations:

- Fast drying (less than 15 minutes)

General information	
Type of data	Kinetics in a moisture analyser balance
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilet (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Moisture analyser balance *PCE-MB Series*
Drying time	5 hours
Operating conditions	Temperature: 40, 60 and 80°C
Sample form	~ 3 g of faecal sludge in a crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) in a thermal balance (SOP 8.7.1.5)
Publications	
-	

Data source files

https://www.dropbox.com/s/56rm46w5t144p4t/2019-2020%20FS%20drying%20tests_PRG-UKZN.xlsx?dl=0

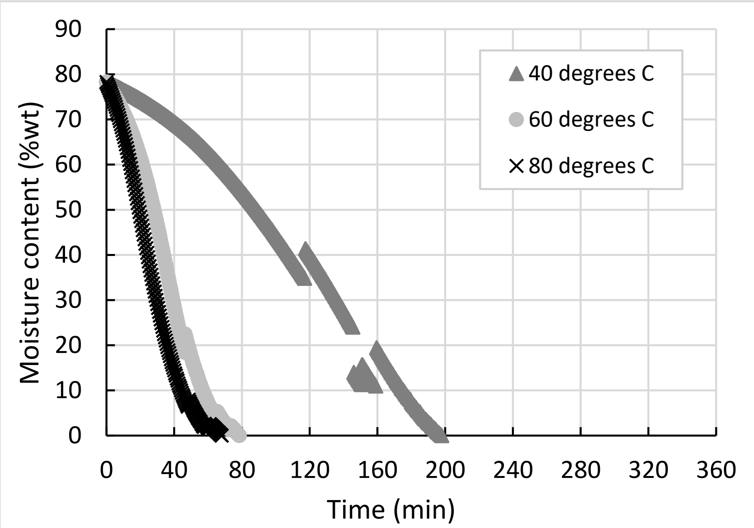
Additional Notes

-

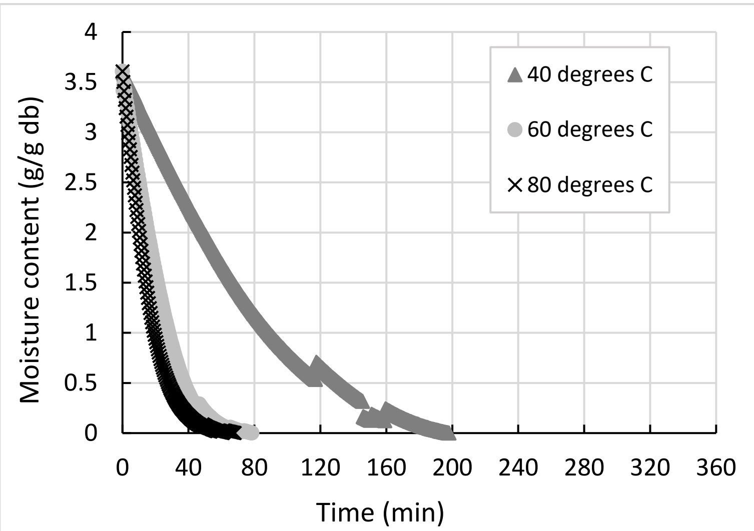
Description of Data

Moisture content versus time as a function of temperature

Wet basis



Dry basis



Observations:

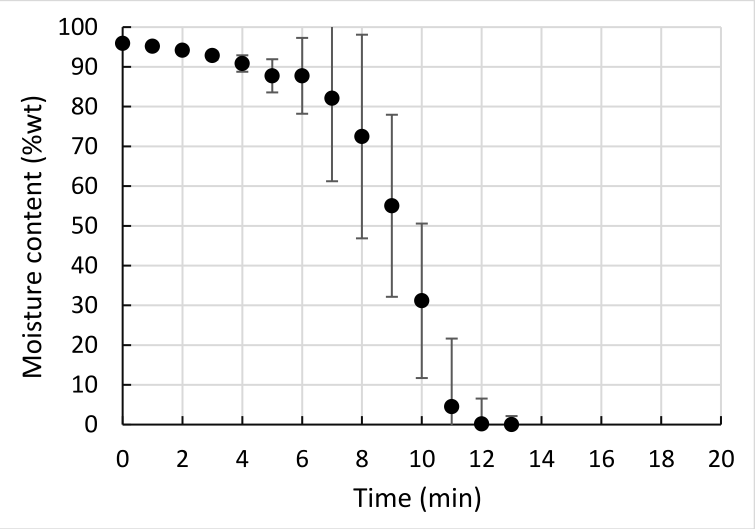
- Faster drying rate as temperature increases
- Important difference between 40 and 60°C
- Lower difference between 60 and 80°C

General information	
Type of data	Kinetics in a moisture analyser balance
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	~ 65%db
Ash content	~ 35%db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Moisture Analyser balance *PCE-MB Series*
Drying time	Until complete drying
Operating conditions	Temperature: 100°C
Sample form in the dryer	1.5 g of sample on an 90 mm diameter aluminium crucible
Analysed parameters	Moisture content
Employed methods	Thermogravimetry (determined through the measurement of the sample mass variation) (SOP 8.7.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

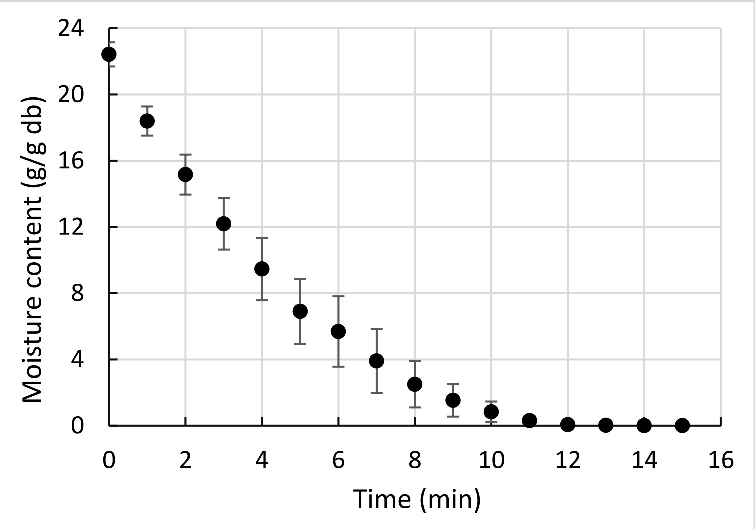
Data source files
https://www.dropbox.com/s/ahtih6apycqwx16/2018-2019%20Drying%20kinetics%20%28moisture%20analyser%29.xlsx?dl=0
Additional Notes
-
Description of Data

Moisture content versus time

Wet basis



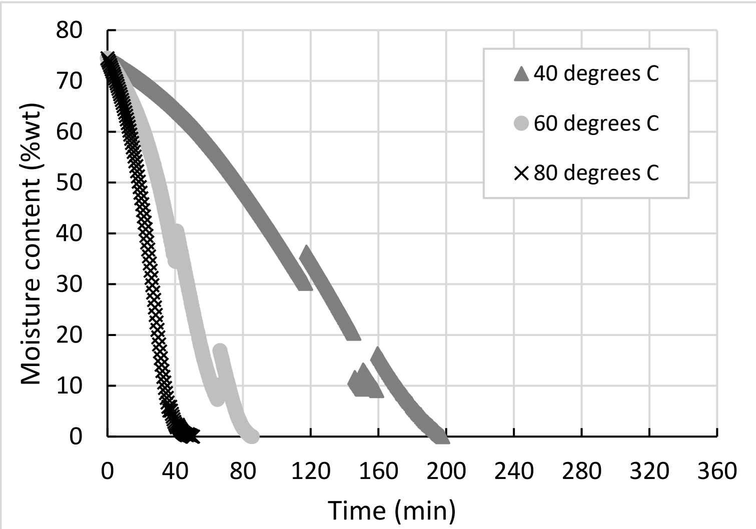
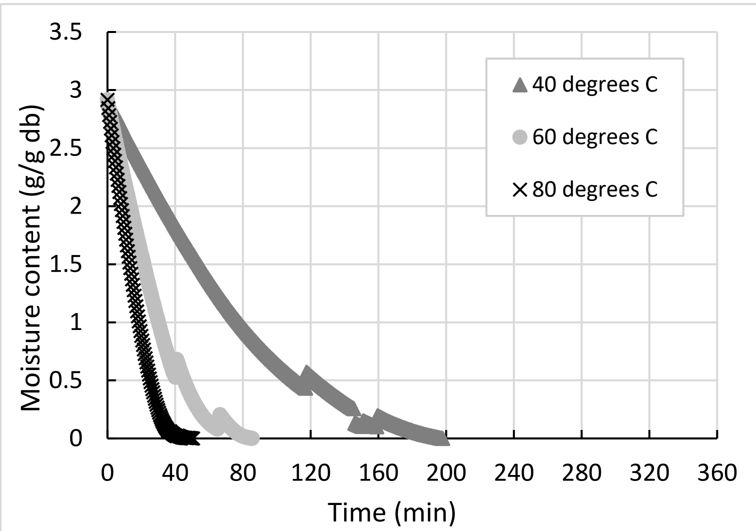
Dry basis



Observations:

- Fast drying (less than 15 minutes)

General information	
Type of data	Kinetics in a moisture analyser balance
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine toilet (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Moisture analyser balance *PCE-MB Series*
Drying time	5 hours
Operating conditions	Temperature: 40, 60 and 80°C
Sample form	~ 3 g of faecal sludge in a crucible
Analysed parameters	Moisture content
Employed method	Thermogravimetry (determined through the measurement of the sample mass variation) in a thermal balance (SOP 8.7.1.5)
Publications	
-	

Data source files	
https://www.dropbox.com/s/56rm46w5t144p4t/2019-2020%20FS%20drying%20tests_PRG-UKZN.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Moisture content versus time as a function of temperature **Wet basis**  **Dry basis** 	Observations: ○ Faster drying rate as temperature increases ○ Important difference between 40 and 60°C ○ Lower difference between 60 and 80°C

General information	
Type of data	Kinetics in a moisture analyser balance
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Temperature: ambient (~ 20°C) ○ Relative humidity: ambient (~ 60%)
Sample form in the dryer	900 g of sample placed in 1 L plastic bucket
Analysed parameters	Moisture content
Employed method	Direct measurement by moisture analyser balance *PCE-MB Series* (SOP 8.7.1.5)
Publications	
-	

Data source files

https://www.dropbox.com/s/3w62xnsmet4fvsy/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20Batch%202%20Kinetics%20in%20a%20moisture%20analyser_UKZN%20PRG.xlsx?dl=0

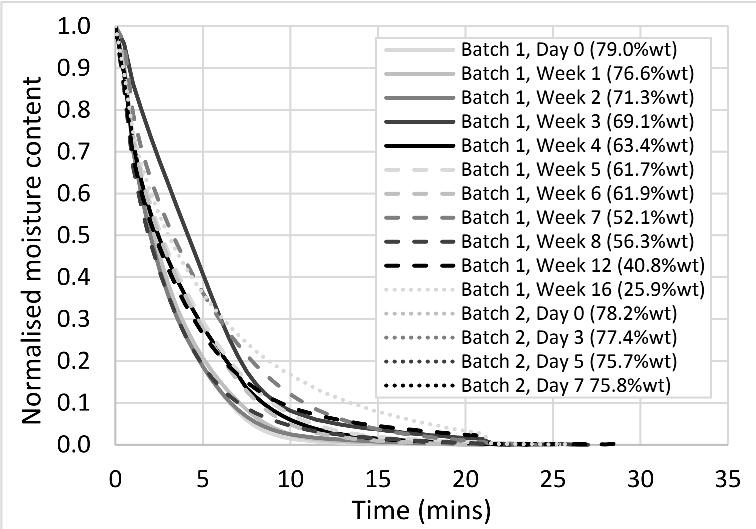
https://www.dropbox.com/s/d4tp25vu9ylqhmh/2019-2020%20Fresh%20faeces%20Natural%20Drying%20kinetics_UKZN%20PRG.xlsx?dl=0

Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Containers with sample placed in a ventilated area
- Mesh placed at the opening of the container to avoid the development of maggots
- Samples from batch 1 analysed in a weekly basis for 16 weeks
- Samples from batch 2 analysed at days 0, 3, 5 and 7 during one week

Description of Data

Normalized moisture content (with respect to the initial value) as a function of time for the samples from batch 1 and 2



Observations

- No considerable effect of the initial moisture content on the drying kinetics
- Time for complete drying between 10 and 20 minutes

General information	
Type of data	Kinetics of natural drying
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Temperature: ambient (~ 20°C) ○ Relative humidity: ambient (~ 60%)
Sample form in the dryer	900 g of sample placed in 1 L plastic bucket
Analysed parameters	Moisture content
Employed method	Weighing the sample before and after drying at 105°C in the laboratory oven for 24 hours (SOP 8.7.1.1)
Publications	
-	

Data source files

https://www.dropbox.com/s/xbv6su0jxsipiok/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20the%20open%20air_UKZN%20PRG.xlsx?dl=0

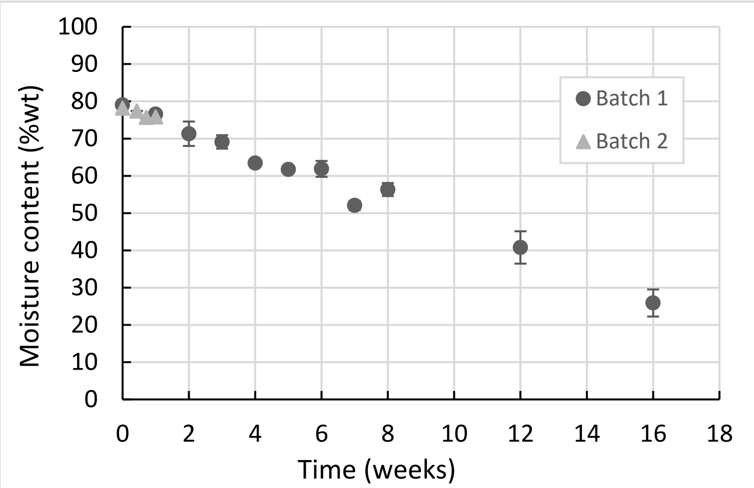
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Containers with sample placed in a ventilated area
- Mesh placed at the opening of the container to avoid the development of maggots
- Samples from batch 1 analysed in a weekly basis for 16 weeks
- Samples from batch 2 analysed at days 0, 3, 5 and 7 during one week

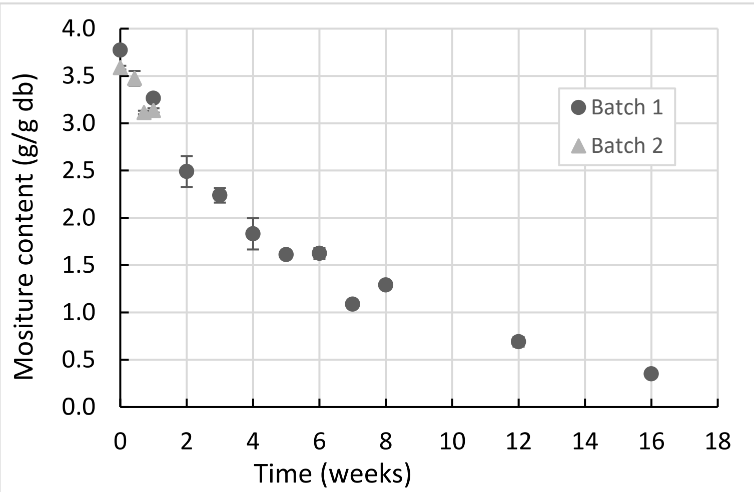
Description of Data

Moisture content as a function of storage time for the samples from batch 1 and 2

Wet basis



Dry basis



Observations

- Decrease of moisture content from 80%wt (3.5 g/g db) to 25%wt (0.5 g/g db) after 16 weeks of natural drying

General information	
Type of data	Drying time
Place of experimentation	Chemical Engineering & Applied Chemistry, University of Toronto (Canada)
Dates of the experiments	2012
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Ontario, Canada
Age before collection	A few days
Moisture content	~ 85%wt
Total solids content	~ 15%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Environmental chamber
Drying time	Several hours
Operating conditions	○ Temperature: 28ºC ○ Air flowrate: 2100 L/min (air velocities of 4.6 m/s) ○ Relative humidity: 85%
Sample form in the dryer	Thin layer of 110 x 110 x 2 mm
Analysed parameters	Moisture content
Employed methods	Gravimetric method (determined through the measurement of the sample mass variation)
Publications	
-	

Data source files

https://www.dropbox.com/s/hloxql9ixp462re/2012%20Drying%20Kinetics%20of%20Human%20faeces_Toronto%20University.xlsx?dl=0

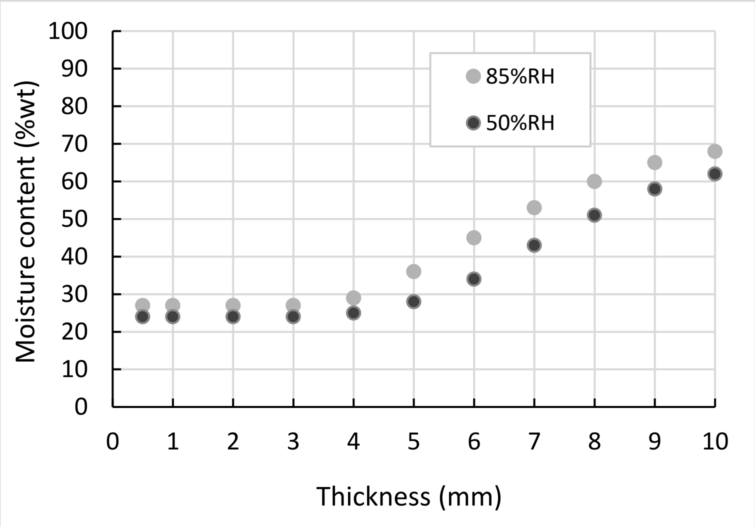
Additional Notes

Fresh faeces collected from voluntary and anonymous donations

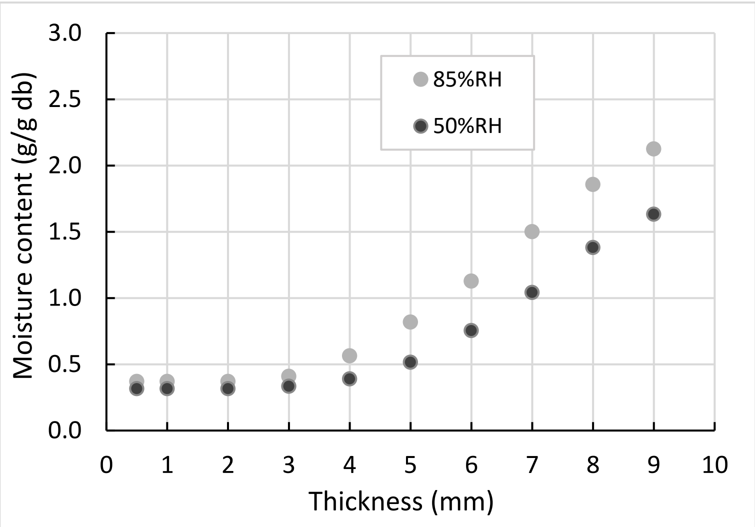
Description of Data

Moisture content after 24 hours of drying as a function of the sample thickness and relative humidity

Wet Basis

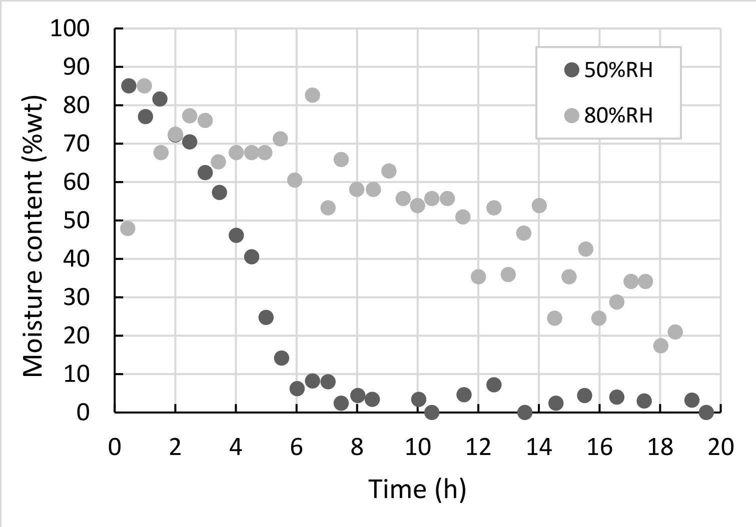
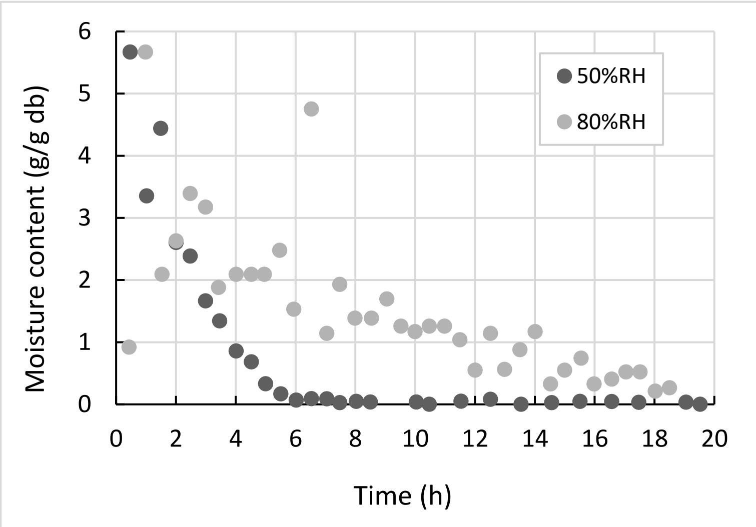


Dry Basis



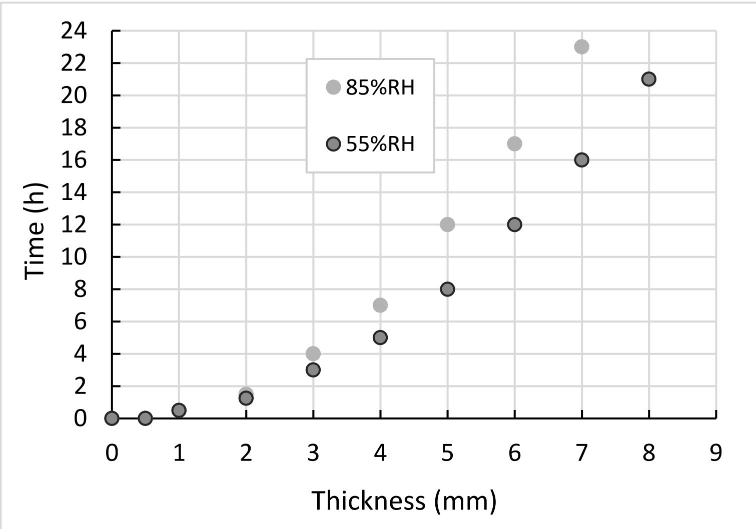
Observations

- Decrease of final moisture content by decreasing the thickness of the sample
- Below 3 mm thickness, same final moisture content (25-30%wt, which could be the equilibrium moisture content)

Moisture content as a function of time and relative humidity at 50%	Observations
Wet Basis  **Dry Basis** 	○ Considerably faster drying at a relative humidity of 50% compared to 80%

General information	
Type of data	Drying time
Place of experimentation	Chemical Engineering & Applied Chemistry, University of Toronto (Canada)
Dates of the experiments	2012
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Ontario, Canada
Age before collection	A few days
Moisture content	~ 85%wt
Total solids content	~ 15%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 55%wt moisture content
Operating conditions	○ Temperature: 28ºC ○ Air flowrate: 900 – 2100 L/min (air velocities of 1.9 – 4.6 m/s) ○ Relative humidity: 50 and 85%
Sample form in the dryer	Thin layer of 1 to 8 mm thickness
Analysed parameters	Drying time
Employed methods	Measurement of time
Publications	
-	

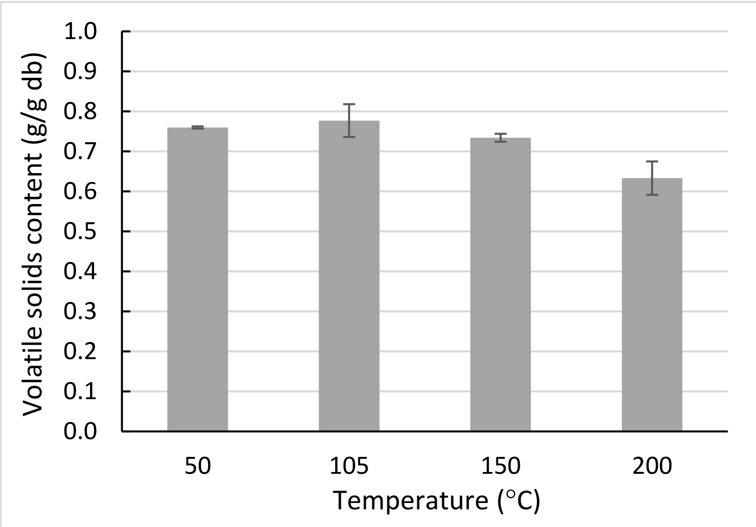
Data source files
https://www.dropbox.com/s/hloxql9ixp462re/2012%20Drying%20Kinetics%20of%20Human%20faeces_Toronto%20University.xlsx?dl=0
Additional Notes
Fresh faeces collected from voluntary and anonymous donations
Description of Data

Drying time to reduce the moisture content from 83 (initial value) to 55%wt (final value) as a function of the sample thickness and relative humidity	Observations
	○ Increase of drying time by increasing the thickness of the sample

PHYSIOCHEMICAL PROPERTIES

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until completely dry
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Volatile solids
Employed method	Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files	
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Volatile solids content as a function of temperature	Observations:



- No effect of temperature
- Lower volatile solid content at 200°C (possible thermal degradation)

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal, South Africa
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Volatile solids
Employed method	Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

Data source files

https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

Additional Notes

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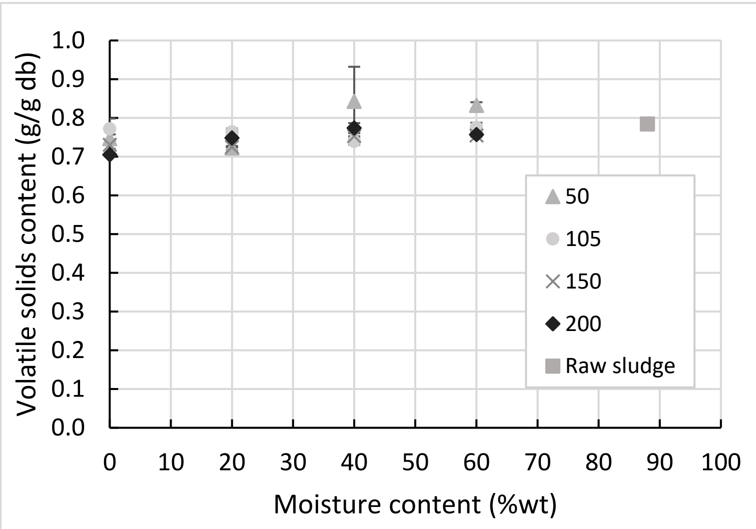
Description of Data

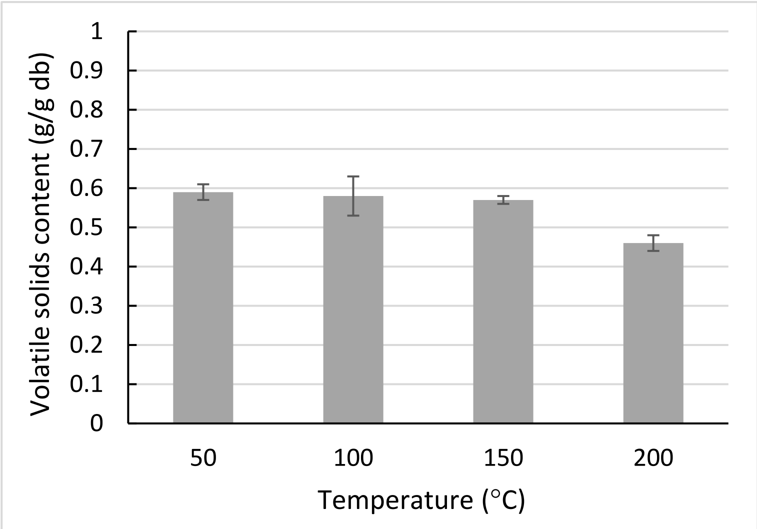
Volatile solids content as a function of moisture content and temperature



Observations:

- Volatile solid content constant as sludge dried
- No effect of drying temperature

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal, South Africa
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from a urine diversion dry toilet (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until completely dry
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Volatile solids
Employed method	Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files	
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Volatile solids content as a function of temperature 	Observations: ○ Volatile solids constant between 50 and 150°C ○ Lower volatile solid content at 200°C (possible thermal degradation)

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Volatile solids
Employed method	Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

Data source files

https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

Additional Notes

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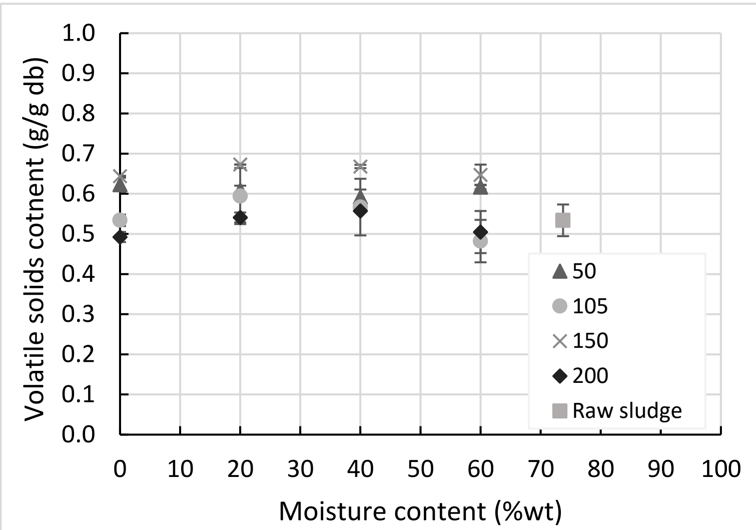
Description of Data

Volatile solids content as a function of moisture content and temperature



Observations:

- Volatile solid content constant as sludge dried
- No effect of drying temperature

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal, Durban South Africa
Dates of the experiments	2014-2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 70% db
Ash content	~ 30% db
Presence of trash?	Yes
Pre-treatment	o Screening to remove the large pieces of trash o Addition of 3%wt of sawdust for pellets formation
Experimental Procedure	
Drying experimental setup	Laboratory-scale medium infrared (MIR) dryer ('LaDePa')
Drying time	0, 4, 9, 13, 17, 25, 40 min
Operating conditions	o MIR emitters power: 3, 5 and 6.5 kW (corresponding to ~ 85, 135 and 215°C respectively) o Distance between the emitters and the sample: 115 mm o Air stream flowrate: 18.3 m^3/min o Air humidity: ambient (70-80%)
Sample form in the dryer	Pellets of 8, 10, 12 and 14 mm diameter
Analysed parameters	Volatile solids/ash content
Employed methods	Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)
Publications	
Mirara, S.W. (2017). Drying and Pasteurisation of VIP Latrine Faecal Sludge using a Bench Scale Medium Infrared Machine. Master thesis. University of KwaZulu-Natal, Durban, South Africa.	

Septien, S., Mirara, S.W., Singh, A., Velkushanova, K., & Buckley, C. (2018). Characterisation of On-Site Sanitation Material and Products: VIP Latrines and Pour-Flush Toilets. WRC project final report. South Africa.

Septien, S., Mirara, S. W., Makununika, B., Singh, A., Pocock, J., Velkushanova, K., & Buckley, C. A. (2019). Effect of drying on the physical and chemical properties of faecal sludge for its reuse. Journal of Environmental Chemical Engineering, 103652.

Data source files

https://www.dropbox.com/s/qbqkf45sx5ysk25/2014-2015%20VIP%20composition%20analysis.xlsx?dl=0

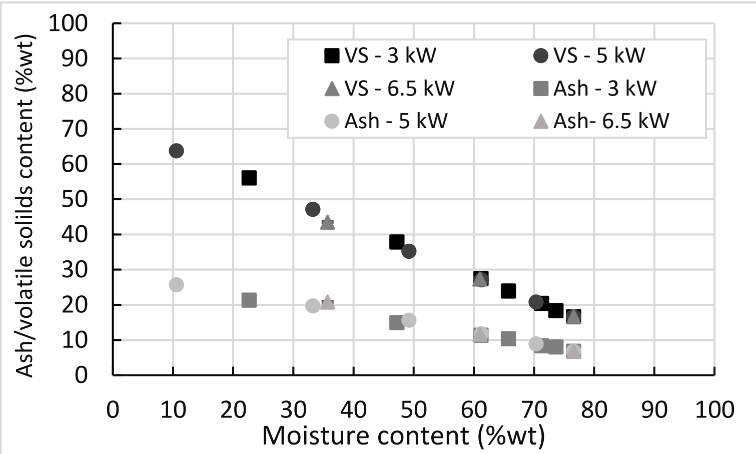
Additional Notes

- Volatile solids content + Ash content = 1

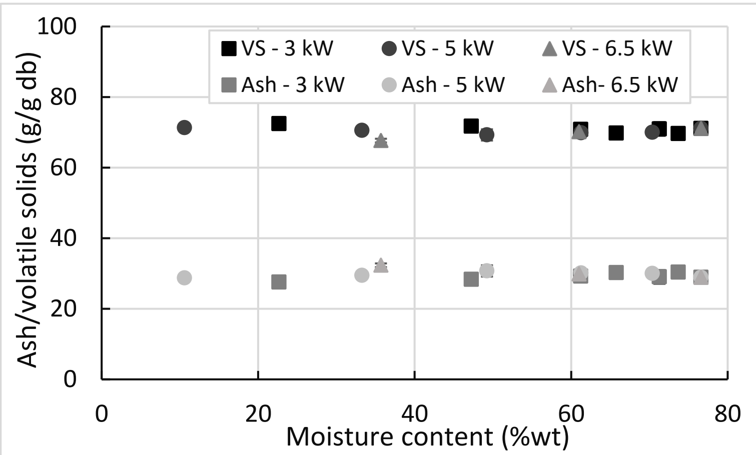
Description of Data

Ash and volatile solids (VS) content versus moisture content as a function of the MIR emitter power

Wet basis



Dry basis

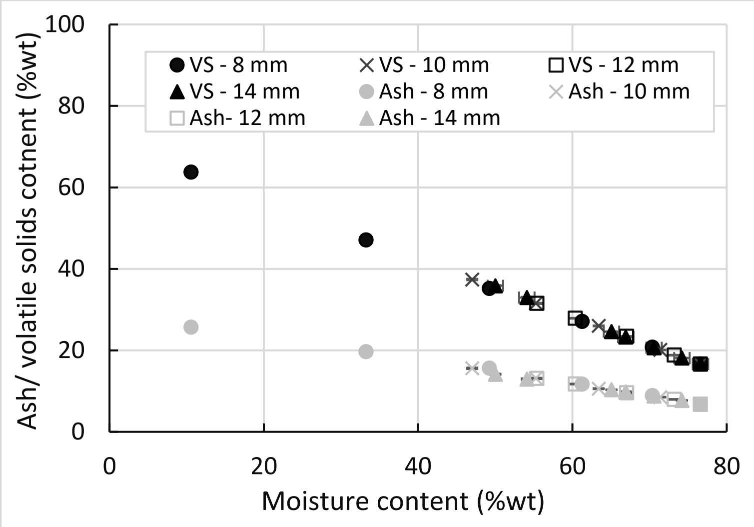


Observations:

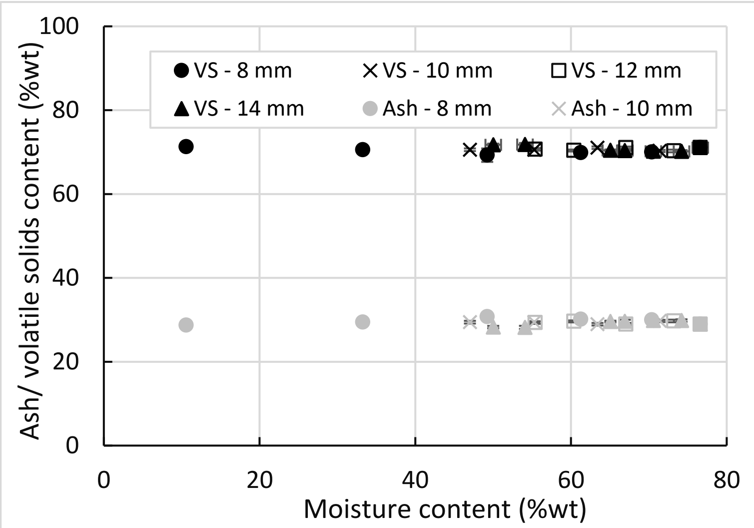
- Increase of ash and volatile solids content in wet basis as sludge dried
- Constant ash and volatile solids content in dry basis during drying
- No effect of MIR emitter power on the volatile solids / ash content

Ash and volatile solids (VS) content versus moisture content as a function of the pellet diameter

Wet basis



Dry basis



Observations:

- Increase of ash and volatile solids content in wet basis as sludge dried
- Constant ash and volatile solids content in dry basis during drying
- No effect of MIR emitter power on the volatile solids / ash content

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge collected from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 50% db
Ash content	~ 50% db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom design convective drying rig
Drying time	Until mass stabilisation
Operating conditions	o Air temperature: 40, 60 and 80°C o Air humidity: 0% o Air velocity: 0.06 cm/s
Sample form in the dryer	Pellets of 8 mm diameter
Analysed parameters	(1) Moisture/total solids (2) Volatile solids/ash content
Employed methods	(1) Weighing the sample before and after drying at 105°C for 24 h (SOP 8.7.1.1) (2) Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)

Publications

Makununika, B. S. N. (2016). Thermal drying of faecal sludge from VIP latrines and characterisation of dried faecal material. Master thesis. University of KwaZulu-Natal, Durban, South Africa.

Data source files

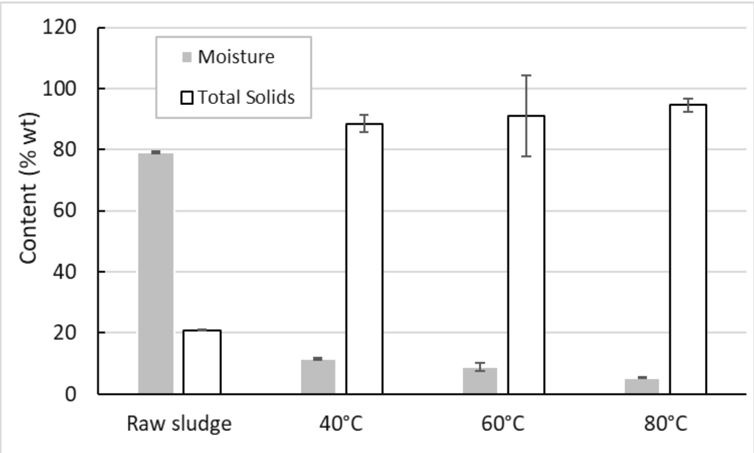
https://www.dropbox.com/s/2dg6xp8s0m5pfse/2014-2015%20VIP%20Physicochemical%20properties.xlsx?dl=0

Additional Notes

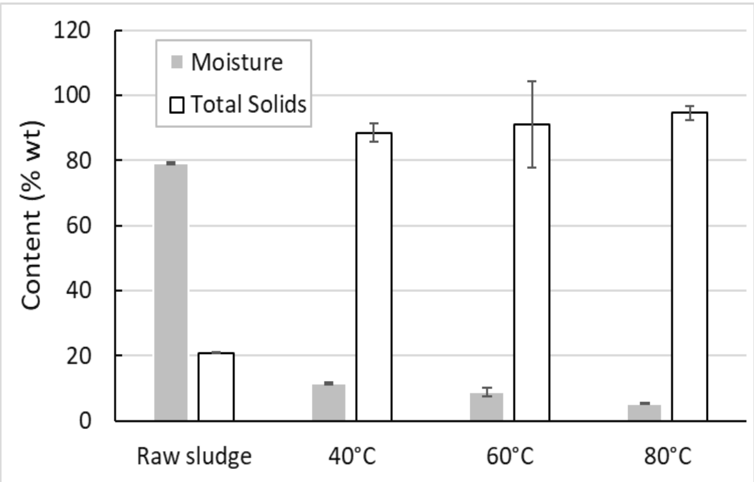
- Moisture content + Total Solids content = 1
- Volatile Solids content + Ash content = 1

Description of Data

Moisture and total solids content as a function of temperature



Ash and volatile solids content as a function of temperature



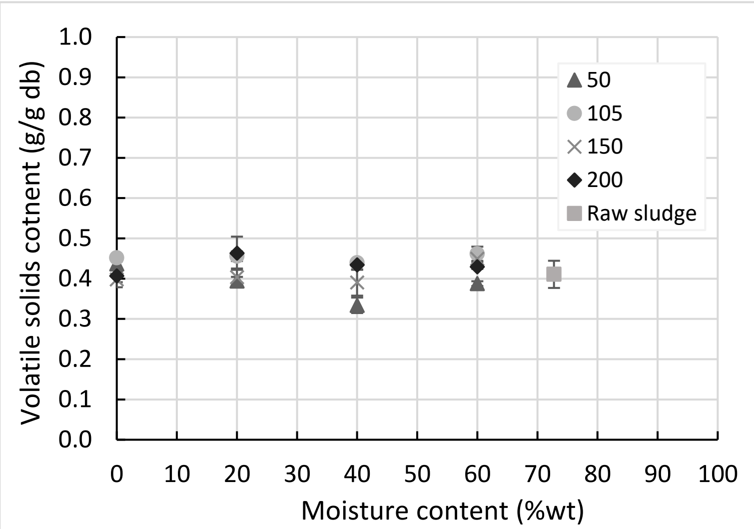
Observations:

- Lower moisture content achieved after drying at the highest temperature (80°C)
- Not complete drying achieved
- No effect of drying temperature on the volatile solid and ash content

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 40%db
Ash content	~ 60%db
Presence of trash?	Yes (mainly hair extensions, plastic and rocks)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Volatile solids
Employed method	Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.
Data source files
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0
Additional Notes
-
Description of Data

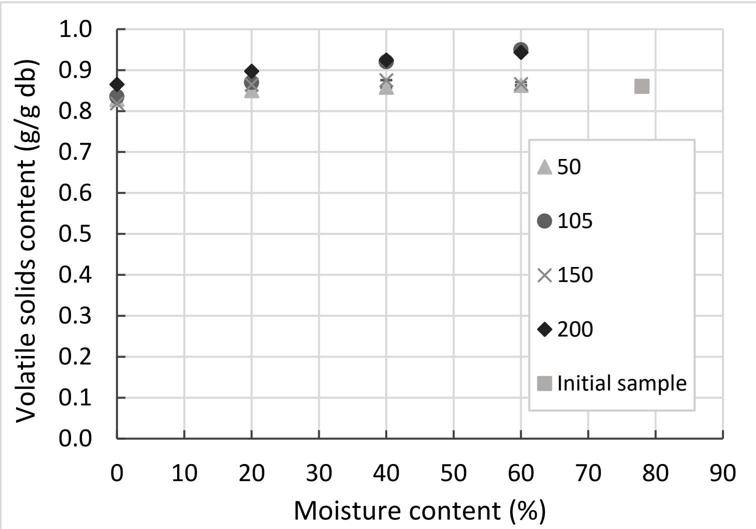
Volatile solids content as a function of moisture content and temperature



Observations:

- Volatile solid content constant as sludge dried
- No effect of drying temperature

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 0, 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Volatile solids
Employed method	Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)
Publications	
-	

Data source files	
https://www.dropbox.com/s/vpa68hptk81v4e4/2019%20Fresh%20faeces%20tests_PRG.xlsx?dl=0	
Additional Notes	
Fresh faeces collected from voluntary and anonymous donations	
Description of Data	
Volatile solids as a function of moisture content of the faeces and temperature 	Observations: ○ Lower volatile solid content of dried sludge compared to raw material ○ No effect of temperature

General information	
Type of data	Composition
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Temperature: ambient (~ 20°C) ○ Relative humidity: ambient (~ 60%)
Sample form in the dryer	900 g of sample placed in 1 L plastic bucket
Analysed parameters	Volatile solids content
Employed method	Weighing the sample before and after calcination at 550°C (SOP 8.7.1.2)
Publications	
-	

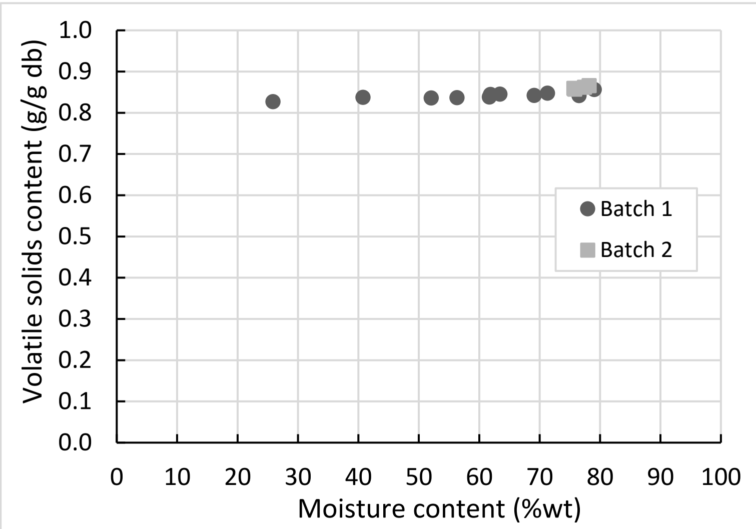
Data source files

https://www.dropbox.com/s/xbv6su0jxsipiok/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20the%20open%20air_UKZN%20PRG.xlsx?dl=0

Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Containers with sample placed in a ventilated area
- Mesh placed at the opening of the container to avoid the development of maggots
- Samples from batch 1 analysed in a weekly basis for 16 weeks
- Samples from batch 2 analysed at days 0, 3, 5 and 7 during one week

Description of Data

Volatile solids content as a function of moisture content for the samples from batch 1 and 2	Observations:
	○ Constant volatile solid content during drying

General information	
Type of data	Elemental nutrient content
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 70% db
Ash content	~ 30% db
Presence of trash?	Yes
Pre-treatment	o Screening to remove the large pieces of trash o Addition of 3%wt of sawdust for pellets formation
Experimental Procedure	
Drying experimental setup	Laboratory-scale medium infrared (MIR) dryer ('LaDePa')
Drying time	0, 4, 9, 13, 17, 25, 40 min
Operating conditions	o MIR emitters power: 3, 5 and 6.5 kW (corresponding to ~ 85, 135 and 215°C respectively) o Distance between the emitters and the sample: 115 mm o Air stream flowrate: 18.3 m^3/min o Air humidity: ambient (70-80%)
Sample form in the dryer	Pellets of 8 and 14 mm diameter
Analysed parameters	Carbon (C), nitrogen (N), sulphur (S), Phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg)
Employed methods	(1) Use of CNS analyzer (SOP 8.7.7.2) (2) Use of microwave plasma – atomic emission spectroscopy (SOP 8.7.7.1)

Publications

Mirara, S.W. (2017). Drying and Pasteurisation of VIP Latrine Faecal Sludge using a Bench Scale Medium Infrared Machine. Master thesis. University of KwaZulu-Natal, Durban, South Africa.

Septien, S., Mirara, S.W., Singh, A., Velkushanova, K., & Buckley, C. (2018). Characterisation of On-Site Sanitation Material and Products: VIP Latrines and Pour-Flush Toilets. WRC project final report. South Africa.

Septien, S., Mirara, S. W., Makununika, B., Singh, A., Pocock, J., Velkushanova, K., & Buckley, C. A. (2019). Effect of drying on the physical and chemical properties of faecal sludge for its reuse. Journal of Environmental Chemical Engineering, 103652.

Data source files

https://www.dropbox.com/s/qbqkf45sx5ysk25/2014-2015%20VIP%20composition%20analysis.xlsx?dl=0

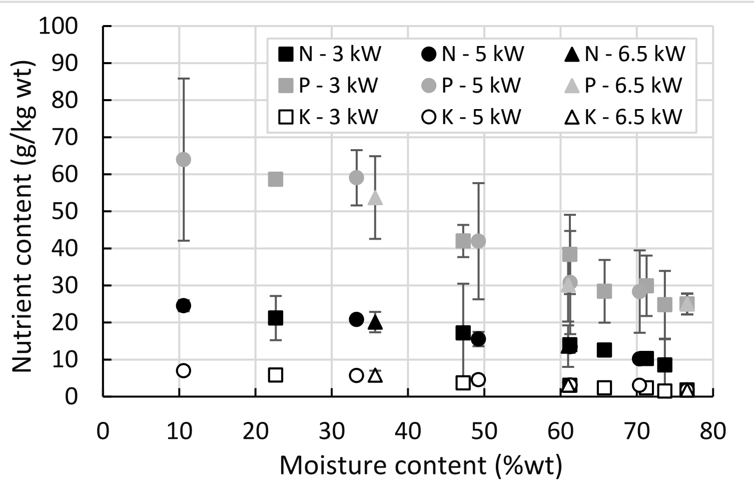
Additional Notes

-

Description of Data

Nitrogen (N), phosphorous (P) and potassium (K) content versus moisture content as a function of the MIR emitter power

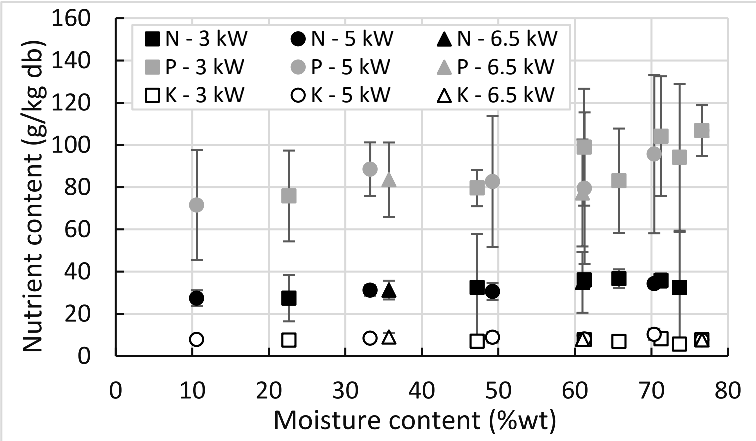
Wet basis



Observations:

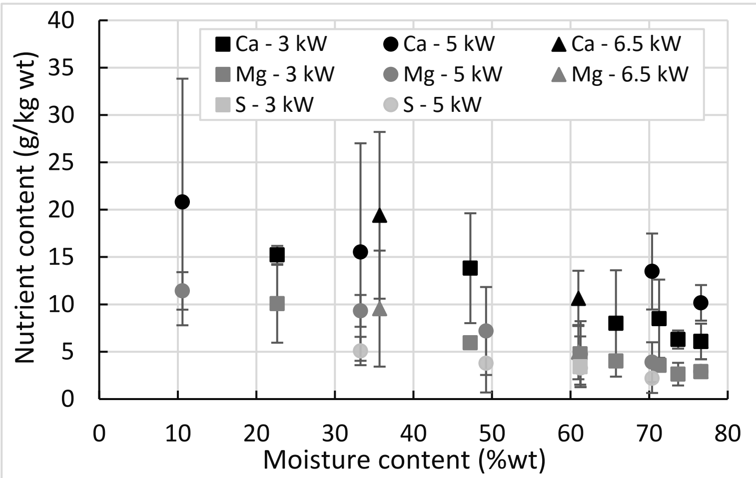
- Increase of nutrient content in wet basis as sludge dried
- Constant nutrient content in dry basis during drying
- No effect of MIR emitter power on the nutrient content

Dry basis

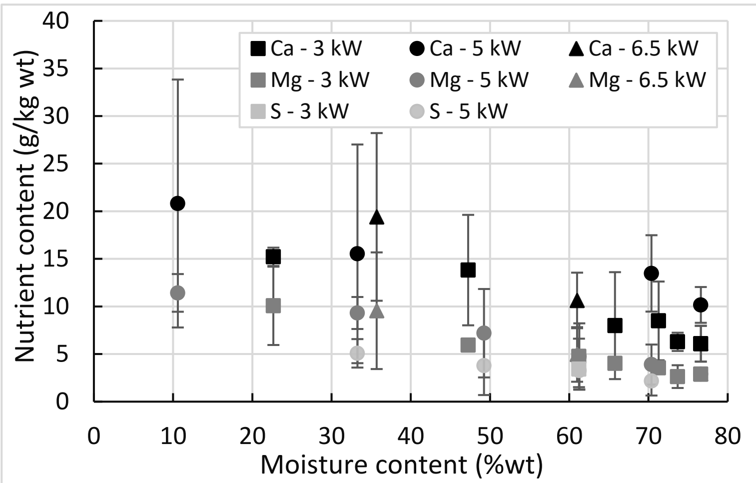


Calcium (Ca), magnesium (Mg) and sulphur (S) content versus moisture content as a function of the MIR emitter power

Wet basis



Dry basis

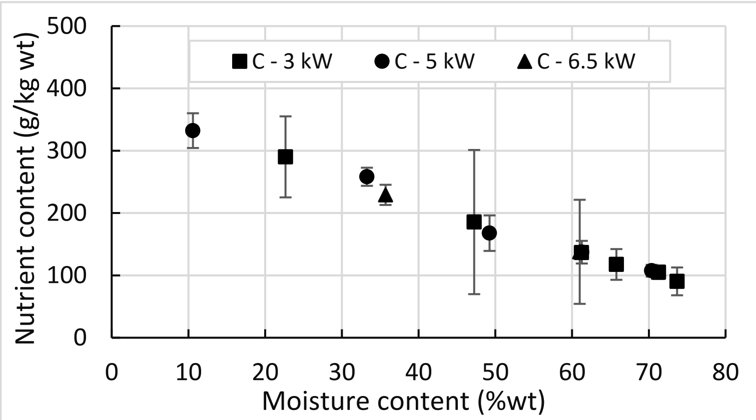


Observations:

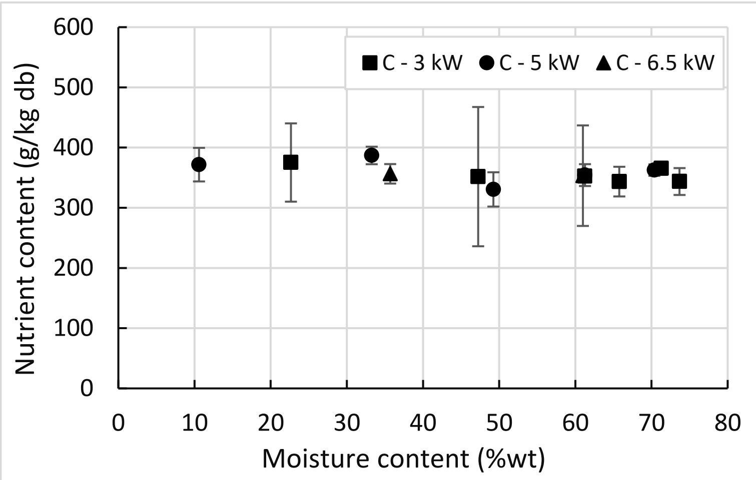
- Increase of nutrient content in wet basis as sludge dried
- Constant nutrient content in dry basis during drying
- No effect of MIR emitter power on the nutrient content

Carbon (C) content versus moisture content as a function of the MIR emitter power

Wet basis

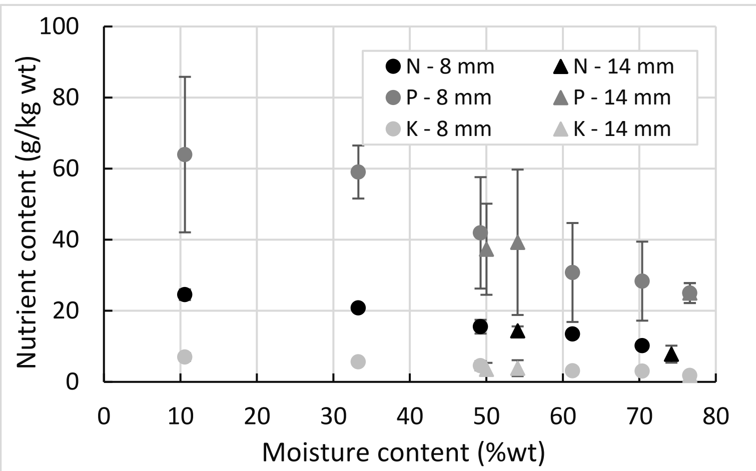


Dry basis



Nitrogen (N), phosphorous (P) and potassium (K) content versus moisture content as a function of the pellet diameter

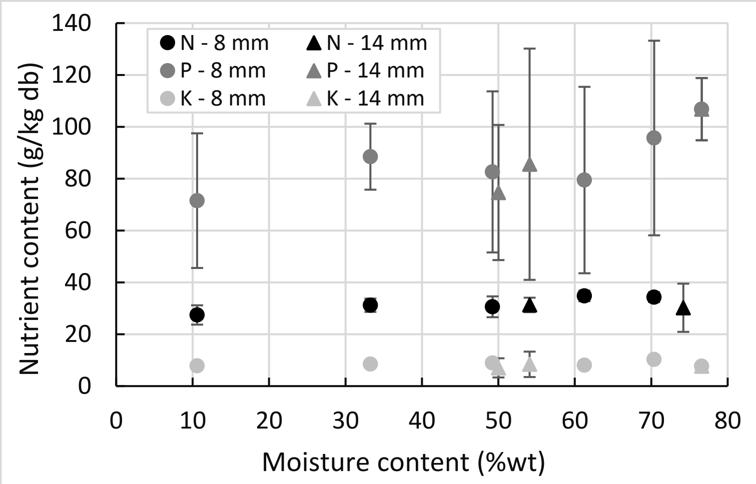
Wet basis



Observations:

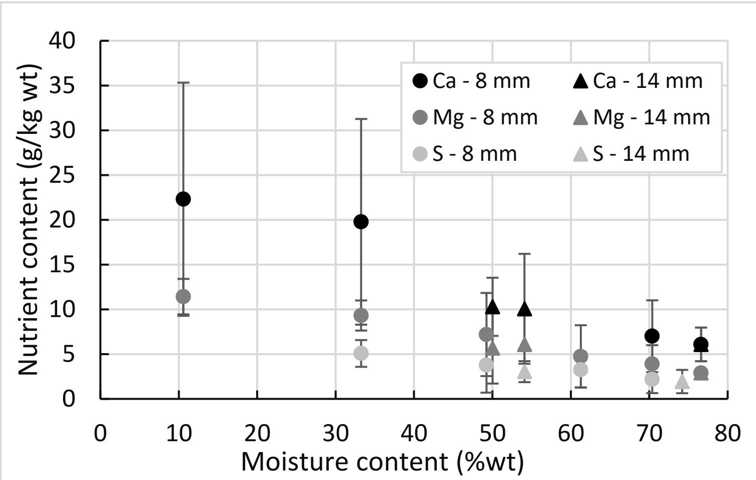
- Increase of nutrient content in wet basis as sludge dried
- Constant nutrient content in dry basis during drying
- No effect of pellet size on the nutrient content

Dry basis

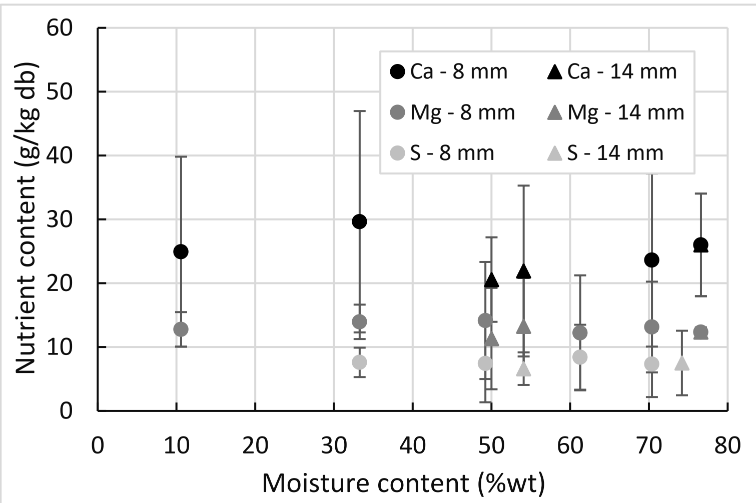


Calcium (Ca), magnesium (Mg) and sulphur (S) content (versus moisture content as a function of the pellet diameter

Wet basis



Dry basis

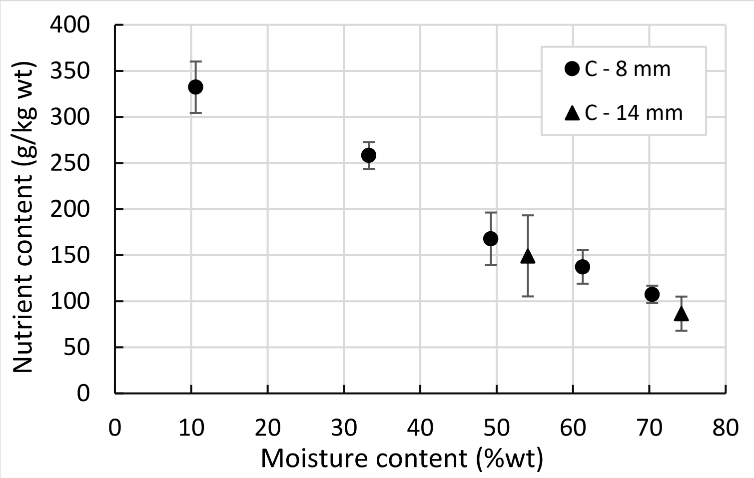


Observations:

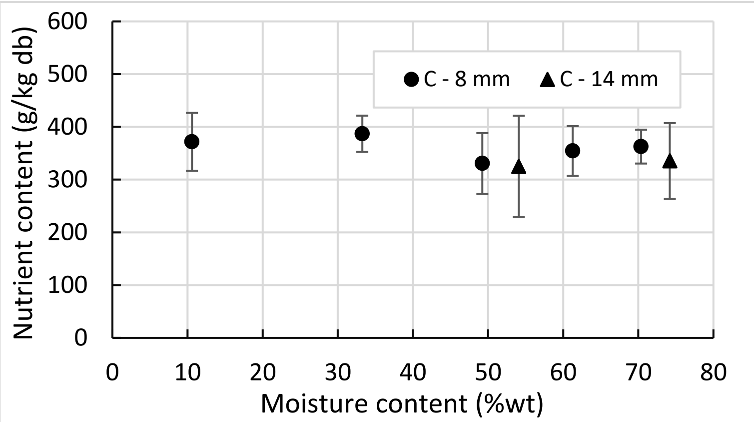
- Increase of nutrient content in wet basis as sludge dried
- Constant nutrient content in dry basis during drying
- No effect of pellet size on the nutrient content

Carbon (C) content versus moisture content as a function of the pellet diameter

Wet basis



Dry basis



General information	
Type of data	Elemental nutrient content
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge collected from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 50% db
Ash content	~ 50% db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom design convective drying rig
Drying time	Until mass stabilisation
Operating conditions	o Air temperature: 40, 60 and 80°C o Air humidity: 0% o Air velocity: 0.06 cm/s
Sample form in the dryer	Pellets of 8, 10 and 14 mm diameter
Analysed parameters	Carbon (C), nitrogen (N), sulphur (S), Phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg)
Employed methods	(1) Use of CNS analyzer (SOP 8.7.7.2) (2) Use of microwave plasma – atomic emission spectroscopy (SOP 8.7.7.1)
Publications	
Makununika, B. S. N. (2016). Thermal drying of faecal sludge from vip latrines and characterisation of dried faecal material. Master thesis. University of KwaZulu-Natal, Durban, South Africa.	

Septien, S., Mirara, S. W., Makununika, B., Singh, A., Pocock, J., Velkushanova, K., & Buckley, C. A. (2019). Effect of drying on the physical and chemical properties of faecal sludge for its reuse. Journal of Environmental Chemical Engineering, 103652.

Data source files

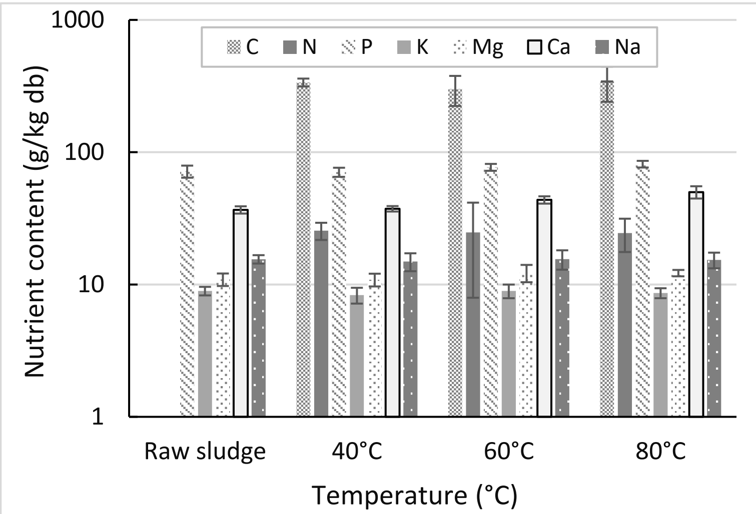
https://www.dropbox.com/s/2dg6xp8s0m5pfse/2014-2015%20VIP%20Physicochemical%20properties.xlsx?dl=0

Additional Notes

-

Description of Data

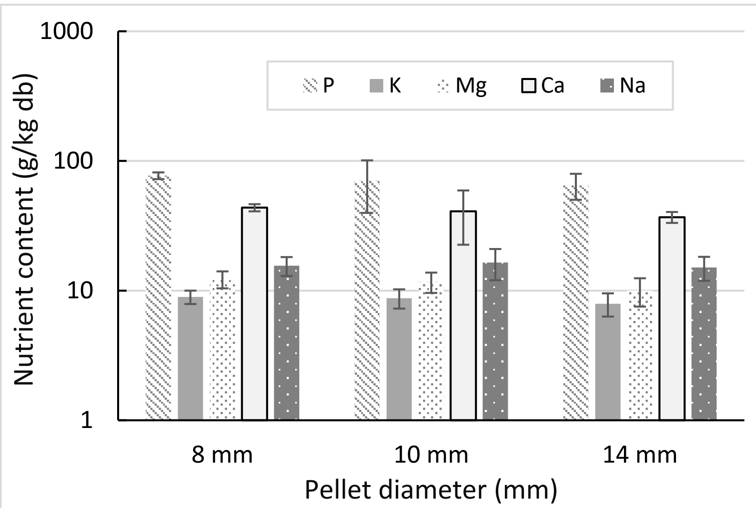
Nutrient content (in dry basis) as a function of temperature



Observations:

- Same nutrient content in dry basis between the raw and dried sludge
- No effect of drying temperature on the nutrient content

Nutrient content (in dry basis) as a function of pellet diameter



Observations:

- Same nutrient content in dry basis between the raw and dried sludge
- No effect of pellet size on the nutrient content

General information	
Type of data	Elemental nutrient content
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal, Durban South Africa
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 85% db
Ash content	~ 15% db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Temperature: ambient (~ 20°C) ○ Relative humidity: ambient (~ 60%)
Sample form in the dryer	900 g of sample placed in 1 L plastic bucket
Analysed parameters	Carbon (C), nitrogen (N), sulphur (S)
Employed methods	Use of CNS analyzer (SOP 8.7.7.2)
Publications	
-	

Data source files

https://www.dropbox.com/s/xbv6su0jxsipiok/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20the%20open%20air_UKZN%20PRG.xlsx?dl=0

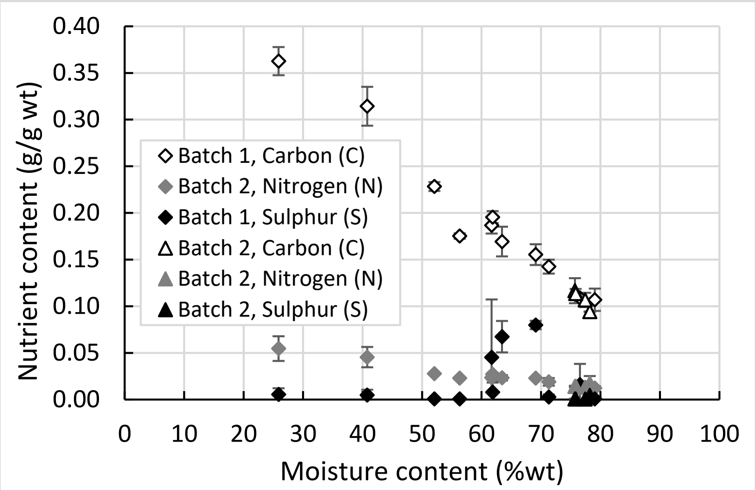
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Containers with sample placed in a ventilated area
- Mesh placed at the opening of the container to avoid the development of maggots
- Samples from batch 1 analysed in a weekly basis for 16 weeks
- Samples from batch 2 analysed at days 0, 3, 5 and 7 during one week

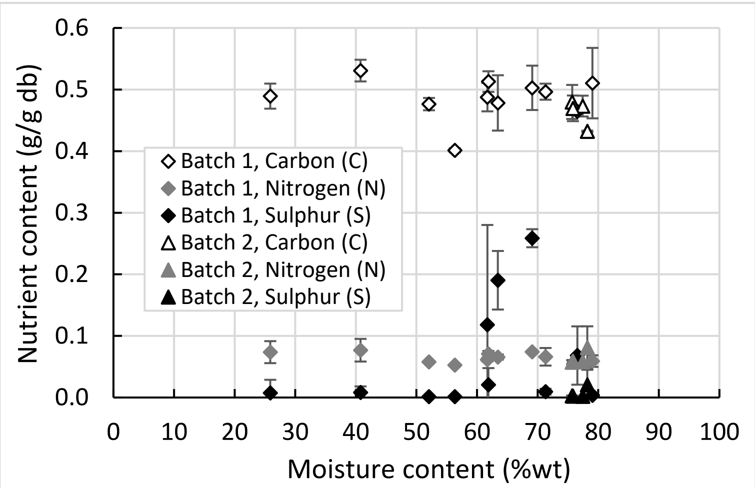
Description of Data

Nutrient content as a function of moisture content for the samples from batch 1 and 2

Wet basis



Dry basis



Observations:

- Increase of the C and N content in wet basis by decreasing the moisture content during drying
- Fairly constant C and N content in dry basis during drying
- No significant variation of the S content during drying

General information	
Type of data	Molecular nutrient content
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	A few years ago
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 70% db
Ash content	~ 30% db
Presence of trash?	Yes
Pre-treatment	○ Screening to remove the large pieces of trash ○ Addition of 3%wt of sawdust for pellets formation
Experimental Procedure	
Drying experimental setup	Laboratory-scale medium infrared (MIR) dryer ('LaDePa')
Drying time	0, 4, 9, 13, 17, 25, 40 min
Operating conditions	○ MIR emitters power: 3, 5 and 6.5 kW (corresponding to ~ 85, 135 and 215°C respectively) ○ Distance between the emitters and the sample: 115 mm ○ Air stream flowrate: 18.3 m^3/min ○ Air humidity: ambient (70-80%)
Sample form in the dryer	Pellets of 8 and 14 mm diameter
Analysed parameters	Ammonium (NH_4^+), nitrites (NO_2^-), nitrates (NO_3^-), phosphates (PO_4^{-3})
Employed methods	Use of spectrophotometer after blending the sample, centrifugation and recovery of the supernatant for analysis (SOP 8.7.5.1; 8.7.5.4; 8.7.5.10)

Publications

Mirara, S.W. (2017). Drying and Pasteurisation of VIP Latrine Faecal Sludge using a Bench Scale Medium Infrared Machine. Master thesis. University of KwaZulu-Natal, Durban, South Africa.

Septien, S., Mirara, S.W., Singh, A., Velkushanova, K., & Buckley, C. (2018). Characterisation of On-Site Sanitation Material and Products: VIP Latrines and Pour-Flush Toilets. WRC project final report. South Africa.

Septien, S., Mirara, S. W., Makununika, B., Singh, A., Pocock, J., Velkushanova, K., & Buckley, C. A. (2019). Effect of drying on the physical and chemical properties of faecal sludge for its reuse. Journal of Environmental Chemical Engineering, 103652.

Data source files

https://www.dropbox.com/s/qbqkf45sx5ysk25/2014-2015%20VIP%20composition%20analysis.xlsx?dl=0

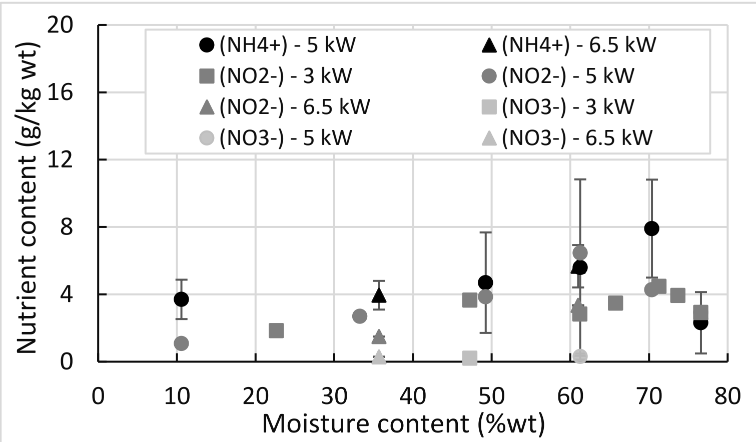
Additional Notes

-

Description of Data

Ammonium (NH_4^+), nitrites (NO_2^-) and nitrates (NO_3^-) content versus moisture content as a function of the MIR emitter power

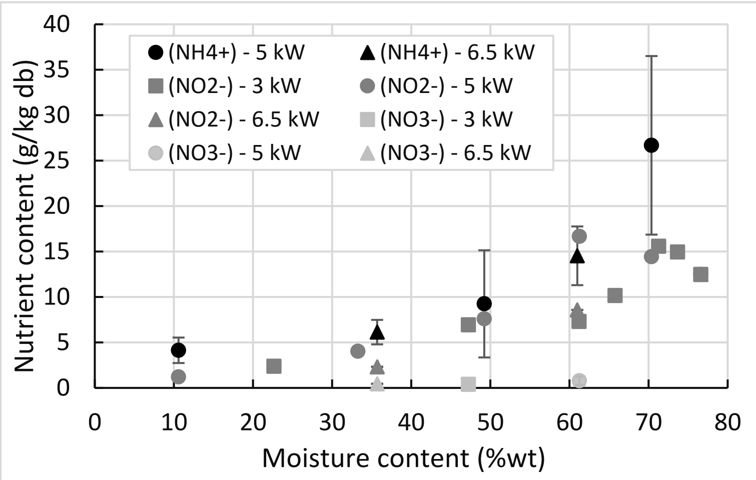
Wet basis



Observations:

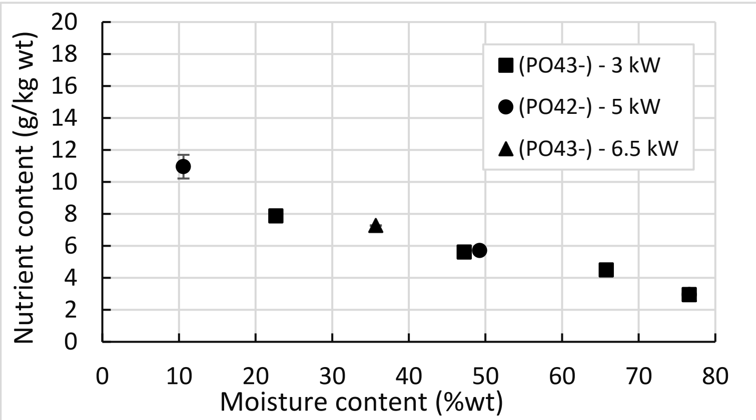
- Decrease of nutrient content as sludge dried (in both wet and dry basis)
- No effect of MIR emitter power on the nutrient content

Dry basis

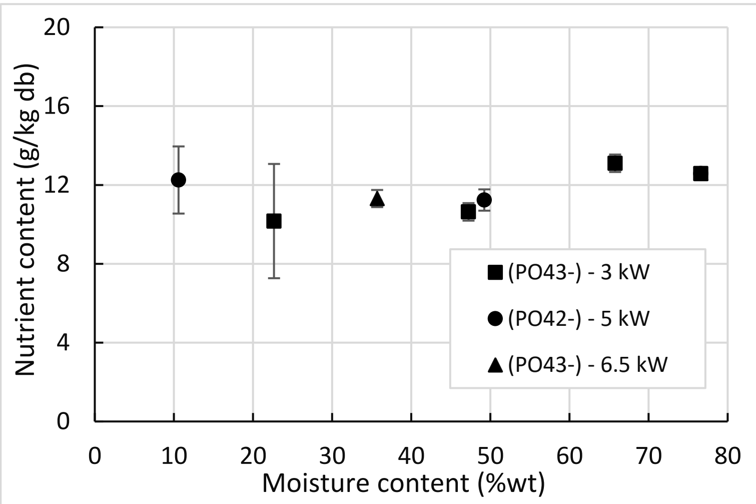


<u>Phosphates (PO_4^{3-}) content versus moisture content as a function of the MIR emitter power</u>

Wet basis



Dry basis



<u>Observations:</u>

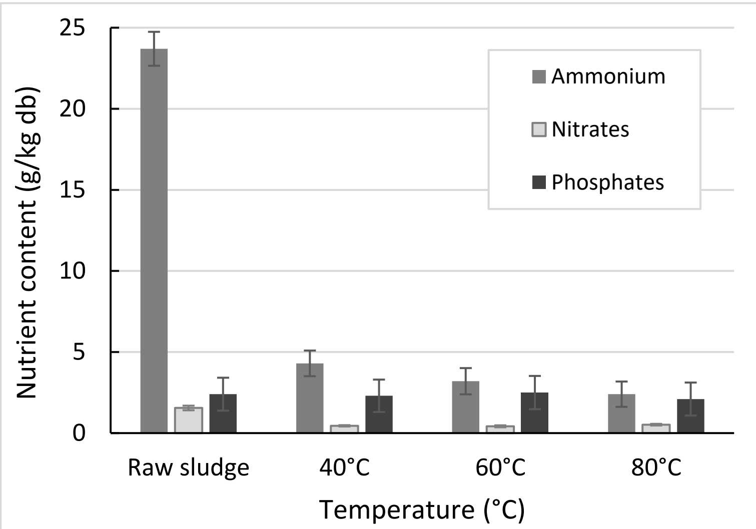
- Decrease of nutrient content as sludge dried (in both wet and dry basis)
- No effect of MIR emitter power on the nutrient content

General information	
Type of data	Molecular nutrient content
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 50% db
Ash content	~ 50% db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom design convective drying rig
Drying time	Until mass stabilisation
Operating conditions	○ Air temperature: 40, 60 and 80°C ○ Air humidity: 0% Air velocity: 0.06 cm/s
Sample form in the dryer	Pellets of 8 mm diameter
Analysed parameters	Ammonium (NH_4^+), nitrites (NO_2^-), nitrates (NO_3^-), phosphates (PO_4^{-3})
Employed methods	Use of spectrophotometer after blending the sample, centrifugation and recovery of the supernatant for analysis (SOP 8.7.5.1; 8.7.5.4; 8.7.5.10)
Publications	

Makununika, B. S. N. (2016). Thermal drying of faecal sludge from VIP latrines and characterisation of dried faecal material. Master thesis. University of KwaZulu-Natal, Durban, South Africa.

Septien, S., Mirara, S. W., Makununika, B., Singh, A., Pocock, J., Velkushanova, K., & Buckley, C. A. (2019). Effect of drying on the physical and chemical properties of faecal sludge for its reuse. Journal of Environmental Chemical Engineering, 103652.
Data source files
https://www.dropbox.com/s/2dg6xp8s0m5pfse/2014-2015%20VIP%20Physicochemical%20properties.xlsx?dl=0
Additional Notes
-
Description of Data

Ammonium (NH_4^+), nitrites (NO_2^-) and phosphates (PO_4^{3-}) as a function of temperature



Observations:

- Decrease of NH_4^+ and NO_2^- content in the dried sludge with respect to the raw material
- Same PO_4^{-3} content between the raw and dried sludge
- No effect of drying temperature on the nutrient content

General information	
Type of data	Molecular nutrient content
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 85% db
Ash content	~ 15% db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Temperature: ambient (~ 20°C) ○ Relative humidity: ambient (~ 60%)
Sample form in the dryer	900 g sample in 1 L plastic bucket
Analysed parameters	Ammonium (NH_4^+) and nitrates (NO_3^-)
Employed methods	Use of spectrophotometer after blending the sample (SOP 8.7.5.6 and 8.7.5.10)
Publications	
-	

Data source files

https://www.dropbox.com/s/xbv6su0jxsipiok/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20the%20open%20air_UKZN%20PRG.xlsx?dl=0

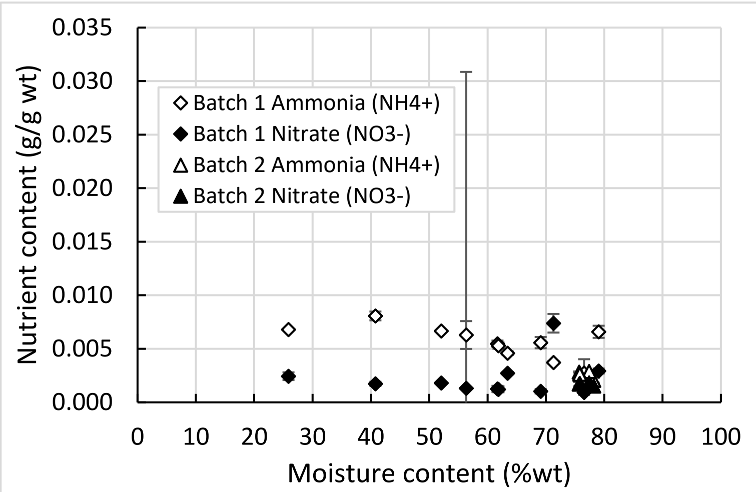
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Containers with sample placed in a ventilated area
- Mesh placed at the opening of the container to avoid the development of maggots
- Samples from batch 1 analysed in a weekly basis for 16 weeks
- Samples from batch 2 analysed at days 0, 3, 5 and 7 within initial week

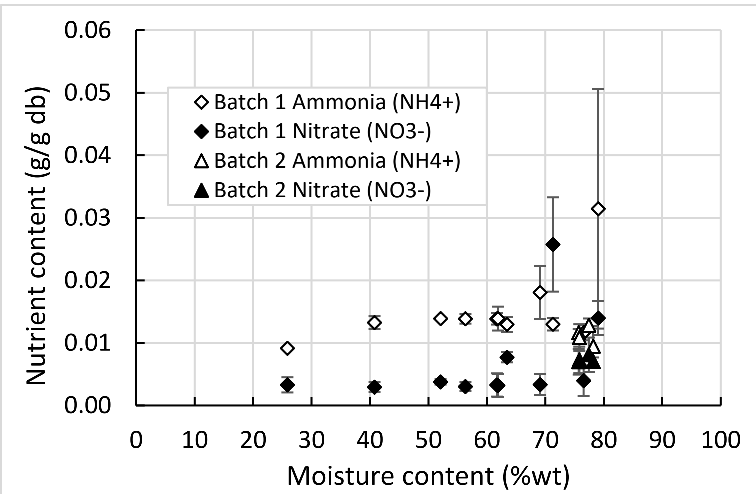
Description of Data

Nutrient content as a function of moisture content for the samples from batch 1 and 2

Wet basis



Dry basis



Observations:

- No significant variation of the nutrient content during drying

General information	
Type of data	Density
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2017 - 2018
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom-design solar thermal drying rig
Drying time	3 to 5 hours
Operating conditions	○ Irradiance: from 75 to 1000 W/m^2 (from overcast to sunny conditions) ○ Air flowrate: 0.5 m^3/min (corresponding to an air velocity of 0.5 and 1 m/s) ○ Air temperature: ambient (~20°C) ○ Air humidity: ~10%
Sample form in the dryer	Thin layer of 5 and 10 mm thickness, and 60 mm diameter
Analysed parameters	Density and Moisture content
Employed method	(1) Measurement of the volume (through the measurement of dimensions) and weight of the sample (SOP 8.8.2.1) (2) Weighing the sample before and after oven drying at 105°C for 24 h (SOP 8.7.1.1)

Publications

Mugauri, T.R. (2019). *Drying of faecal sludge from ventilated improved pit latrines (VIP latrines) using solar thermal energy*. MSc thesis, University of KwaZulu-Natal, South Africa.

Septien, S., Mugauri, T.R., Singh, A., Inambao, F. (2018). *Solar drying of faecal sludge from on-site sanitation facilities*. 5th Southern Africa Solar Thermal Energy Conference, Durban, South Africa, 25-27 June.

Septien, S., Mugauri, T.R., Singh, A., Inambao, F. (2017). *Drying of Faecal Sludge using Solar Thermal Energy* (final report project K5/2582). Water Research Commission, South Africa.

Data source files

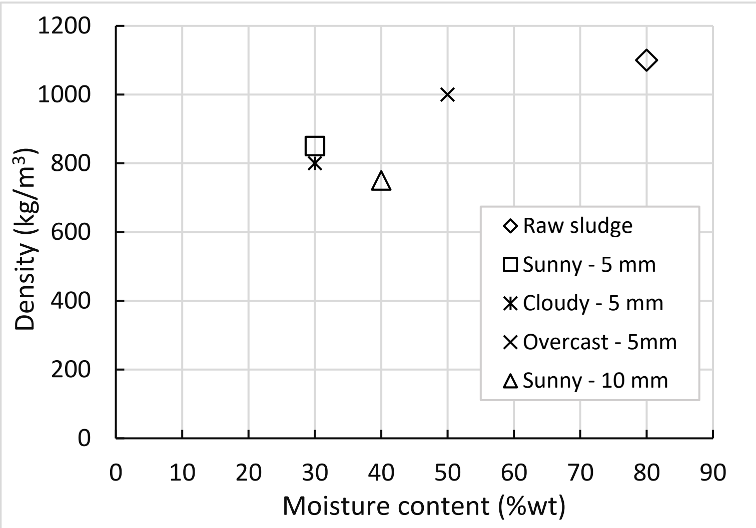
https://www.dropbox.com/s/ssumqzociucjaj2/Shrinkage%20of%20VIP%20sludge%20%282017-2018%29.xlsx?dl=0

Additional Notes

- Low precision of the current method (rough estimation)

Description of Data

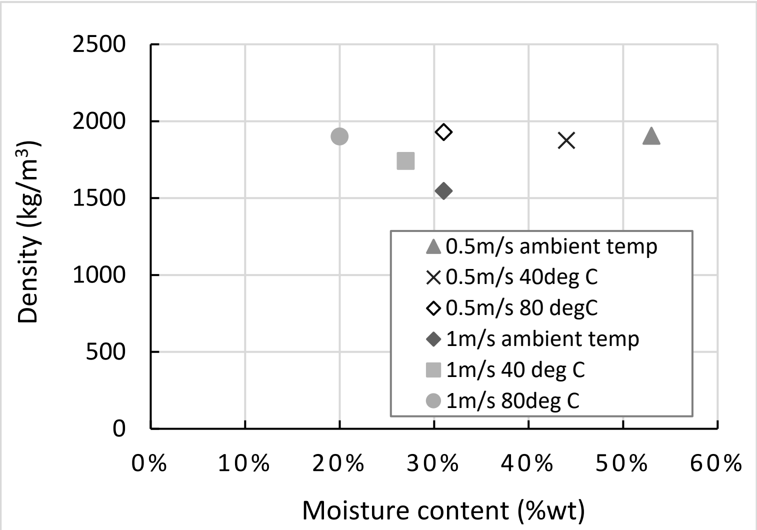
Density versus the moisture content obtained after drying at the different conditions



Observations

- Decrease of density as sample dried at lower moisture content

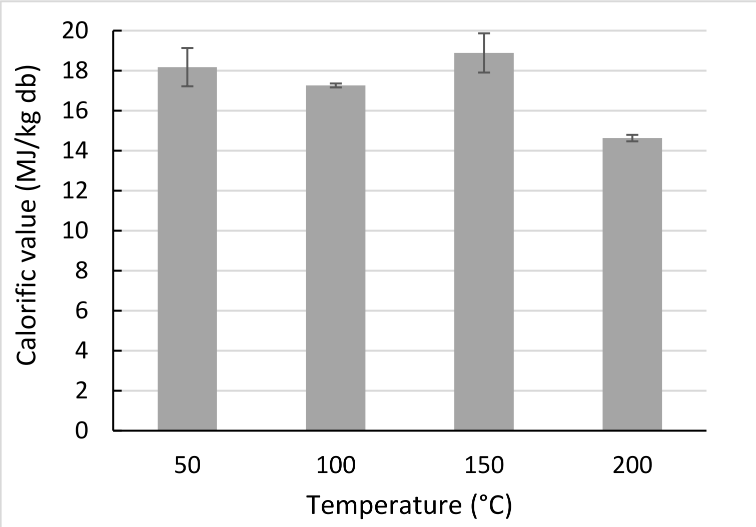
General information	
Type of data	Density
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Laboratory scale solar convective drying rig
Drying time	5 hours
Operating conditions	○ Irradiance: 800 – 1300 W/m^2 (sunny conditions) ○ Air flowrate: 0.5 and 1 m^3/min (corresponding to an air velocity of 0.5 and 1 m/s) ○ Air temperature: ambient (~20°C), 40 and 80°C ○ Air humidity: ~10%
Sample form	Thin layer of 5 mm thickness and 110 mm diameter
Analysed parameters	Density
Employed method	Measurement of the volume (through the measurement of dimensions) and weight of the sample (SOP 8.8.2.1)
Publications	
-	

Data source files	
https://www.dropbox.com/s/gscuvzvus55zfsr/2019-2020%20VIP%20Shrinkage%20data.xlsx?dl=0	
Additional Notes	
○ Density measured on the sample obtained at the end of a few experiments ○ Low precision of the current method (rough estimation)	
Description of Data	
Density versus the moisture content at the end of a few experiments 	Observations: ○ No significant variation of the density

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until completely dry
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Calorific value
Employed method	Use of calorimeter bomb *Parr 6200* (SOP 8.8.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0
Additional Notes
-
Description of Data

Gross calorific value as a function of temperature



Observations:

- Similar gross calorific value between 50 and 150°C
- Significant decrease at 200°C (possible thermal degradation)

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Calorific value
Employed method	Use of calorimeter bomb *Parr 6200* (SOP 8.8.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

Data source files

https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

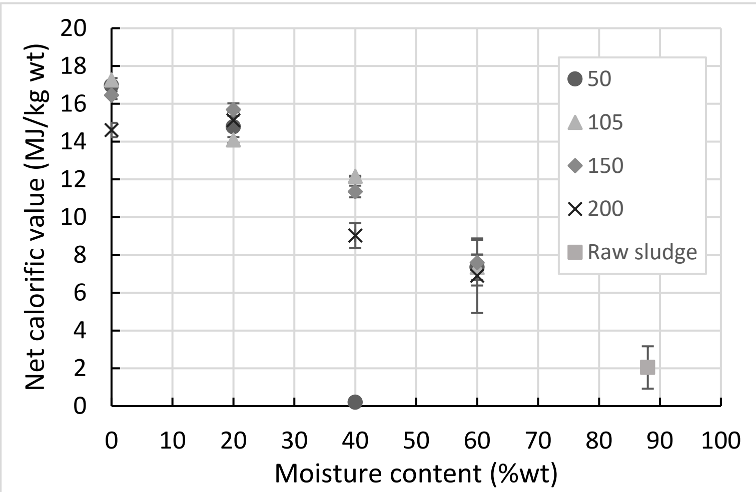
Additional Notes

-

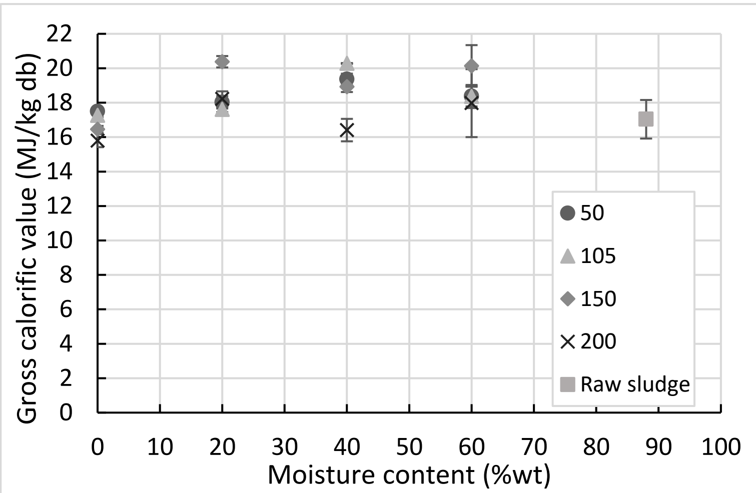
Description of Data

Calorific value as a function of moisture content and temperature

Wet basis



Dry basis



Observations:

- Increase of net calorific value as sludge dried
- Constant gross calorific value as sludge dried
- No effect of temperature

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until completely dry
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Calorific value
Employed method	Use of calorimeter bomb *Parr 6200* (SOP 8.8.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files

https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

Additional Notes

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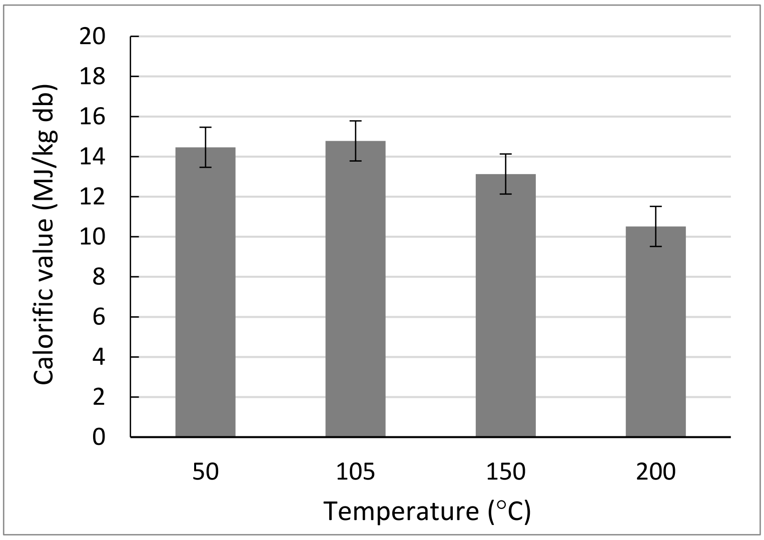
Description of Data

Gross calorific value as a function of temperature



Observations:

- Similar gross calorific value between 50 and 150°C
- Significant decrease at 200°C (possible thermal degradation)

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Calorific value
Employed method	Use of calorimeter bomb *Parr 6200* (SOP 8.8.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

Data source files

https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

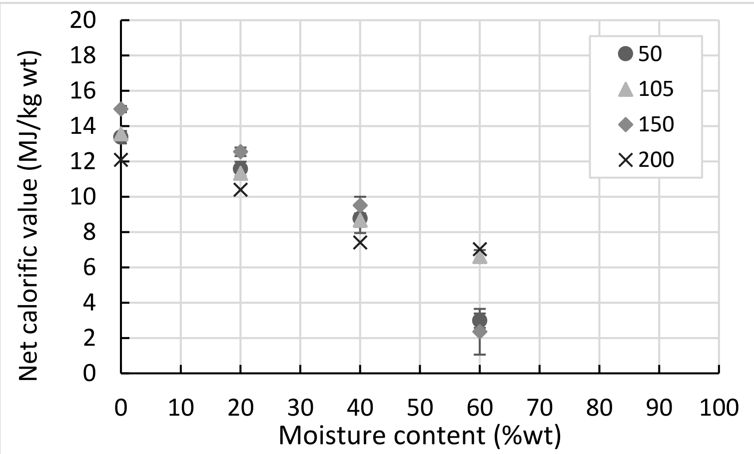
Additional Notes

-

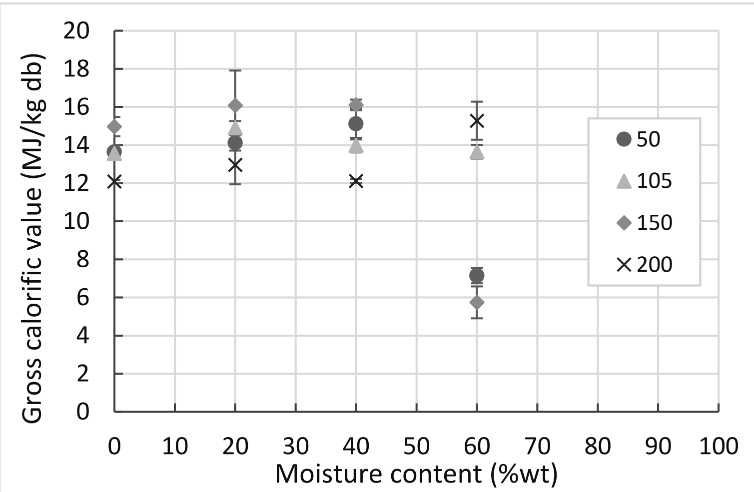
Description of Data

Calorific value as a function of moisture content and temperature

Wet basis



Dry basis



Observations:

- Increase of net calorific value as sludge dried
- Constant gross calorific value as sludge dried
- No effect of temperature
- Possible experimental error for 60%wt sample at 50 and 150°C

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80% wt
Total solids content	~ 20% wt
Volatile solids content	~ 70% db
Ash content	~ 30% db
Presence of trash?	Yes
Pre-treatment	○ Screening to remove the large pieces of trash ○ Addition of 3%wt of sawdust for pellets formation
Experimental Procedure	
Drying experimental setup	Laboratory-scale medium infrared (MIR) dryer ('LaDePa')
Drying time	0, 4, 9, 13, 17, 25, 40 min
Operating conditions	○ MIR emitters power: 3, 5 and 6.5 kW (corresponding to ~ 85, 135 and 215°C respectively) ○ Distance between the emitters and the sample: 115 mm ○ Air stream flowrate: 18.3 m^3/min ○ Air humidity: ambient (70-80%)
Sample form in the dryer	Pellets of 8, 10, 12 and 14 mm diameter
Analysed parameters	Calorific Value
Employed methods	Use of calorimeter (SOP 8.8.1.1)

Publications

Mirara, S.W. (2017). Drying and Pasteurisation of VIP Latrine Faecal Sludge using a Bench Scale Medium Infrared Machine. Master thesis. University of KwaZulu-Natal, Durban, South Africa.

Septien, S., Mirara, S.W., Singh, A., Velkushanova, K., & Buckley, C. (2018). Characterisation of On-Site Sanitation Material and Products: VIP Latrines and Pour-Flush Toilets. WRC project final report. South Africa.

Septien, S., Mirara, S. W., Makununika, B., Singh, A., Pocock, J., Velkushanova, K., & Buckley, C. A. (2019). Effect of drying on the physical and chemical properties of faecal sludge for its reuse. Journal of Environmental Chemical Engineering, 103652.

Data source files

https://www.dropbox.com/s/qbqkf45sx5ysk25/2014-2015%20VIP%20composition%20analysis.xlsx?dl=0

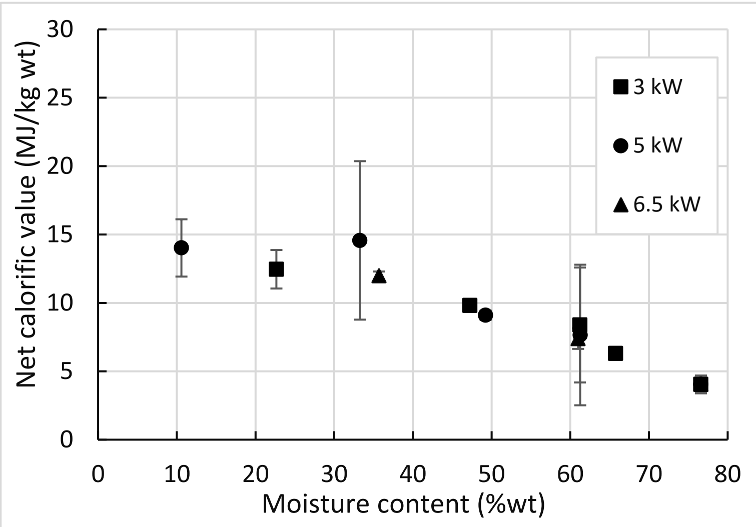
Additional Notes

-

Description of Data

Calorific value (wet and dry basis respectively) versus moisture content as a function of the MIR emitter power

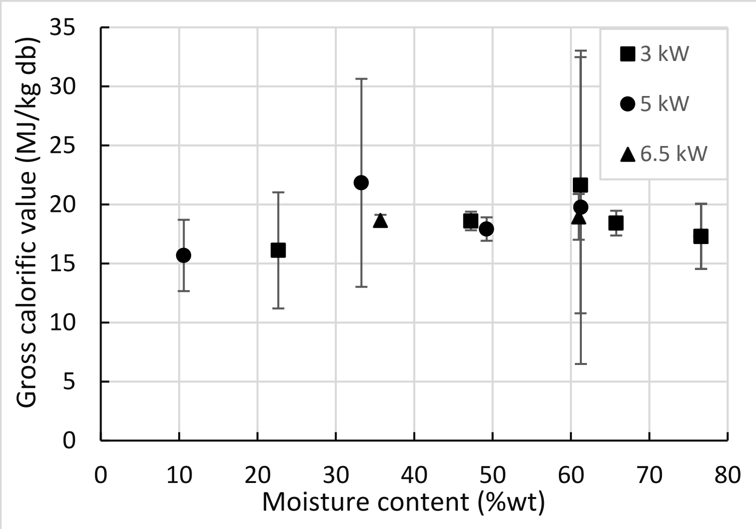
Wet basis



Observations:

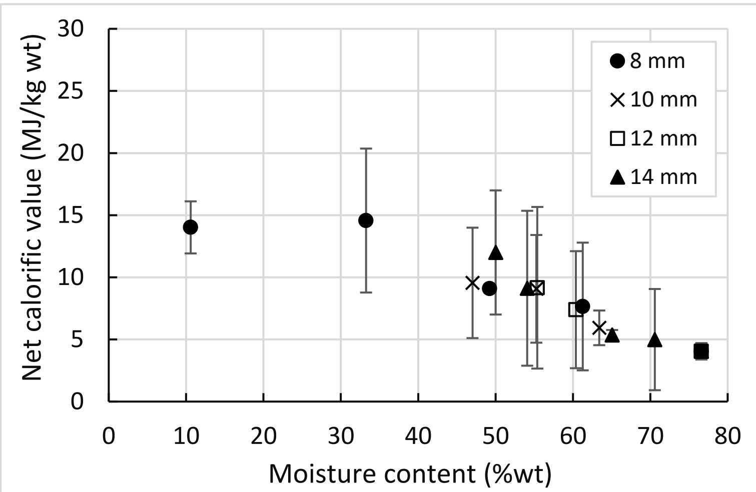
- Increase of net calorific value as sludge dried
- Constant gross calorific value during drying
- No effect of MIR emitter power on the calorific value

Dry basis

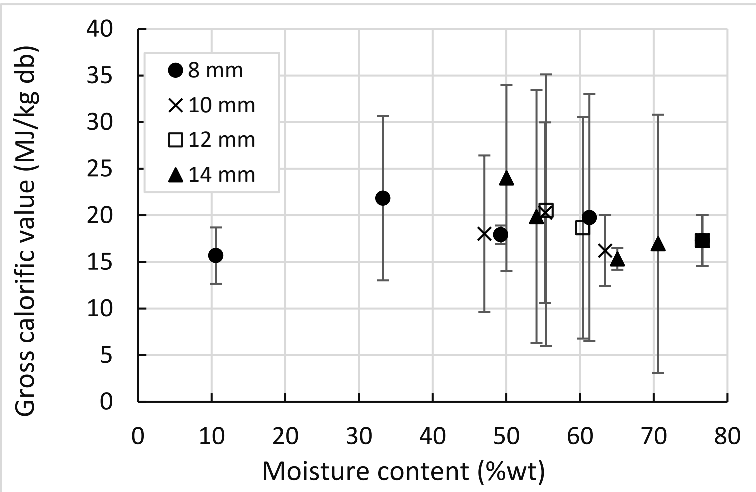


Net and gross calorific value versus moisture content as a function of the pellet diameter

Wet basis



Dry basis



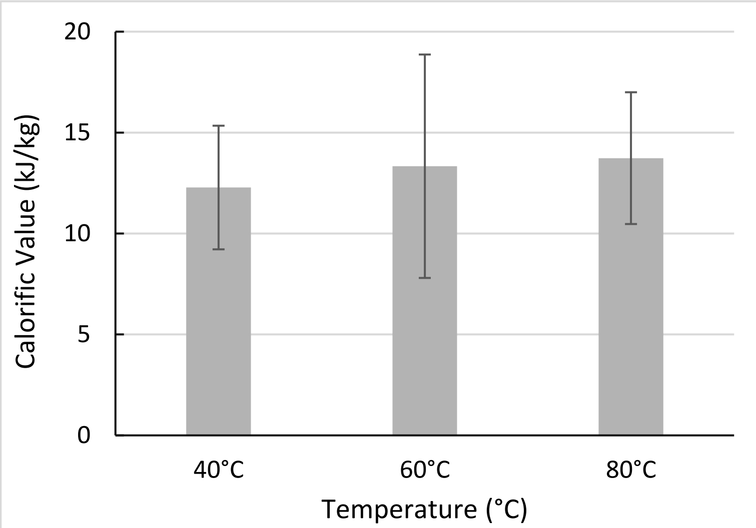
Observations:

- Increase of net calorific value as sludge gets
- Constant gross calorific value during drying
- No effect of pellet diameter on the calorific value

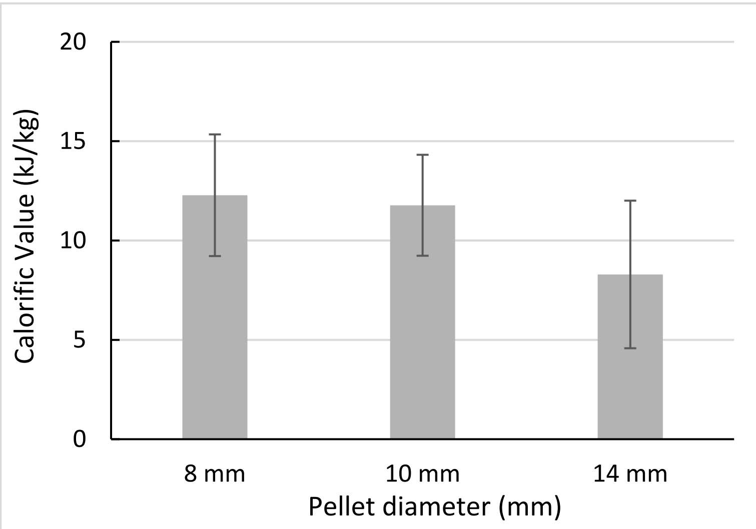
General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal Durban, South Africa
Dates of the experiments	2015-2016
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom design convective drying rig
Drying time	Until mass stabilisation
Operating conditions	○ Air temperature: 40, 60 and 80°C ○ Air humidity: 0% ○ Air velocity: 0.06 cm/s
Sample form in the dryer	Pellets of 8, 10 and 14 mm diameter
Analysed parameters	Calorific Value
Employed methods	Use of calorimeter (SOP 8.8.1.1)
Publications	
-	

Data source files
https://www.dropbox.com/s/2dg6xp8s0m5pfse/2014-2015%20VIP%20Physicochemical%20properties.xlsx?dl=0
Additional Notes
○ Sludge almost completely dried
Description of Data

Calorific value as a function of temperature



Calorific value as a function of pellet diameter



Observations:

- No effect of temperature and pellet size on the calorific value

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 40%db
Ash content	~ 60%db
Presence of trash?	Yes (mainly hair extensions and rocks)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Calorific value
Employed method	Use of calorimeter bomb *Parr 6200* (SOP 8.8.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

Data source files

https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

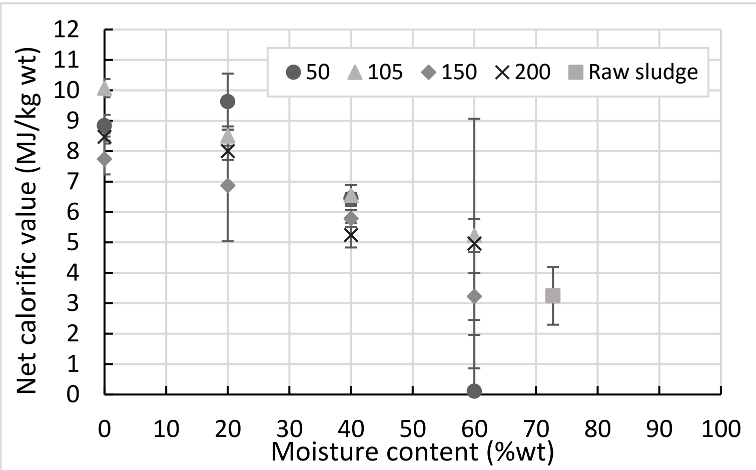
Additional Notes

-

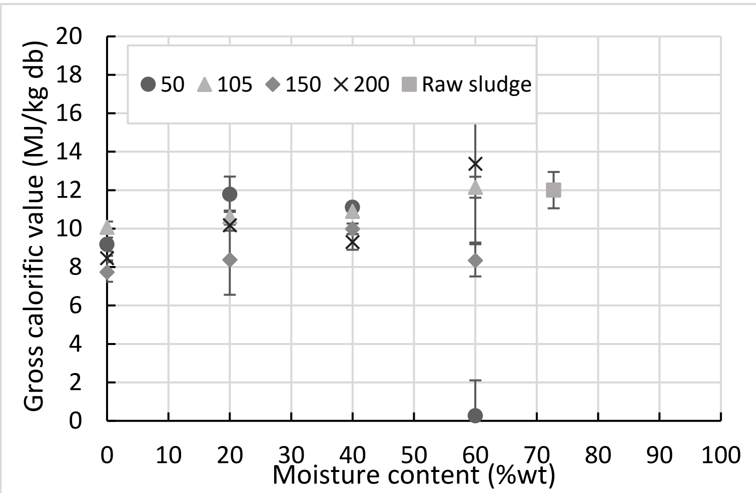
Description of Data

Calorific value as a function of moisture content and temperature

Wet basis



Dry basis



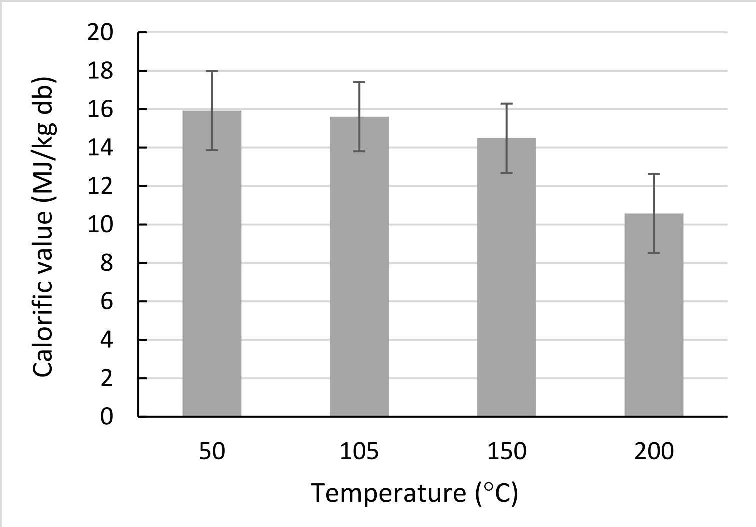
Observations:

- Increase of net calorific value as sludge dried
- Constant gross calorific value as sludge dried
- No effect of temperature
- Possible experimental error for 60%wt sample at 50°C

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	~ 65%db
Ash content	~ 35%db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Calorific value
Employed method	Use of calorimeter bomb *Parr 6200* (SOP 8.8.1.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Data source files
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0
Additional Notes
-
Description of Data

Gross calorific value as a function of temperature



Observations:

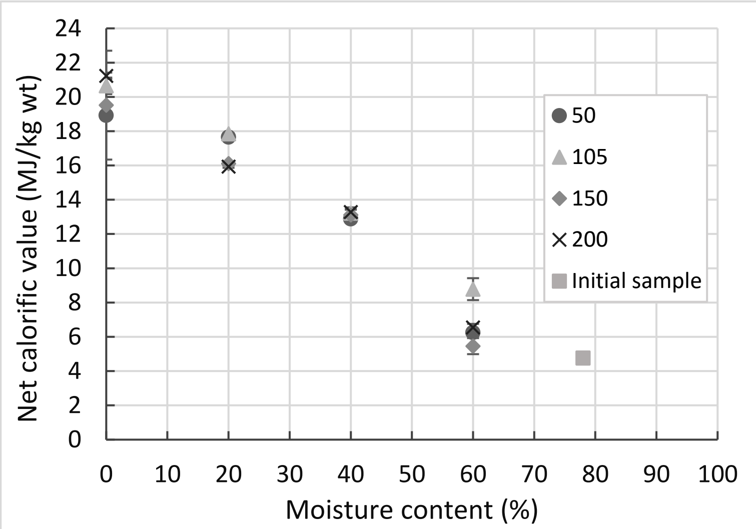
- Similar gross calorific value between 50 and 150°C
- Significant decrease at 200°C (possible thermal degradation)

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Calorific value
Employed method	Use of calorimeter bomb *Parr 6200* (SOP 8.8.1.1)
Publications	
-	

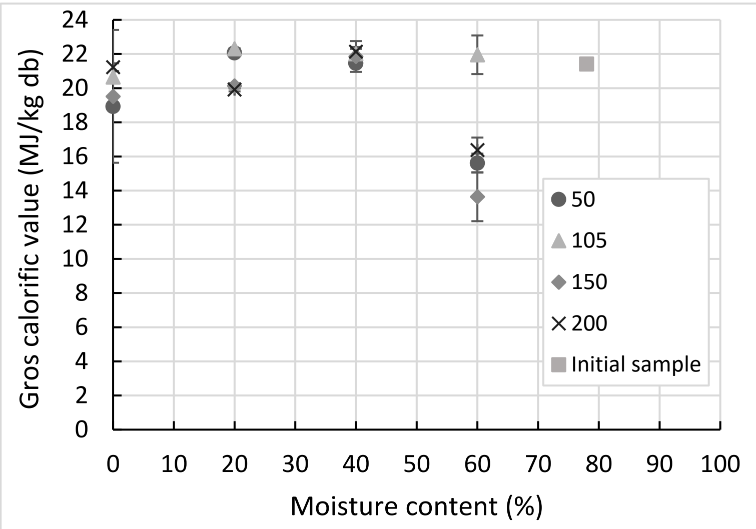
Data source files
https://www.dropbox.com/s/vpa68hptk81v4e4/2019%20Fresh%20faeces%20tests_PRG.xlsx?dl=0
Additional Notes
Fresh faeces collected from voluntary and anonymous donations
Description of Data

Calorific value as a function of moisture content and temperature

Wet basis



Dry basis



Observations:

- Increase of net calorific value as sludge dried
- Constant gross calorific value as sludge dried (except for the outliers corresponding to the samples with 60%wt at 60°C)
- No effect of temperature

General information	
Type of data	Calorific value
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Temperature: ambient (~ 20°C) ○ Relative humidity: ambient (~ 60%)
Sample form in the dryer	900 g of sample in 1 L plastic bucket
Analysed parameters	Calorific value
Employed method	Use of calorimeter bomb *Parr 6200* (SOP 8.8.1.1.)
Publications	
-	

Data source files

https://www.dropbox.com/s/xbv6su0jxsipiok/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20the%20open%20air_UKZN%20PRG.xlsx?dl=0

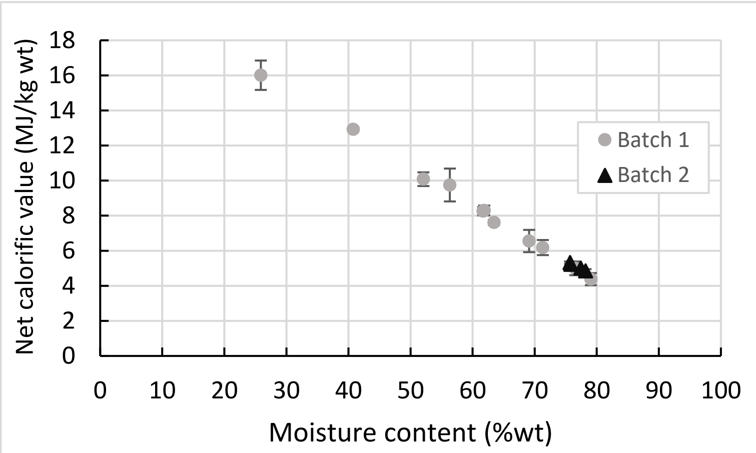
Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Containers with the sample placed in a ventilated area
- Mesh placed at the opening of the container to avoid the development of maggots
- Samples from batch 1 analysed in a weekly basis for 16 weeks
- Samples from batch 2 analysed at days 0, 3, 5 and 7 during one week

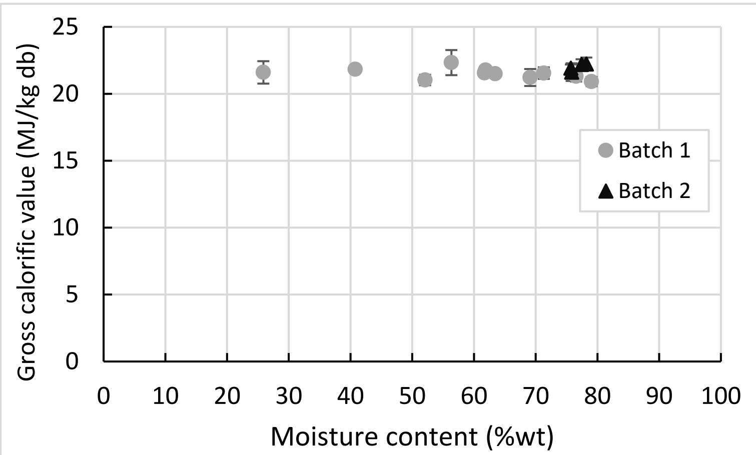
Description of Data

Calorific value as a function of moisture content of the faeces for the samples from batch 1 and 2

Wet basis



Dry basis



Observations:

- Increase of net calorific value by decreasing the moisture content during drying
- Constant gross calorific value during drying

General information	
Type of data	Thermal Properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Thermal conductivity and heat capacity
Employed method	Use of a modified transient plane source technique analyser *C-Therm TCi* (SOP 8.8.6.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

Data source files

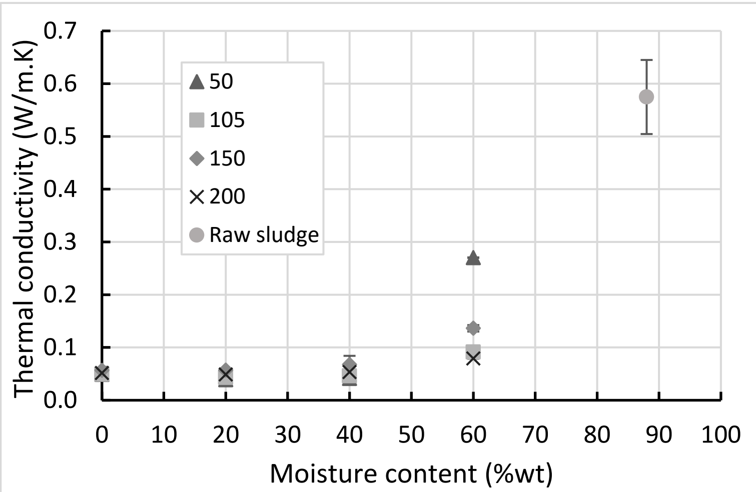
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

Additional Notes

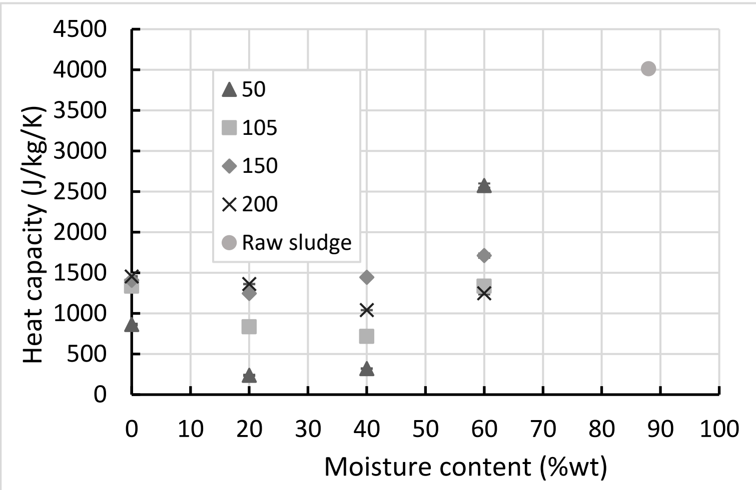
-

Description of Data

Thermal conductivity as a function of moisture content and temperature



Heat capacity as a function of moisture content and temperature



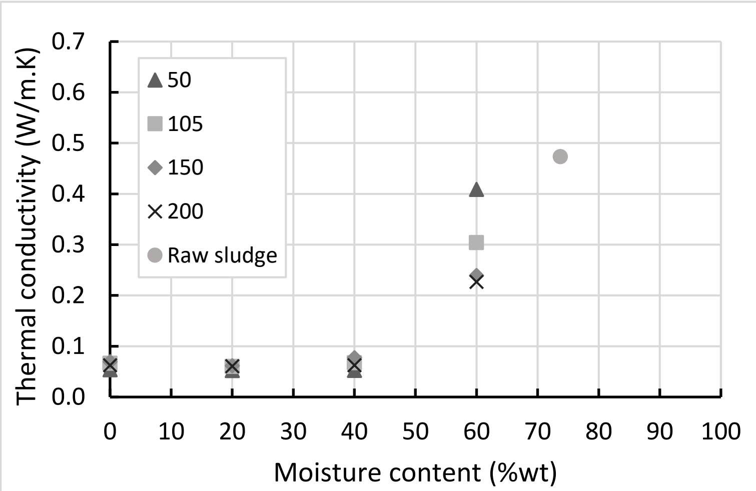
Observations:

- Decrease of the thermal conductivity as sludge dried until achieving 40%wt moisture content
- Stabilization of thermal conductivity below 40%wt
- No clear trend with the heat capacity
- No effect of temperature on the thermal conductivity and heat capacity

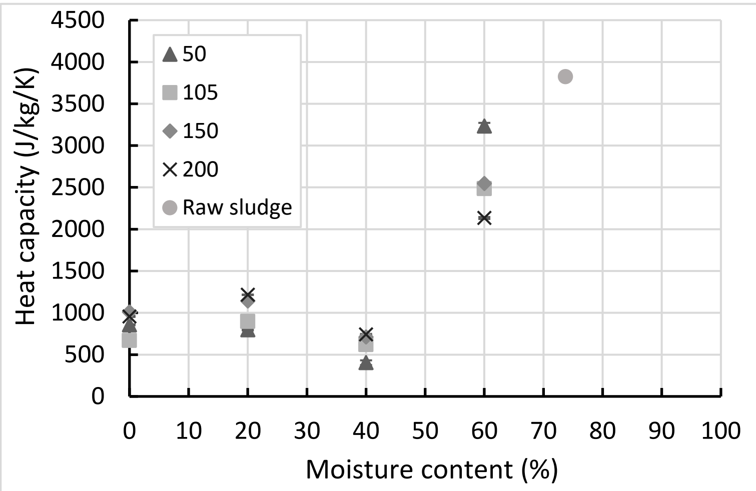
General information	
Type of data	Thermal Properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Thermal conductivity and heat capacity
Employed method	Use of a modified transient plane source technique analyser *C-Therm TCi* (SOP 8.8.6.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.
Data source files
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0
Additional Notes
-
Description of Data

Thermal conductivity as a function of moisture content and temperature



Heat capacity as a function of moisture content and temperature



Observations:

- Decrease of the thermal conductivity and heat capacity as sludge dried until achieving 40%wt moisture content
- Stabilization below 40%wt
- No effect of temperature

General information	
Type of data	Thermal Properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Thermal conductivity and heat capacity
Employed method	Use of a modified transient plane source technique analyser *C-Therm TCi* (SOP 8.8.6.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

Data source files

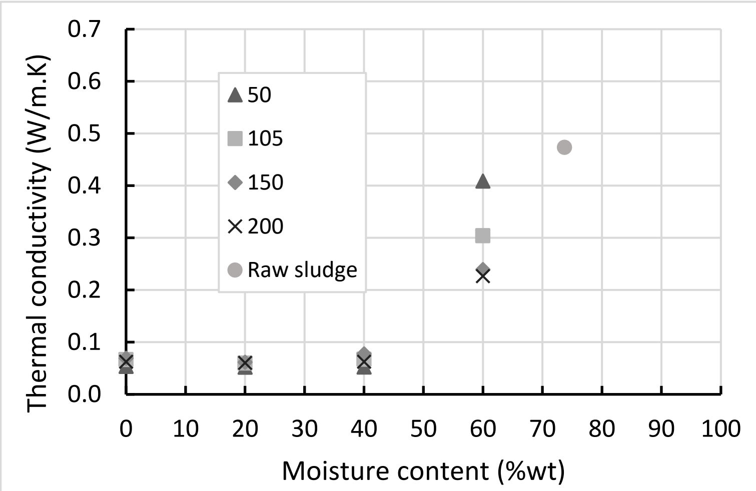
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

Additional Notes

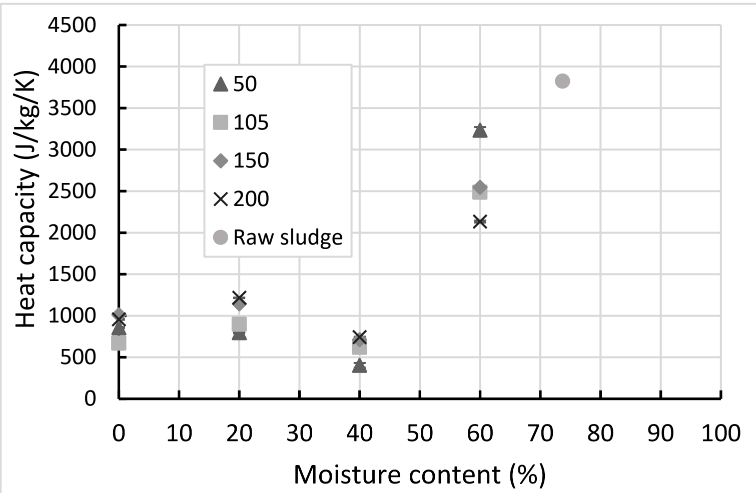
-

Description of Data

Thermal conductivity as a function of moisture content and temperature



Heat capacity as a function of moisture content and temperature



Observations:

- Decrease of the thermal conductivity and heat capacity as sludge dried until achieving 40%wt moisture content
- Stabilization below 40%wt
- No effect of temperature

General information	
Type of data	Thermal Properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Thermal conductivity and heat capacity
Employed method	Use of a modified transient plane source technique analyser *C-Therm TCi* (SOP 8.8.6.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.

Data source files

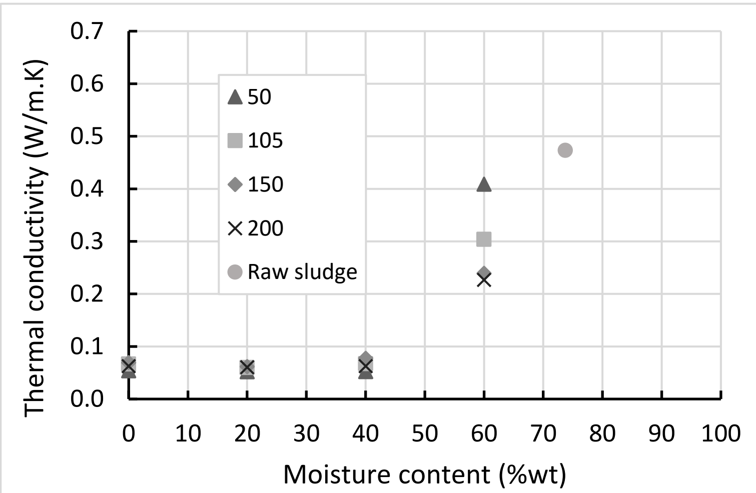
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

Additional Notes

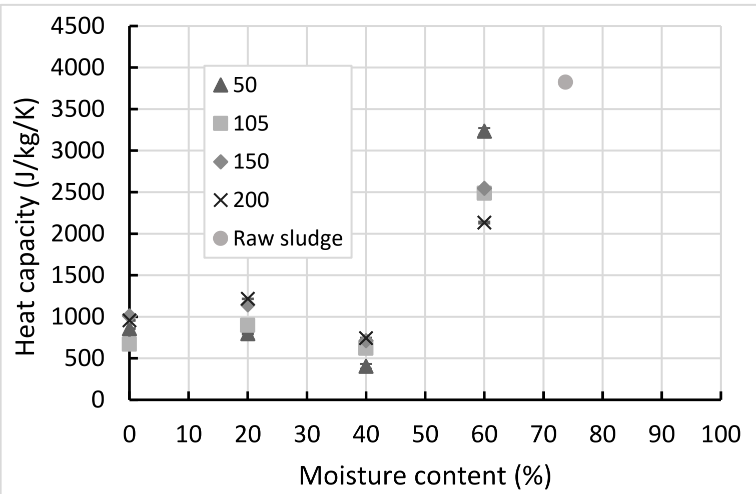
-

Description of Data

Thermal conductivity as a function of moisture content and temperature



Heat capacity as a function of moisture content and temperature



Observations:

- Decrease of the thermal conductivity and heat capacity as sludge dried until achieving 40%wt moisture content
- Stabilization below 40%wt
- No effect of temperature

General information	
Type of data	Thermal properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2015-2016
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~80% wt
Total solids content	~20% wt
Volatile solids content	~70% db
Ash content	~30% db
Presence of trash?	Yes
Pre-treatment	○ Screening to remove the large pieces of trash ○ Addition of 3%wt of sawdust for pellets formation
Experimental Procedure	
Drying experimental setup	Laboratory-scale medium infrared (MIR) dryer ('LaDePa')
Drying time	0, 4, 9, 13, 17, 25, 40 min
Operating conditions	○ MIR emitters power: 3, 5 and 6.5 kW (corresponding to ~ 85, 135 and 215°C respectively) ○ Distance between the emitters and the sample: 115 mm ○ Air stream flowrate: 18.3 m^3/min ○ Air humidity: ambient (70-80%)
Sample form in the dryer	Pellets of 8 and 14 mm diameter
Analysed parameters	Thermal properties
Employed methods	Use of a modified transient plane source technique analyser *C-Therm TCi* (SOP 8.8.6.1)

Publications

Mirara, S.W. (2017). Drying and Pasteurisation of VIP Latrine Faecal Sludge using a Bench Scale Medium Infrared Machine. Master thesis. University of KwaZulu-Natal, Durban, South Africa.

Septien, S., Mirara, S.W., Singh, A., Velkushanova, K., & Buckley, C. (2018). Characterisation of On-Site Sanitation Material and Products: VIP Latrines and Pour-Flush Toilets. WRC project final report. South Africa.

Septien, S., Mirara, S. W., Makununika, B., Singh, A., Pocock, J., Velkushanova, K., & Buckley, C. A. (2019). Effect of drying on the physical and chemical properties of faecal sludge for its reuse. Journal of Environmental Chemical Engineering, 103652.

Data source files

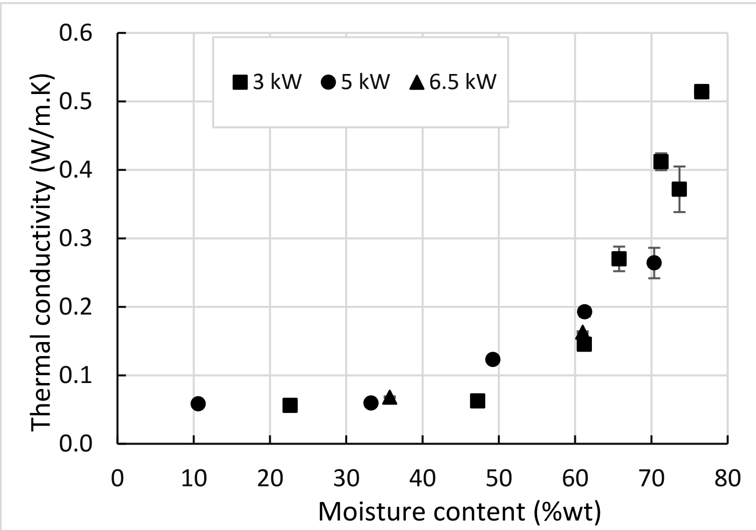
https://www.dropbox.com/s/qbqkf45sx5ysk25/2014-2015%20VIP%20composition%20analysis.xlsx?dl=0

Additional Notes

-

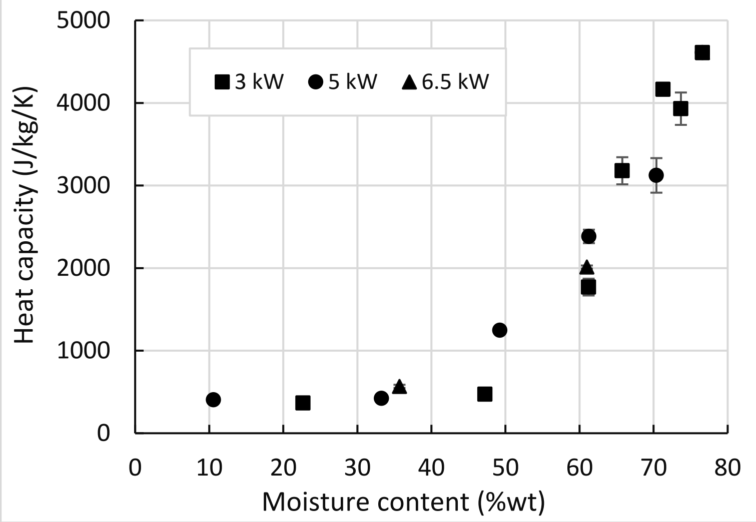
Description of Data

Thermal conductivity and heat capacity versus moisture content as a function of the MIR emitter power

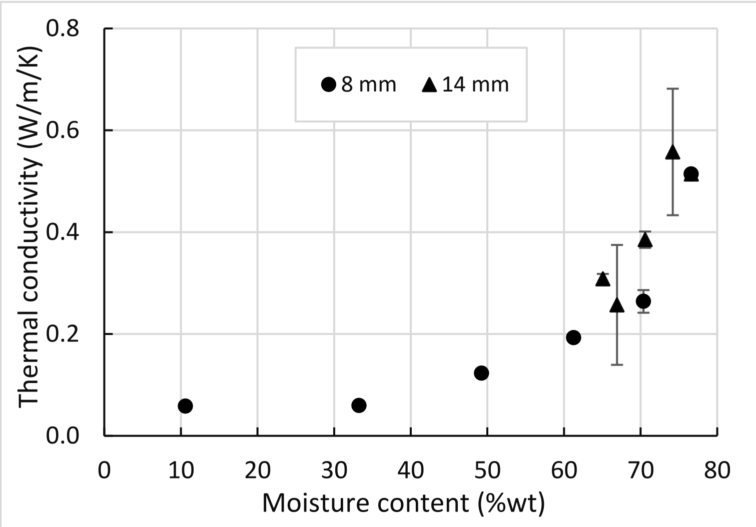


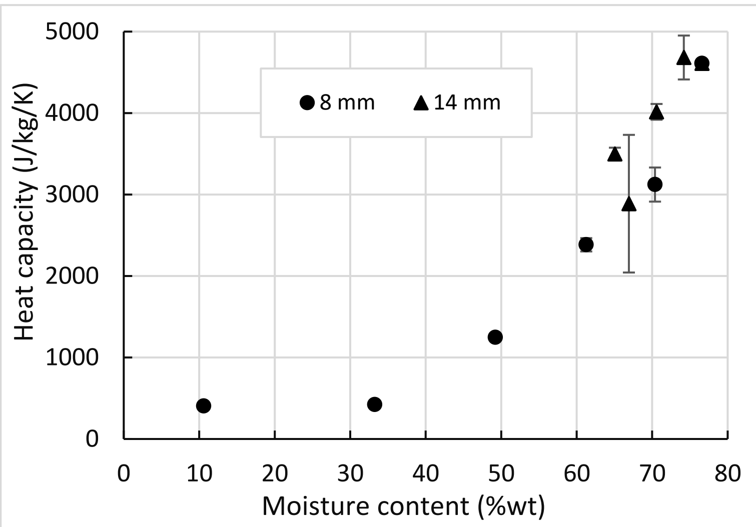
Observations:

- Decrease of thermal conductivity and heat capacity as sludge dried
- Higher thermal diffusivity for sludge dried al low moisture content in comparison to the raw material
- No effect of MIR emitter power on the thermal properties



Thermal conductivity and heat capacity versus moisture content as a function of the pellet diameter





Observations:

- Decrease of thermal conductivity and heat capacity as sludge dried
- Higher thermal diffusivity for sludge dried al low moisture content in comparison to the raw material
- No effect of MIR emitter power on the thermal properties

General information	
Type of data	Thermal properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2015-2016
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom design convective drying rig
Drying time	(1) Until mass stabilization (2) Stopped at different moisture contents (8, 32, 58, 75%wt)
Operating conditions	○ Air temperature: 40, 60 and 80°C ○ Air humidity: 0% ○ Air velocity: 0.06 cm/s
Sample form in the dryer	Pellets of 8, 12 and 14 mm diameter
Analysed parameters	Thermal properties
Employed methods	Use of a modified transient plane source technique analyser *C-Therm TCi* (SOP 8.8.6.1)
Publications	
Makununika, B. S. N. (2016). Thermal drying of faecal sludge from VIP latrines and characterisation of dried faecal material. Master thesis. University of KwaZulu-Natal, Durban, South Africa.	

Septien, S., Mirara, S. W., Makununika, B., Singh, A., Pocock, J., Velkushanova, K., & Buckley, C. A. (2019). Effect of drying on the physical and chemical properties of faecal sludge for its reuse. Journal of Environmental Chemical Engineering, 103652.

<u>Data source files</u>

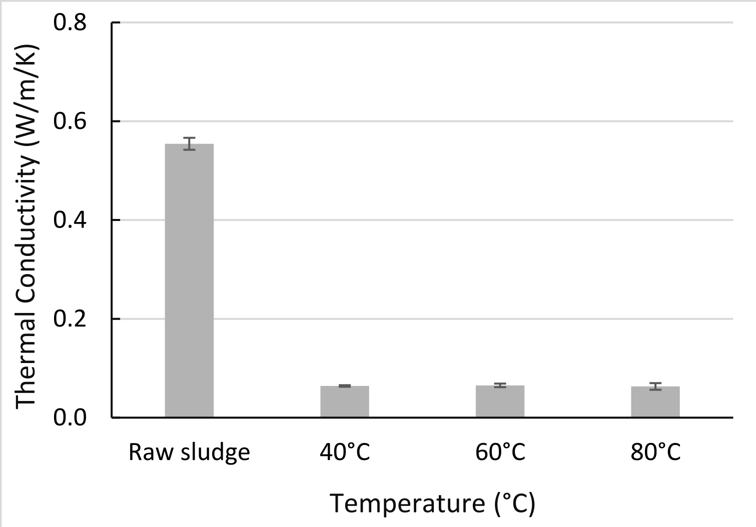
https://www.dropbox.com/s/2dg6xp8s0m5pfse/2014-2015%20VIP%20Physicochemical%20properties.xlsx?dl=0

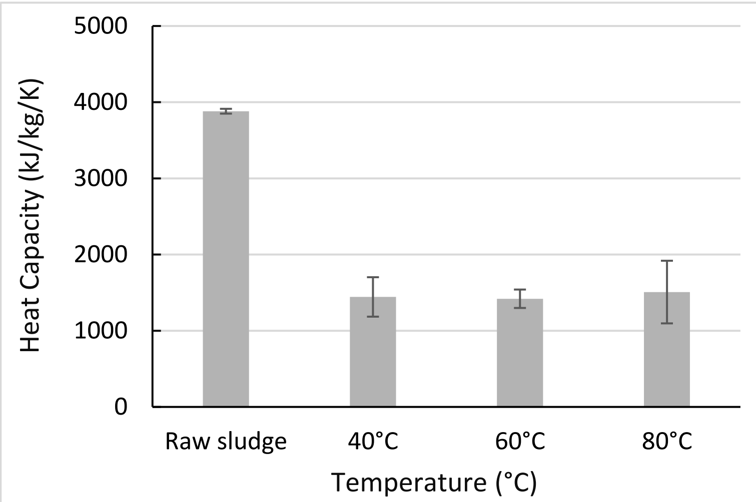
<u>Additional Notes</u>

-

<u>Description of Data</u>

<u>Thermal conductivity and heat capacity as a function of temperature</u>



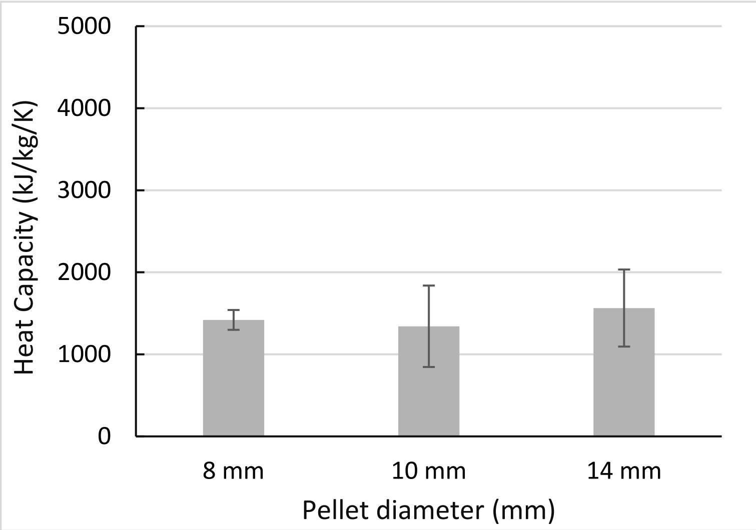


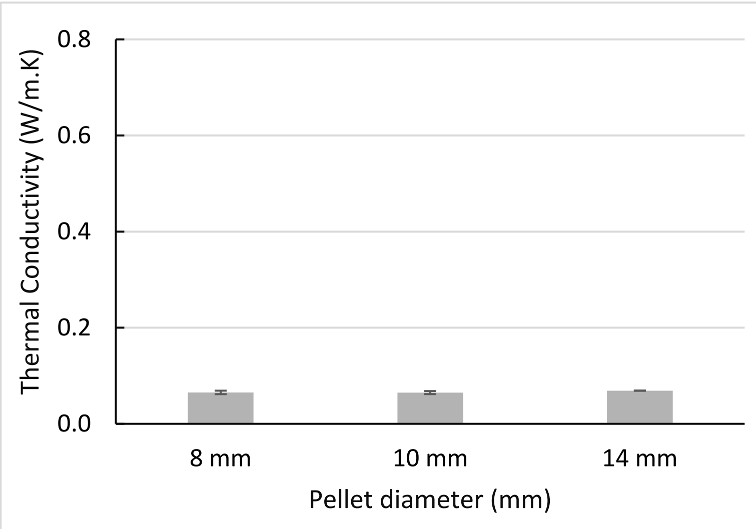
<u>Observations:</u>

- Decrease of thermal conductivity and heat capacity in the dried sludge with respect to the raw material
- No effect of temperature on the on the thermal properties

<table>
<tr>
<td>

Thermal conductivity and heat capacity as a function of pellet diameter



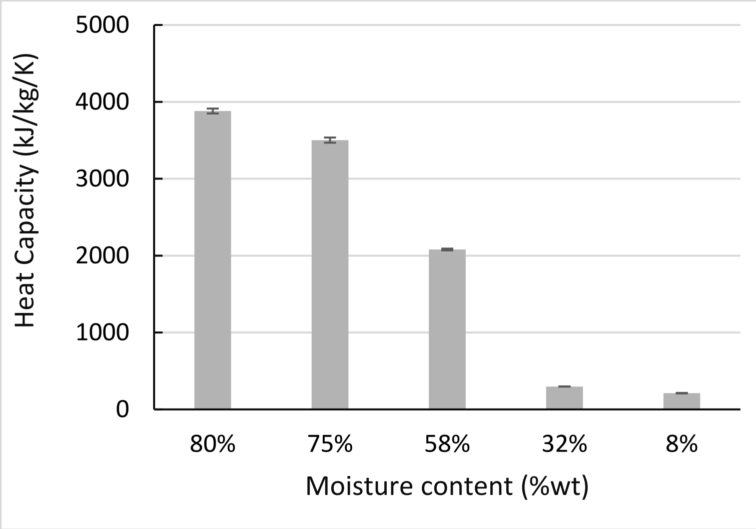
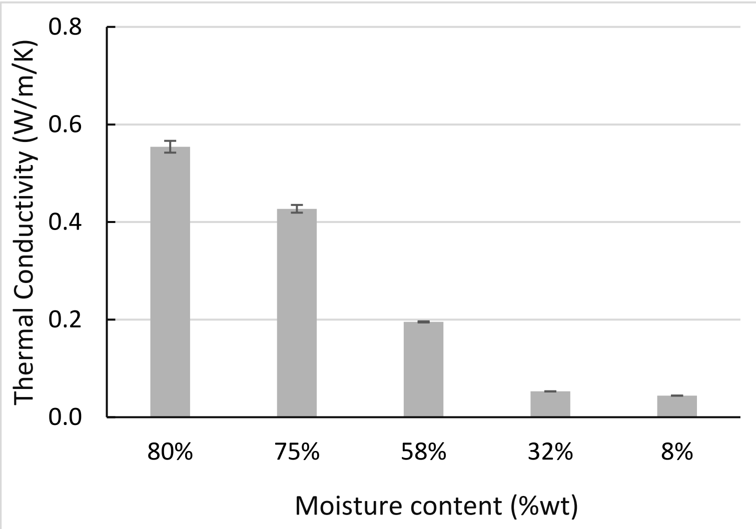


</td>
<td>

Observations:

- Decrease of thermal conductivity and heat capacity as sludge dried

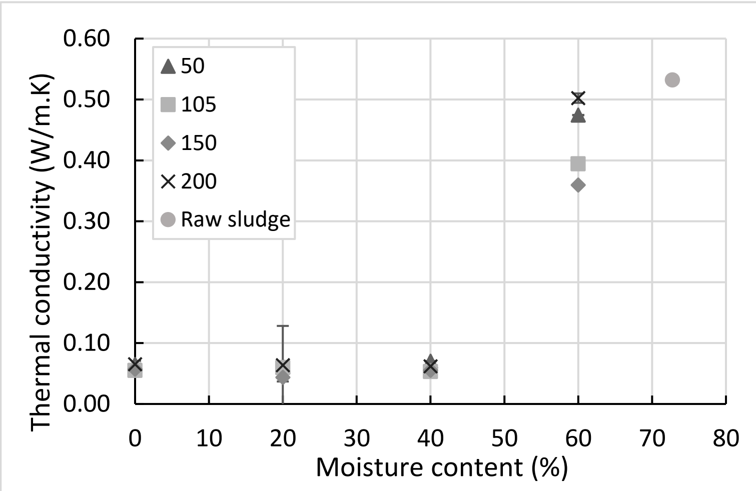
</td>
</tr>
</table>

Thermal conductivity and heat capacity as a function of pellet moisture content	Observations:
 	○ Decrease of thermal conductivity and heat capacity as sludge dried

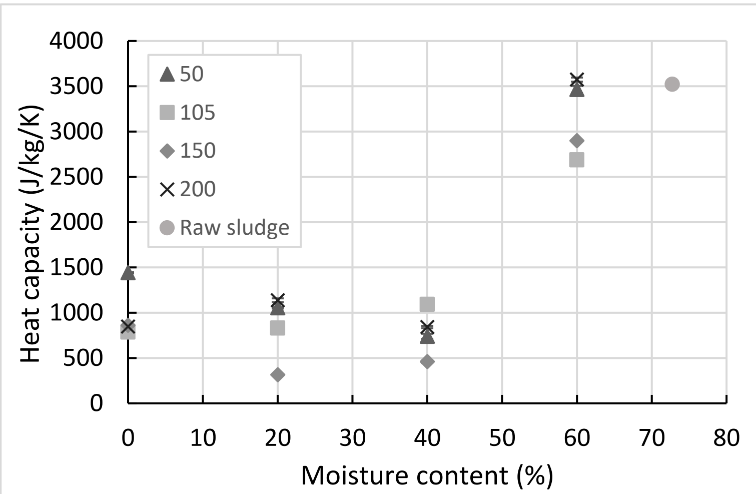
General information	
Type of data	Thermal Properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 40%db
Ash content	~ 60%db
Presence of trash?	Yes (mainly hair extensions, plastic and rocks)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Thermal conductivity and heat capacity
Employed method	Use of a modified transient plane source technique analyser *C-Therm TCi* (SOP 8.8.6.1)
Publications	
Getahun, S., Septien, S., Mata, J., Somorin, T., Mabbett, I., & Buckley, C. (2020). Drying characteristics of faecal sludge from different on-site sanitation facilities. *Journal of Environmental Management*, *261*, 110267.	

Getahun, S., Septien, S., Buckley, C.A. (2019). Effect of Drying Temperature and Moisture Content on The Enduse of Faecal Sludge as a Solid Fuel. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.
Data source files
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0
Additional Notes
-
Description of Data

Thermal conductivity as a function of moisture content and temperature



Heat capacity as a function of moisture content and temperature



Observations:

- Decrease of the thermal conductivity and heat capacity as sludge dried until achieving 40%wt moisture content
- Stabilization below 40%wt
- No effect of temperature

General information	
Type of data	Thermal Properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 0, 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	Thermal conductivity and heat capacity
Employed method	Use of a modified transient plane source technique analyser *C-Therm TCi* (SOP 8.8.6.1)
Publications	
-	

Data source files

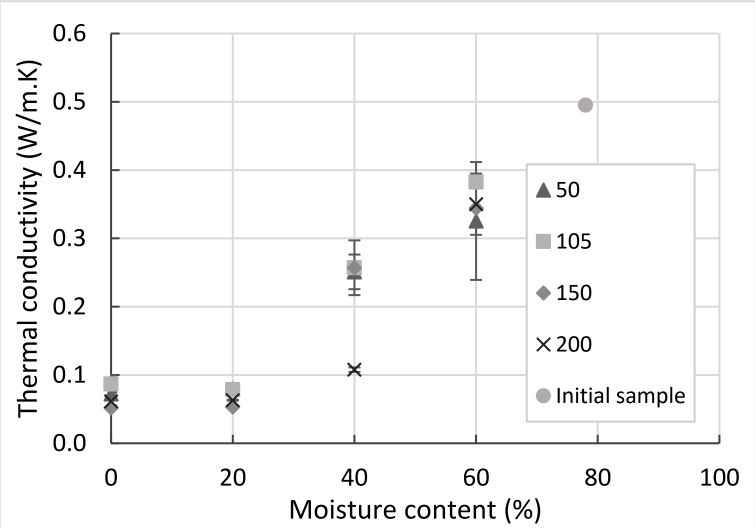
https://www.dropbox.com/s/vpa68hptk81v4e4/2019%20Fresh%20faeces%20tests_PRG.xlsx?dl=0

Additional Notes

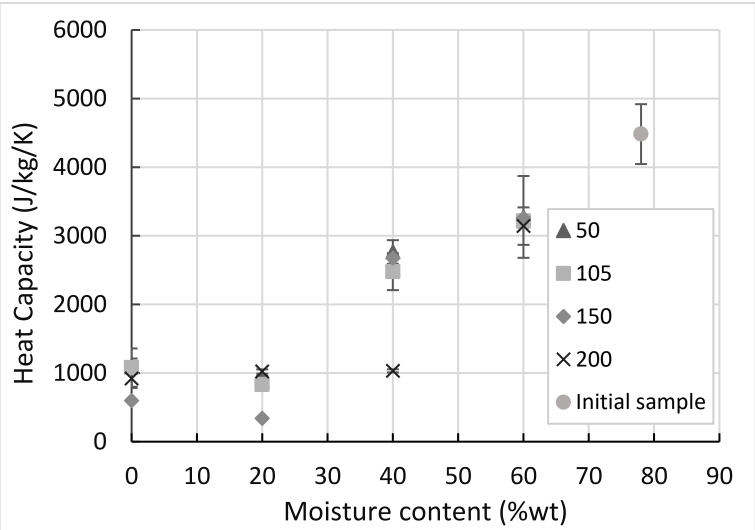
Fresh faeces collected from voluntary and anonymous donations

Description of Data

Thermal conductivity as a function of moisture content and temperature



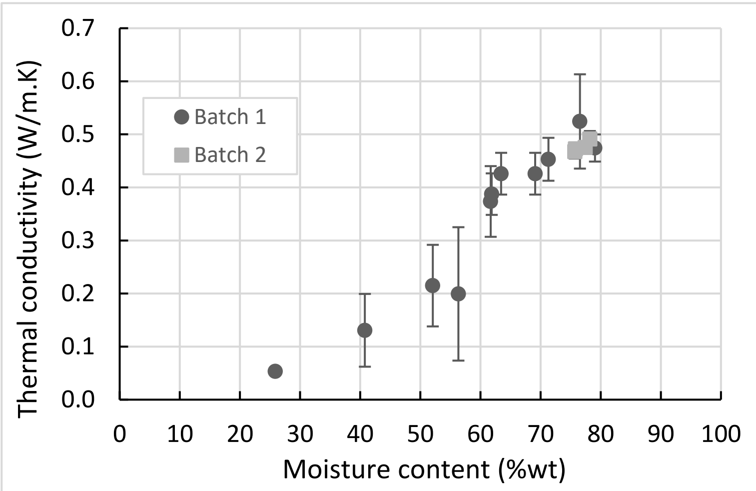
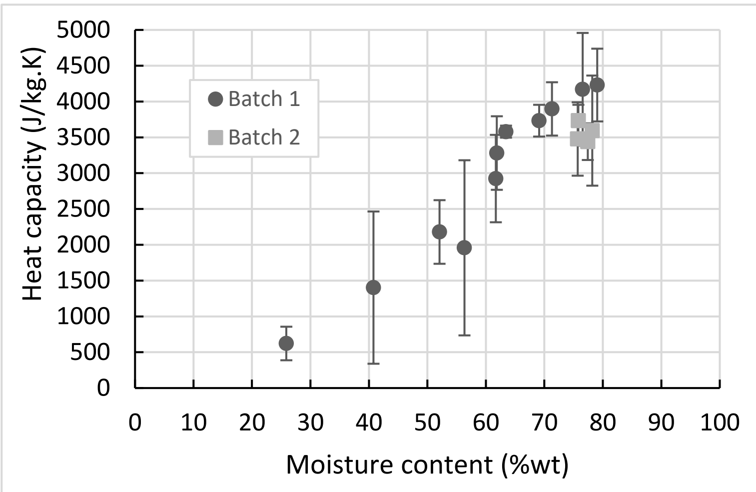
Heat capacity as a function of moisture content and temperature



Observations:

- Decrease of the thermal conductivity and heat capacity as sludge dried until achieving 20%wt moisture content
- Stabilization below 20%wt
- No effect of temperature

General information	
Type of data	Thermal Properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Temperature: ambient (~ 20°C) ○ Relative humidity: ambient (~ 60%)
Sample form in the dryer	900 g in 1 L plastic bucket
Analysed parameters	Thermal conductivity and heat capacity
Employed method	Use of a modified transient plane source technique analyser *C- therm TCi* (SOP 8.8.6.1)
Publications	
-	

<table>
<tr><th colspan="2">Data source files</th></tr>
<tr><td colspan="2">https://www.dropbox.com/s/xbv6su0jxsipiok/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20the%20open%20air_UKZN%20PRG.xlsx?dl=0</td></tr>
<tr><th colspan="2">Additional Notes</th></tr>
<tr><td colspan="2">○ Fresh faeces collected from voluntary and anonymous donations
○ Containers with sample placed in a ventilated area
○ Mesh placed at the opening of the container to avoid the development of maggots
○ Samples from batch 1 analysed in a weekly basis for 16 weeks
○ Samples from batch 2 analysed at days 0, 3, 5 and 7 within initial week</td></tr>
<tr><th colspan="2">Description of Data</th></tr>
<tr><td>Thermal conductivity as a function of the moisture content for the samples from batch 1 and 2
</td><td rowspan="2">Observations:
○ Decrease of the thermal conductivity and heat capacity by decreasing the moisture content
○ Initial values of the thermal conductivity and heat capacity close to those from pure water</td></tr>
<tr><td>Heat capacity as a function of the moisture content
</td></tr>
</table>

General information	
Type of data	Radiative properties
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 85%wt
Total solids content	~ 15%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Transmittance and reflectance
Employed method	Use of an UV-Vis-NIR spectrophotometer *Perkin Elmer Lambda 750S*
Publications	
-	

Data source files

Reflectance
https://www.dropbox.com/s/fatpciqrc1rxb1o/Swansea%20University%20ABR%20sludge%20Reflectance%20%282018-2020%29.xlsx?dl=0

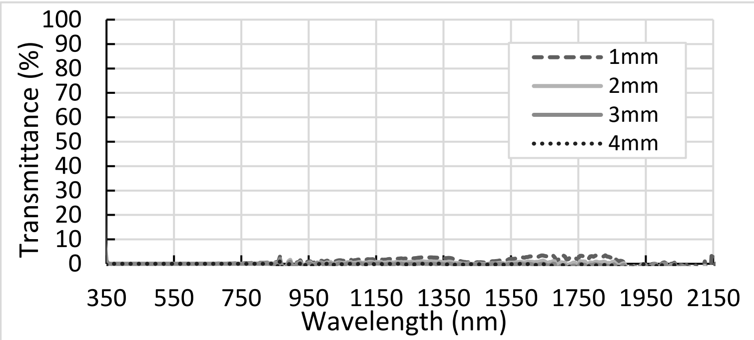
Transmittance
https://www.dropbox.com/s/y1dq29i47moqtl6/Swansea%20University%20Sludge%20UV%20Transmittance%20Properties%20%282018-2020%29.xlsx?dl=0

Additional Notes

- Sample couriered from South Africa
- Analysis for different faecal sludge thickness: 1, 2, 3 and 4 mm
- Measurement of the transmittance and reflectance by the analyser
- Determination of the absorbance by difference (absorbance ≈ 1 – reflectance)
- Data Collection range: 2500-250 nm
- Data collection interval: 5.00 nm
- Scan Speed: 1196.19 nm/minute
- Lamp: D2

Description of Data

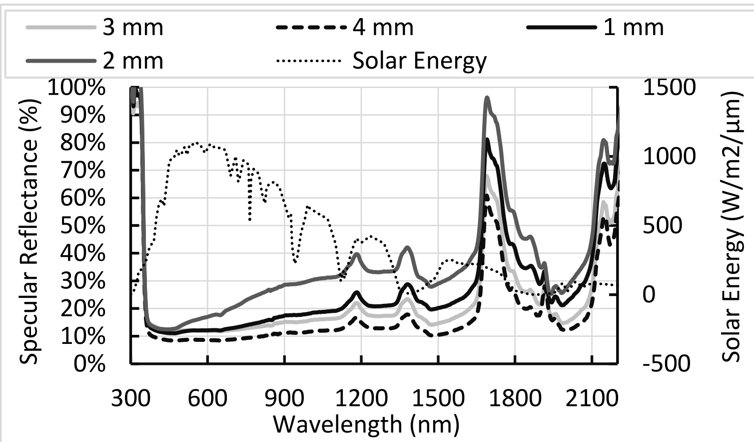
Transmittance of 1, 2, 3 and 4 mm thickness samples



Observations

- Low transmittance for all thickness (< 5%)
- Decrease of the transmittance by increasing the thickness

Reflectance of 1, 2, 3 and 4 mm thickness samples and comparison to the solar spectrum (ASTEM E903)



Observations

- Low reflectance in the visible light spectrum (400 – 700 nm) in average (~ 10%)
- Medium reflectance in the near infrared spectrum (700 – 2500 nm) in average (~ 40%)
- Average reflectance value about 35% showing the potential of solar thermal drying (absorbance ~ 65%)
- Not a clear effect of the sample thickness

General information	
Type of data	Radiative properties
Place of experimentation	Materials Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilet (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Transmittance and reflectance
Employed method	Use of an UV-Vis-NIR spectrophotometer *Perkin Elmer Lambda 750S*
Publications	
-	

Data source files

Reflectance
https://www.dropbox.com/s/o5x05sc995jixjb/Swansea%20University%20UDDT%20sludge%20Reflectance%20Properties%20%282018-2020%29.xlsx?dl=0

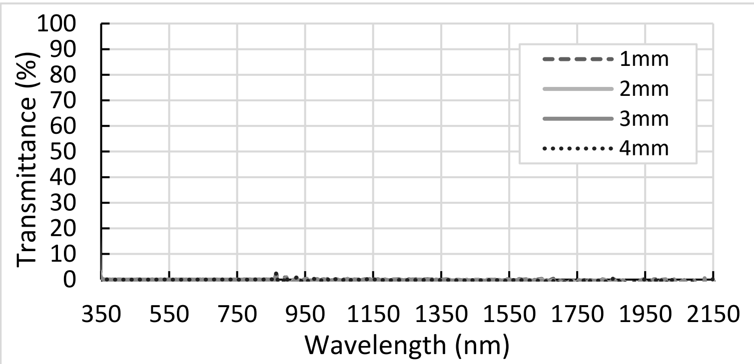
Transmittance
https://www.dropbox.com/s/y1dq29i47moqtl6/Swansea%20University%20Sludge%20UV%20Transmittance%20Properties%20%282018-2020%29.xlsx?dl=0

Additional Notes

- Sample couriered from South Africa
- Analysis for different faecal sludge thickness: 1, 2, 3 and 4 mm
- Measurement of the transmittance and reflectance by the analyser
- Determination of the absorbance by difference (absorbance ≈ 1 – reflectance)
- Data Collection range: 2500-250 nm
- Data collection interval: 5.00 nm
- Scan Speed: 1196.19 nm/minute
- Lamp: D2

Description of Data

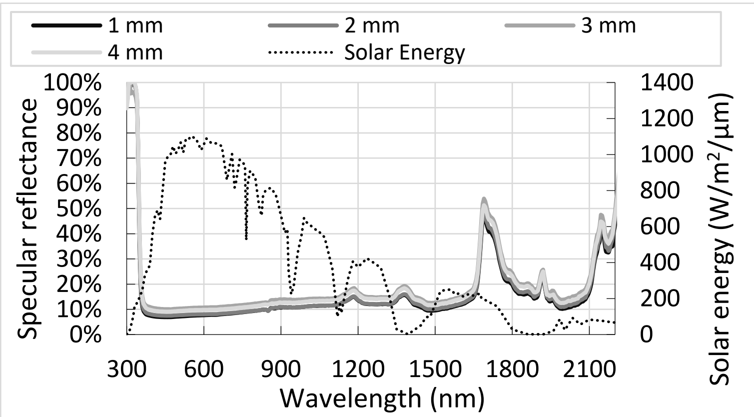
Transmittance of the 1, 2, 3 and 4 mm thickness samples



Observations

- Null transmittance for all thickness

Reflectance of the 1, 2, 3 and 4 mm thickness samples and comparison to the solar spectrum (ASTM E903)



Observations

- Low reflectance in the visible light spectrum (400 – 700 nm) in average (~ 10%)
- Medium reflectance in the near infrared spectrum (700 – 2500 nm) in average (~ 30%)
- Average reflectance value about 30% showing the potential of solar thermal drying (absorbance 70%)
- Not a clear effect of the sample thickness

General information	
Type of data	Radiative properties
Place of experimentation	Materials Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Transmittance and reflectance
Employed method	Use of an UV-Vis-NIR spectrophotometer *Perkin Elmer Lambda 750S*
Publications	
-	

Data source files

Reflectance
https://www.dropbox.com/s/y9p8zg4kzpu9b3n/Swansea%20University%20VIP%20sludge%20Reflectance%20Properties%20%282018-2020%29.xlsx?dl=0

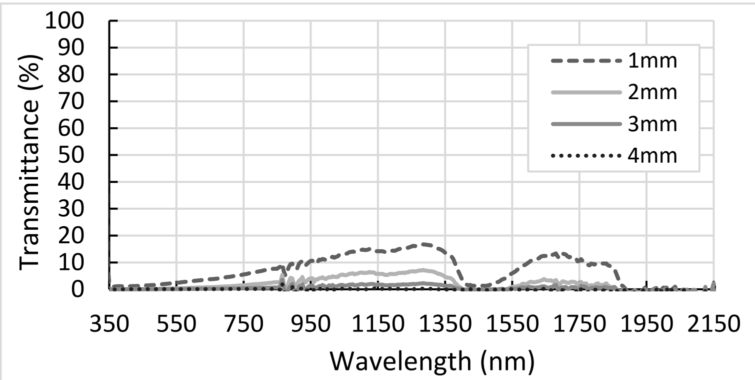
Transmittance
https://www.dropbox.com/s/y1dq29i47moqtl6/Swansea%20University%20Sludge%20UV%20Transmittance%20Properties%20%282018-2020%29.xlsx?dl=0

Additional Notes

- Sample couriered from South Africa
- Analysis for different faecal sludge thickness: 1, 2, 3 and 4 mm
- Measurement of the transmittance and reflectance by the analyser
- Determination of the absorbance by difference (absorbance ≈ 1 – reflectance)
- Data Collection range: 2500-250 nm
- Data collection interval: 5.00 nm
- Scan Speed: 1196.19 nm/minute
- Lamp: D2

Description of Data

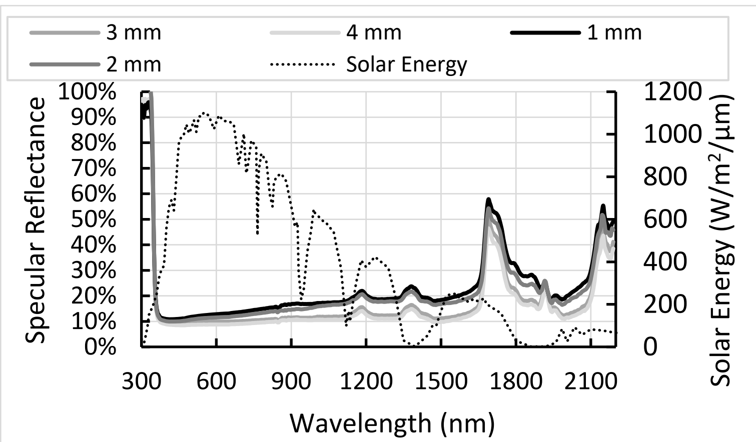
Transmittance of 1, 2, 3 and 4 mm thickness samples



Observations

- Low transmittance for all thickness (< 20%)
- Decrease of the transmittance by increasing the thickness

Reflectance of 1, 2, 3 and 4 mm thickness samples and comparison to the solar spectrum (ASTM E903)



Observations

- Low reflectance in the visible light spectrum (400 – 700 nm) in average (~ 10%)
- Medium reflectance in the near infrared spectrum (700 – 2500 nm) in average (~ 30%)
- Average reflectance value about 30% showing the potential of solar thermal drying (absorbance ~ 70%)
- Not a clear effect of the sample thickness

General information	
Type of data	Radiative properties
Place of experimentation	Materials Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Cranfield, UK
Age before collection	A few days
Moisture content	~ 60%wt
Total solids content	~ 40%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Transmittance and reflectance
Employed method	Use of an UV-Vis-NIR spectrophotometer *Perkin Elmer Lambda 750S*
Publications	
-	

Data source files

Reflectance
https://www.dropbox.com/s/lwhnevbpw02kdg4/Swansea%20University%20Human%20Faeces%20Reflectance%20Properties%20%282018-2020%29.xlsx?dl=0

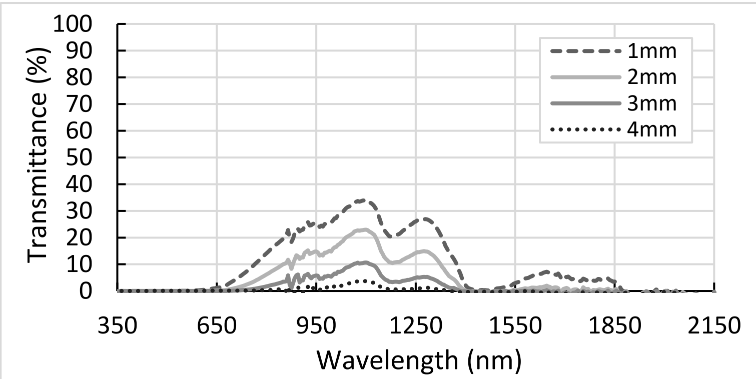
Transmittance
https://www.dropbox.com/s/y1dq29i47moqtl6/Swansea%20University%20Sludge%20UV%20Transmittance%20Properties%20%282018-2020%29.xlsx?dl=0

Additional Notes

- Faeces obtained from anonymous and voluntary donations
- Analysis for different faecal sludge thickness: 1, 2, 3 and 4 mm
- Measurement of the transmittance and reflectance by the analyser
- Determination of the absorbance by difference (absorbance ≈ 1 – reflectance)
- Data Collection range: 2500-250 nm
- Data collection interval: 5.00 nm
- Scan Speed: 1196.19 nm/minute
- Lamp: D2

Description of Data

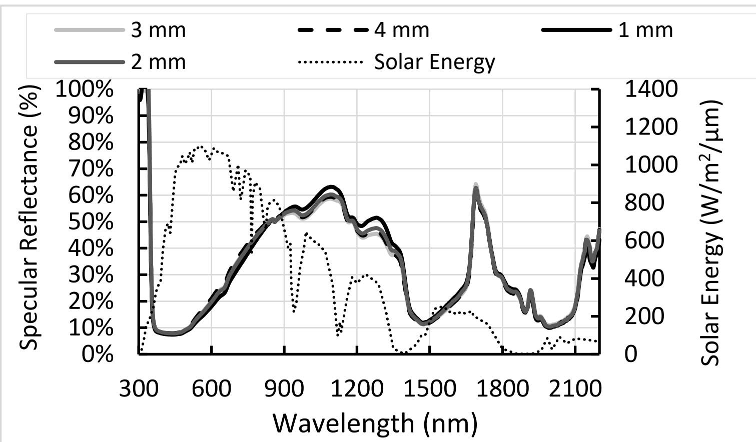
Transmittance of the 1, 2, 3 and 4 mm thickness samples



Observations

- Low to medium transmittance at 850 – 1350 nm (peak from 5 to 35%)
- Decrease of the transmittance by increasing the thickness

Reflectance of the 1, 2, 3 and 4 mm thickness samples and solar irradiance spectrum (ASTM E903)



Observations

- Low reflectance in the visible light spectrum (400 – 700 nm) in average (~ 15%)
- Medium reflectance in the near infrared spectrum (700 – 2500 nm) in average (~ 45%)
- Average reflectance value about 40% showing the potential of solar thermal drying (absorbance ~ 60%)
- Not a clear effect of the sample thickness

MORPHOLOGICAL CHARACTERISTICS

General information	
Type of data	Specific surface area and porosity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	BET specific surface area and pore size
Employed method	Use of BET analyser *Tristar II Series*
Publications	
-	

Data source files

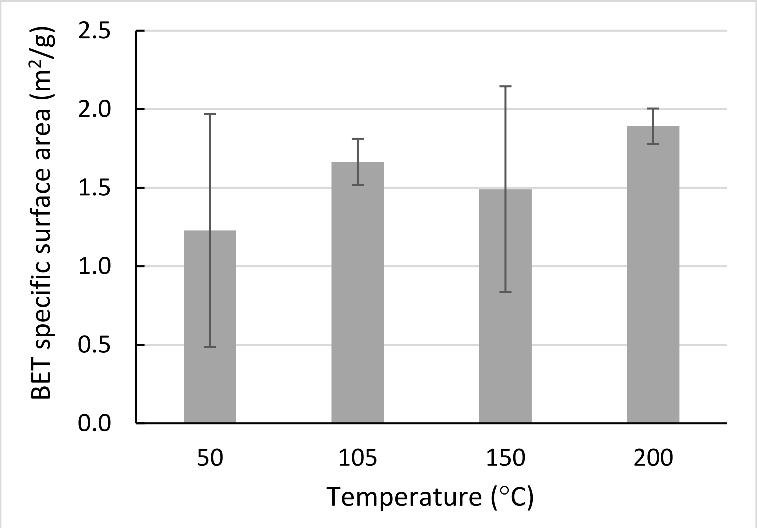
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

Additional Notes

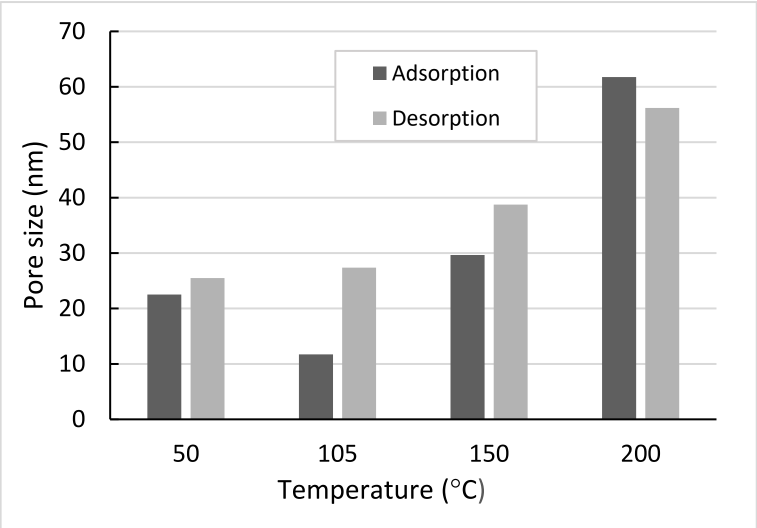
-

Description of Data

Surface area as a function of temperature



Pore size as a function of temperature



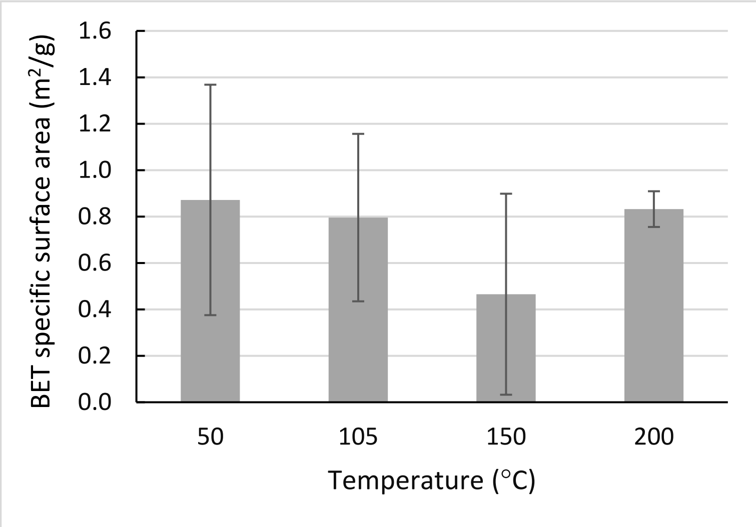
Observations:

- No effect of temperature on the specific surface
- Apparent increase of the pore size by increasing the drying temperature

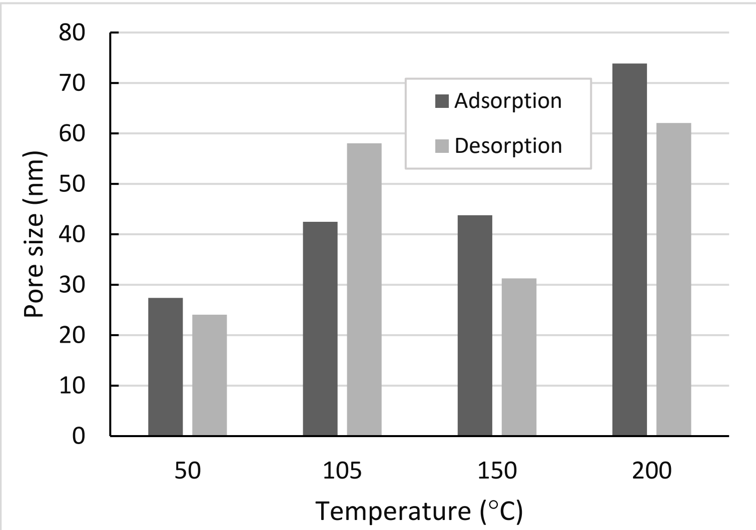
General information	
Type of data	Specific surface area and porosity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones and textiles)
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	BET specific surface area and pore size
Employed method	Use of BET analyser Tristar II Series
Publications	
-	

Data source files
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0
Additional Notes
-
Description of Data

Surface area as a function of temperature



Pore size as a function of temperature



Observations:

- No effect of temperature on the specific surface, and pore size below 200°C
- Apparent higher pore size at 200°C

General information	
Type of data	Specific surface area and porosity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 40%db
Ash content	~ 60%db
Presence of trash?	Yes (mainly hair and stones)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	BET specific surface area and pore size
Employed method	Use of BET analyser *Tristar II Series*
Publications	
-	

<u>Data source files</u>

https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0

<u>Additional Notes</u>

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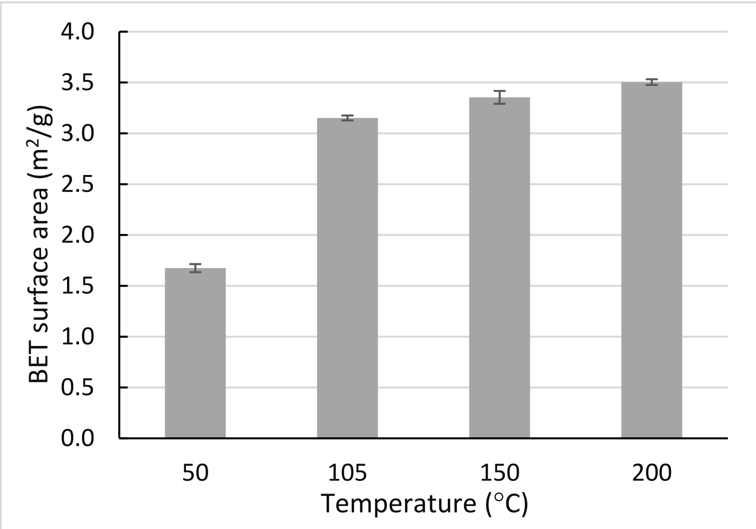
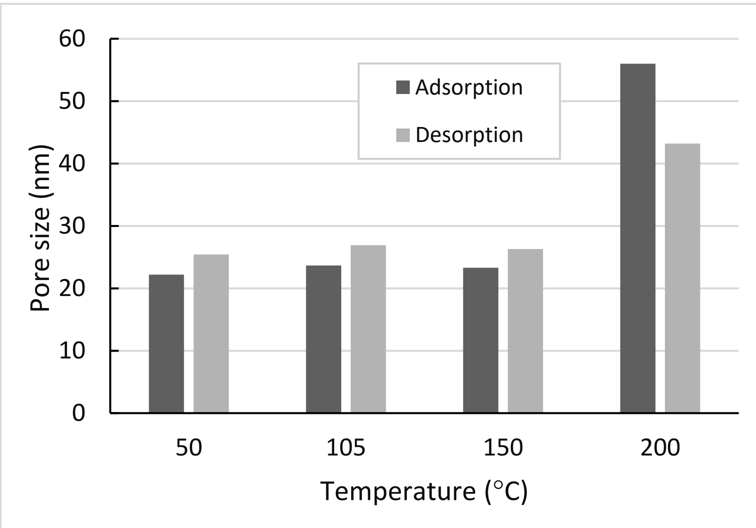
Description of Data

<u>Surface area as a function of temperature</u>



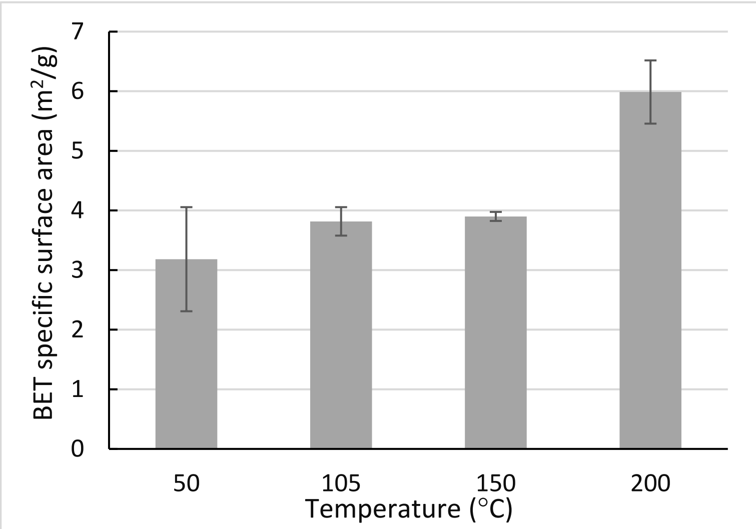
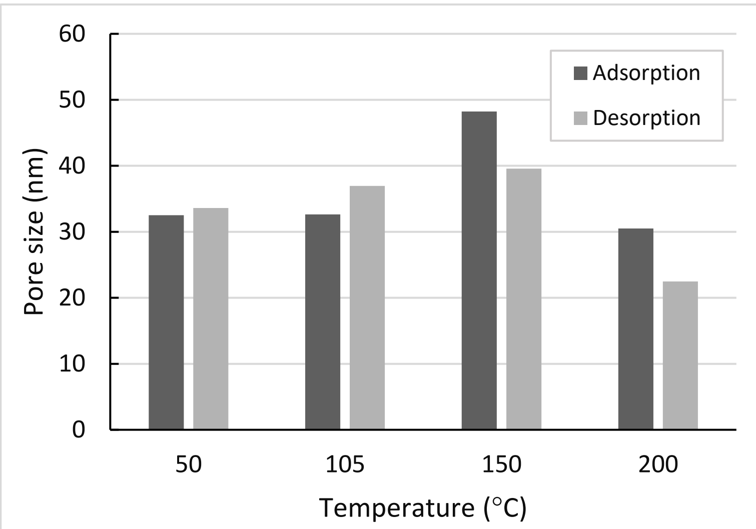
<u>Pore size as a function of temperature</u>



<u>Observations:</u>

- No effect of temperature on the specific surface above 50°C and pore size below 200°C
- Lower specific area at 50°C
- Higher pore size at 200°C

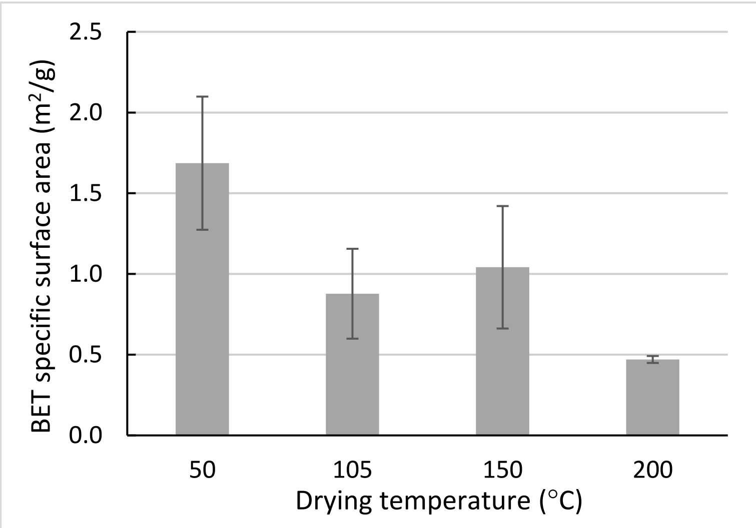
General information	
Type of data	Specific surface area and porosity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018-2019
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	~ 65%db
Ash content	~ 35%db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	BET specific surface area and pore size
Employed method	Use of BET analyser *Tristar II Series*
Publications	
-	

Data source files	
https://www.dropbox.com/s/qo53unswsdmvjgp/2018-2019%20ABR%2C%20UDDT%20and%20VIP%20tests_PRG.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Surface area as a function of temperature  Pore size as a function of temperature 	Observations: ○ No effect of temperature on the specific surface below 200°C, and pore size at 50, 100 and 200°C ○ Higher specific area at 200°C ○ Higher pore size at 150°C

General information	
Type of data	Specific surface area and porosity
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until complete drying
Operating conditions	Temperature: 50, 100, 150 and 200°C
Sample form in the dryer	250 g of sample on an aluminium tray (52 × 8.4 × 33 cm)
Analysed parameters	BET specific surface area and pore size
Employed method	Use of BET analyser *Tristar II Series*
Publications	
-	

Data source files
https://www.dropbox.com/s/vpa68hptk81v4e4/2019%20Fresh%20faeces%20tests_PRG.xlsx?dl=0
Additional Notes
Fresh faeces collected from voluntary and anonymous donations
Description of Data

Surface area as a function of temperature



Observations:

- Same specific surface area for samples dried at 50, 105 and 150°C
- Lower specific surface area for sample dried at 200°C

General information	
Type of data	Visual aspects
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom-design convective drying rig
Drying time	Batch until complete drying
Operating conditions	○ Air temperature: 40, 60 and 80°C ○ Air humidity: 0, 15 and 25% ○ Air velocity: 0.03, 0.06 and 0.12 cm/s
Sample form in the dryer	Pellets of 8, 10, 12 and 14 mm diameter
Analysed parameters	Visual aspect
Employed method	Photograph
Publications	
Makununika, B. S. N. (2016). Thermal drying of faecal sludge from VIP latrines and characterisation of dried faecal material. Master thesis. University of KwaZulu-Natal, Durban, South Africa.	

Data source files	
-	
Additional Notes	
-	
Description of Data	
Aspect of pellets before (left) and after (right) drying 	Observations ○ After drying: crust and crack formation; shrinkage; loss of shiny surface; change of color (less dark)

General information	
Type of data	Visual aspects
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom-design convective drying rig
Drying time	Batch until complete drying
Operating conditions	○ Air temperature: 40, 60 and 80°C ○ Air humidity: 0, 15 and 25% ○ Air velocity: 0.03, 0.06 and 0.12 cm/s
Sample form in the dryer	Thin layer on a petri dish of 70 mm diameter and 4 mm height
Analysed parameters	Visual aspect
Employed method	Photograph
Publications	
Makununika, B. S. N. (2016). Thermal drying of faecal sludge from VIP latrines and characterisation of dried faecal material. Master thesis. University of KwaZulu-Natal, Durban, South Africa.	

Data source files	
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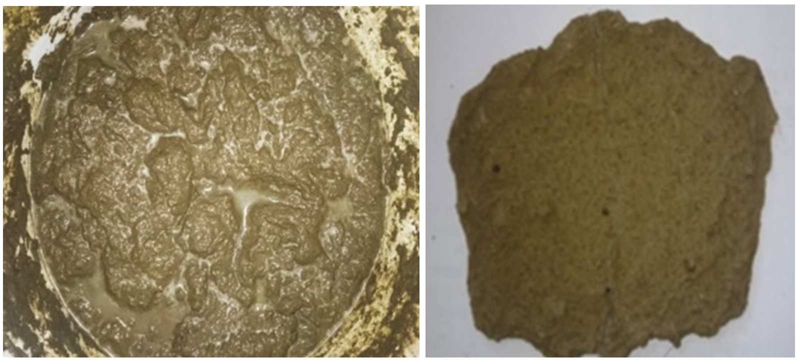
Additional Notes	
-	
Description of Data	
Aspect of the faecal sludge before (left) and after (right) drying 	Observations ○ After drying: crust and crack formation; shrinkage; loss of shiny surface; change of color (less dark)

General information	
Type of data	Visual aspects
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2017 - 2018
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom-design solar thermal drying rig
Drying time	3 to 5 hours
Operating conditions	○ Irradiance: from 800 to 1000 W/m^2 (sunny conditions) ○ Air flowrate: 0.5 m^3/min (corresponding to an air velocity of 0.5 m/s) ○ Air temperature: ambient (~20°C) ○ Air humidity: ~10%
Sample form in the dryer	Thin layer of 5 and 10 mm thickness, and 60 mm diameter
Analysed parameters	Visual aspect
Employed method	Photograph
Publications	
Mugauri, T.R. (2019). *Drying of faecal sludge from ventilated improved pit latrines (VIP latrines) using solar thermal energy*. MSc thesis, University of KwaZulu-Natal, South Africa.	

Septien, S., Mugauri, T.R., Singh, A., Inambao, F. (2018). *Solar drying of faecal sludge from on-site sanitation facilities*. 5th Southern Africa Solar Thermal Energy Conference, Durban, South Africa, 25-27 June.

Septien, S., Mugauri, T.R., Singh, A., Inambao, F. (2017). *Drying of Faecal Sludge using Solar Thermal Energy* (final report project K5/2582). Water Research Commission, South Africa.

Data source files

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Additional Notes

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Description of Data

Aspect of sludge before (a) and after (b) drying

A B

Observations

- After drying: crust and crack formation; shrinkage; loss of shiny surface

General information	
Type of data	Visual aspects
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019-2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Custom-design solar thermal drying rig
Drying time	5 hours
Operating conditions	○ Irradiance: 800 – 1300 W/m^2 (sunny conditions) ○ Air flowrate: 0.5 m^3/min (corresponding to an air velocity of 0.5 m/s) ○ Air temperature: ambient (~20°C), 40 and 80°C ○ Air humidity: ~10%
Sample form	Thin layer of 5 mm thickness and 110 mm diameter
Analysed parameters	Visual aspect
Employed method	Photograph
Publications	
-	

Data source files

-

Additional Notes

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Description of Data

Aspect of sludge before (left) and after (right) drying at ambient conditions, 40 and 80°C

A

B

C

D

Observations:

- After drying: crust and crack formation; shrinkage; loss of shiny surface
- Greater cracking and shrinkage at higher temperature

General information	
Type of data	Shrinkage
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2017 - 2018
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 50%db
Ash content	~ 50%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Custom-design solar thermal drying rig
Drying time	3 to 5 hours
Operating conditions	○ Irradiance: from 75 to 1000 W/m^2 (from overcast to sunny conditions) ○ Air flowrate: 0.5 m^3/min (corresponding to an air velocity of 0.5 m/s) ○ Air temperature: ambient (~20°C) ○ Air humidity: ~10%
Sample form in the dryer	Thin layer of 5 and 10 mm thickness, and 60 mm diameter
Analysed parameters	(1) Reduction of volume after drying (2) Moisture content
Employed method	(1) Measurement of the dimensions of the sample before and after drying (SOP 8.8.2.1) (2) Weighing the sample before and after oven drying at 105°C for 24 h (SOP 8.7.1.1)

Publications

Mugauri, T.R. (2019). *Drying of faecal sludge from ventilated improved pit latrines (VIP latrines) using solar thermal energy*. MSc thesis, University of KwaZulu-Natal, South Africa.

Septien, S., Mugauri, T.R., Singh, A., Inambao, F. (2018). *Solar drying of faecal sludge from on-site sanitation facilities*. 5th Southern Africa Solar Thermal Energy Conference, Durban, South Africa, 25-27 June.

Septien, S., Mugauri, T.R., Singh, A., Inambao, F. (2017). *Drying of Faecal Sludge using Solar Thermal Energy* (final report project K5/2582). Water Research Commission, South Africa.

Data source files

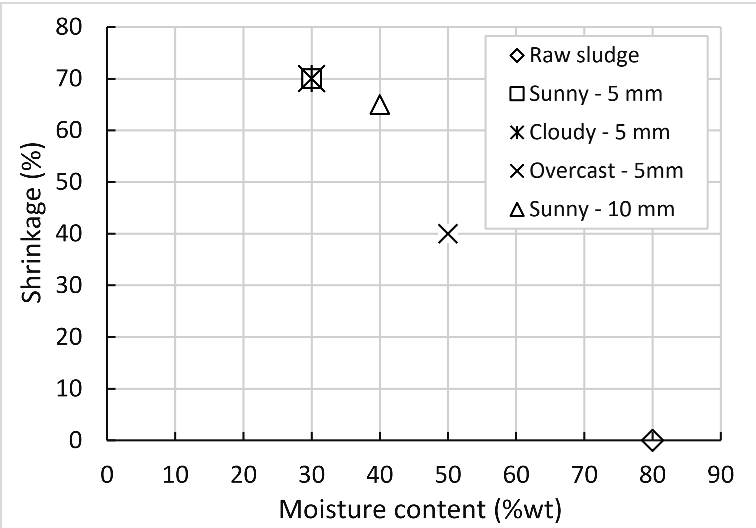
https://www.dropbox.com/s/ssumqzociucjaj2/Shrinkage%20of%20VIP%20sludge%20%282017-2018%29.xlsx?dl=0

Additional Notes

-

Description of Data

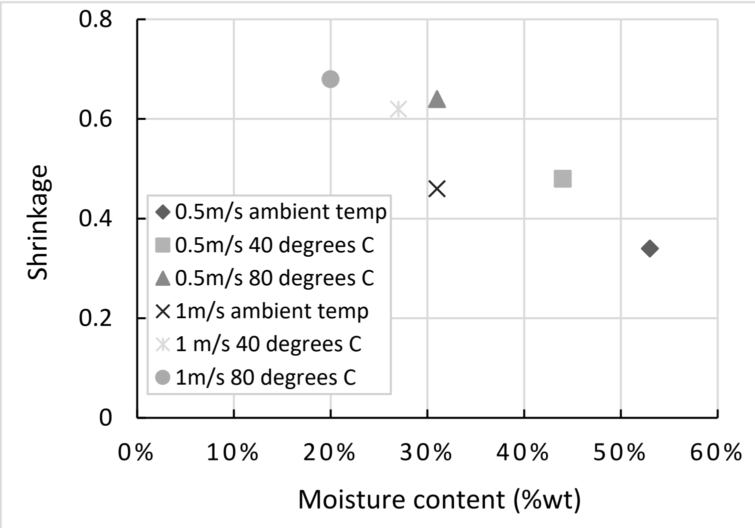
Shrinkage versus the moisture content obtained after drying at the different conditions



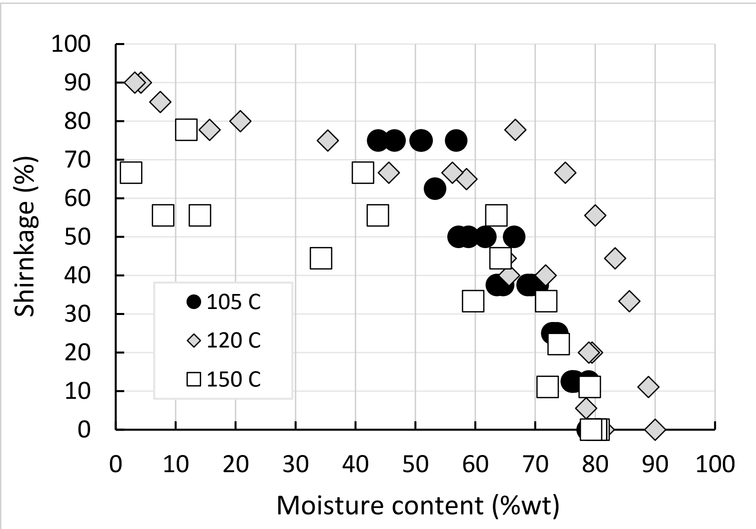
Observations

- More shrinkage as sample dried at lower moisture content

General information	
Type of data	Shrinkage
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Screening for trash removal
Experimental Procedure	
Drying experimental setup	Custom-design solar thermal drying rig
Drying time	5 hours
Operating conditions	○ Irradiance: 800 – 1300 W/m^2 (sunny conditions) ○ Air flowrate: 0.5 and 1 m^3/min (corresponding to an air velocity of 0.5 m/s) ○ Air temperature: ambient (~20°C), 40 and 80°C ○ Air humidity: ~10%
Sample form	Thin layer of 5 mm thickness and 110 mm diameter
Analysed parameters	Reduction of volume after drying
Employed method	Measurement of the dimensions of the sample before and after drying (SOP 8.8.2.1)
Publications	
-	

Data source files	
https://www.dropbox.com/s/gscuvzvus55zfsr/2019-2020%20VIP%20Shrinkage%20data.xlsx?dl=0	
Additional Notes	
○ Density measured on the sample obtained at the end of a few experiments ○ Low precision of the current method (rough estimation)	
Description of Data	
Shrinkage versus the moisture content at the end of a few experiments 	Observations: ○ Higher shrinkage as sludge dried

General information	
Type of data	Shrinkage
Place of experimentation	Duke University Center for WaSH-AID, Durham, NC
Dates of the experiments	2016-2017
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	None
Experimental Procedure	
Drying experimental setup	Convection toaster oven
Drying time	Until stabilisation of the sample mass
Operating conditions	o Air temperature: 105, 120 and 150°C o Relative humidity: ambient o Air velocity: none
Sample form in the dryer	9 mm thick sample in a 100 m diameter petri dish
Analysed parameters	Thickness
Employed method	Callipers to measure the thickness at each time point (diameter assumed unchanged) (SOP 8.7.1.1)

Publications	
-	
Data source files	
https://www.dropbox.com/s/tgg4sehv3xjlfhq/RTI%20International%20data_fresh%20faeces%20convective%20drying%20kinetics%20and%20shrinkage%20%282016-2017%29.xlsx?dl=0	
Additional Notes	
○ Fresh faeces collected from voluntary and anonymous donations	
Description of Data	
Shrinkage during drying at different temperatures  	Observations ○ Shrinkage of the sample until reaching 40-60%wt moisture content ○ Slightly lower shrinkage during drying at 150°C compared to lower temperatures ○ Diameter visually unchanged throughout experiments.

MECHANICAL PROPERTIES

General information	
Type of data	Rheological properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilet (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 70, 80 and 90%wt moisture content
Operating conditions	105°C
Sample form	Faecal sludge in a cup
Analysed parameters	Viscosity and shear stress at 25, 40 and 60°C
Employed method	Rotational test in the rheometer *Anton Paar MCR 72* (SOP 8.8.4.1)
Publications	
-	

Data source files

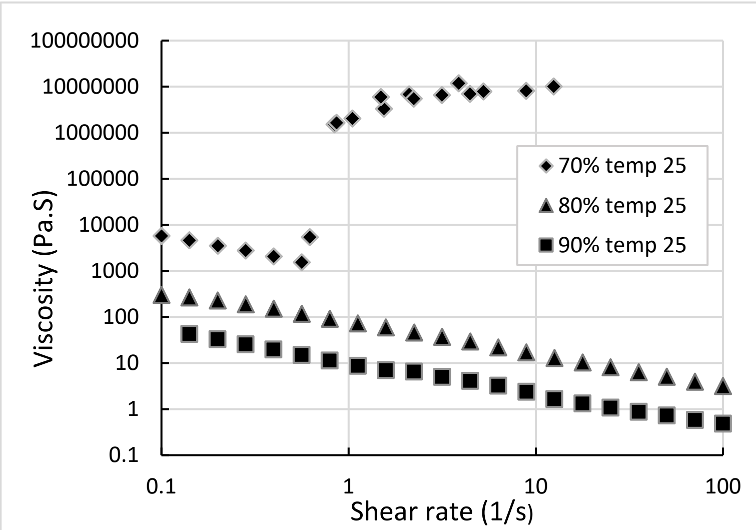
https://www.dropbox.com/s/ukpo4iahlxkwnuz/2019-2020%20UDDT%20Rheological%20properties_PRG-UKZN.xlsx?dl=0

Additional Notes

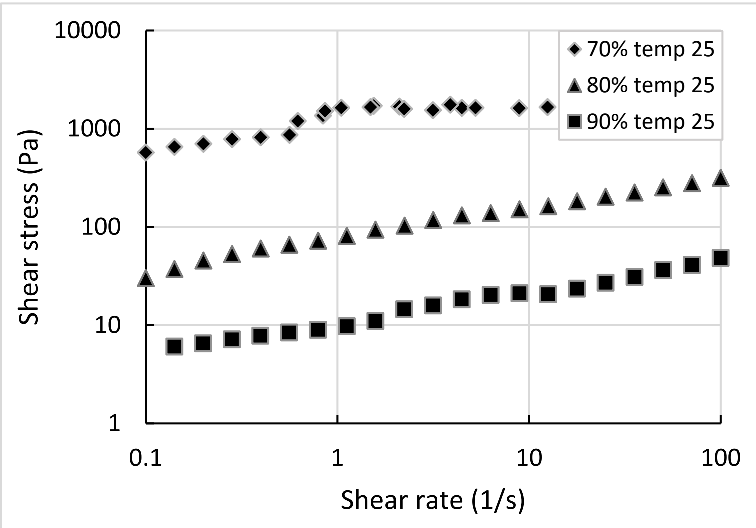
Increase of moisture content to 70, 80 and 90%wt by the addition of water

Description of Data

Viscosity versus shear rate as a function of moisture content (in log scale) at temperature 25°C



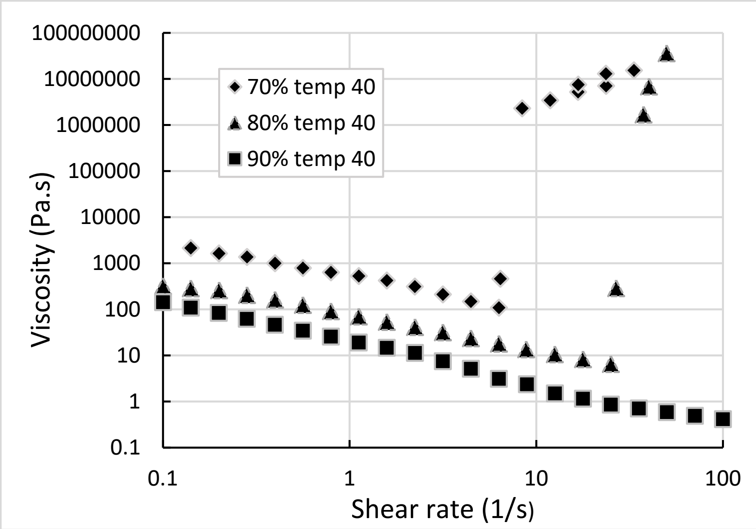
Shear stress versus shear rate as a function of moisture content (in log scale) at temperature 25°C



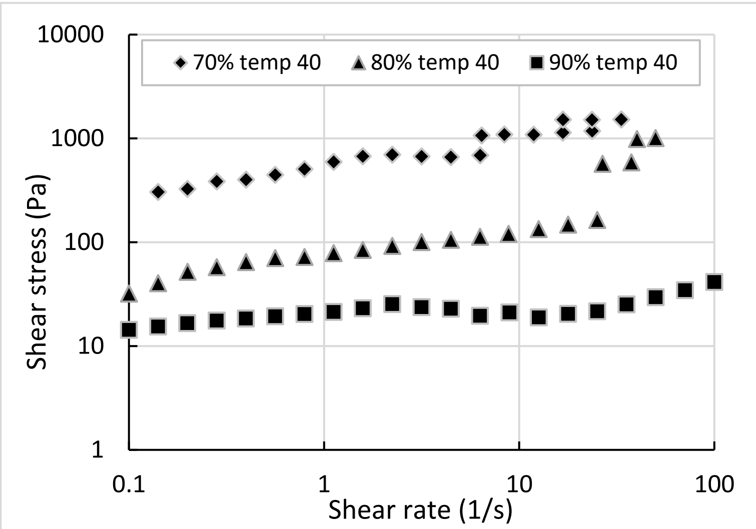
Observations:

- Shear thinning behavior (decrease of viscosity and increase of shear stress by increasing the shear rate)
- Lower shear stress and viscosity at higher moisture content

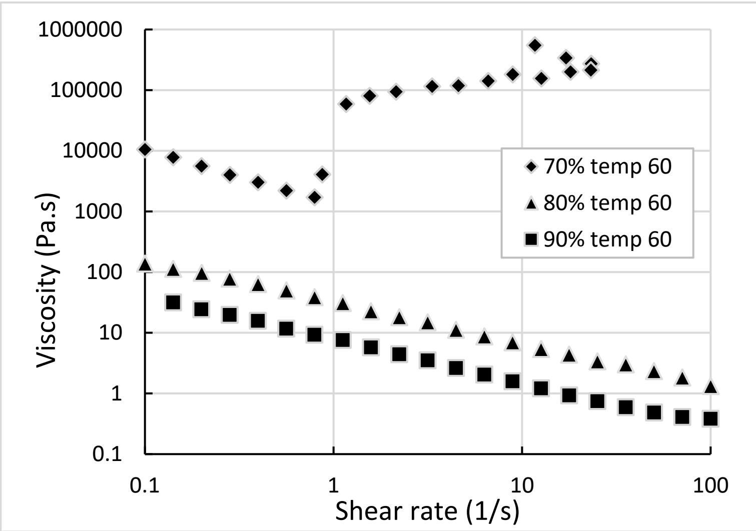
Viscosity versus shear rate as a function of moisture content (in log scale) at temperature 40ºC



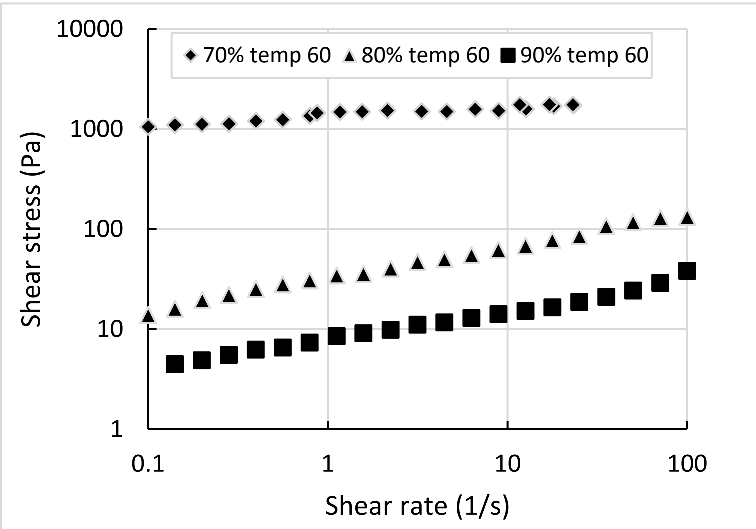
Shear stress versus shear rate as a function of moisture content (in log scale) at temperature 40ºC



Viscosity versus shear rate as a function of moisture content (in log scale) at temperature 60°C



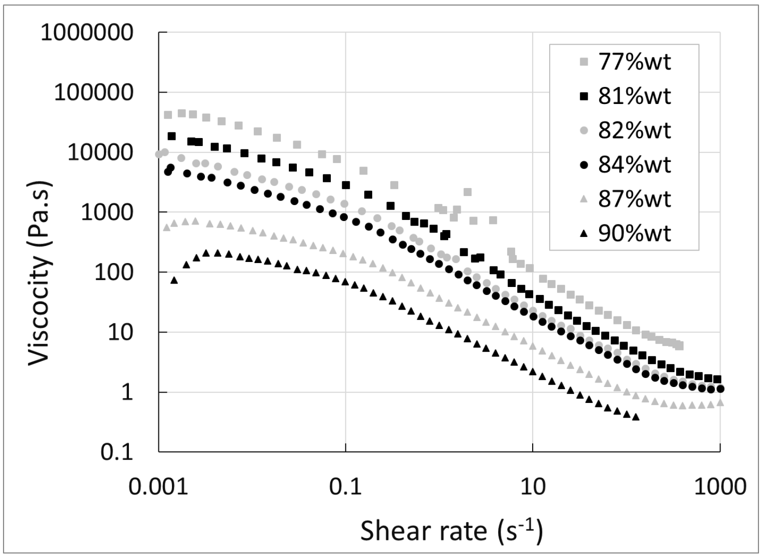
Shear stress versus shear rate as a function of moisture content (in log scale) at temperature 60°C



General information	
Type of data	Rheological properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	A few years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 70%db
Ash content	~ 30%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Laboratory oven
Drying time	Until achieving 77%wt moisture content
Operating conditions	105°C
Sample form	Sludge in a crucible
Analysed parameters	Viscosity and shear stress
Employed method	Rotational test in the rheometer *Anton Paar MCR 51* (SOP 8.8.4.1)
Publications	
Septien, S., Pocock, J., Teba, L., Velkushanova, K., & Buckley, C. A. (2018). Rheological characteristics of faecal sludge from VIP latrines and implications on pit emptying. Journal of environmental management, 228, 149-157.	

Data source files
https://www.dropbox.com/s/7hkn5o22aj70trs/Rheological%20properties%20of%20VIP%20FS%20%282014-2015%29.xlsx?dl=0
Additional Notes
○ Increase of moisture content to 81, 84, 87 and 90%wt by the addition of water
Description of Data

Viscosity versus shear rate as a function of moisture content in log scale



Observations:

- ○ Shear thinning behavior (decrease of viscosity and increase of shear stress by increasing the shear rate)
- ○ Lower shear stress and viscosity at higher moisture content

General information	
Type of data	Rheological properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine toilet (VIP)
Location of collection	Durban, South Africa
Age before collection	3 to 5 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 70, 80 and 90%wt moisture content
Operating conditions	105°C
Sample form	Faecal sludge in a cup
Analysed parameters	Viscosity and shear stress at 25, 40 and 60°C
Employed method	Rotational test in the rheometer *Anton Paar MCR 72*(SOP 8.8.4.1)
Publications	
-	

Data source files

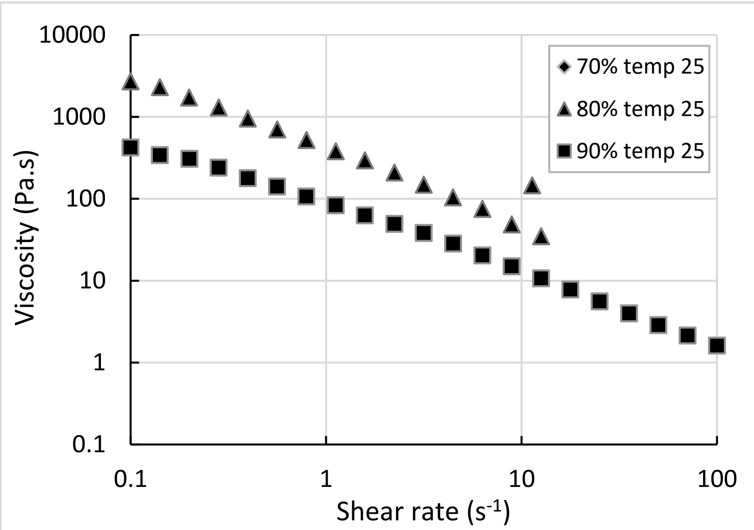
https://www.dropbox.com/s/gor5qyq0yx0zh1y/2019-2020%20VIP%20Rheological%20Properties_PRG-UKZN%20graphs.xlsx?dl=0

Additional Notes

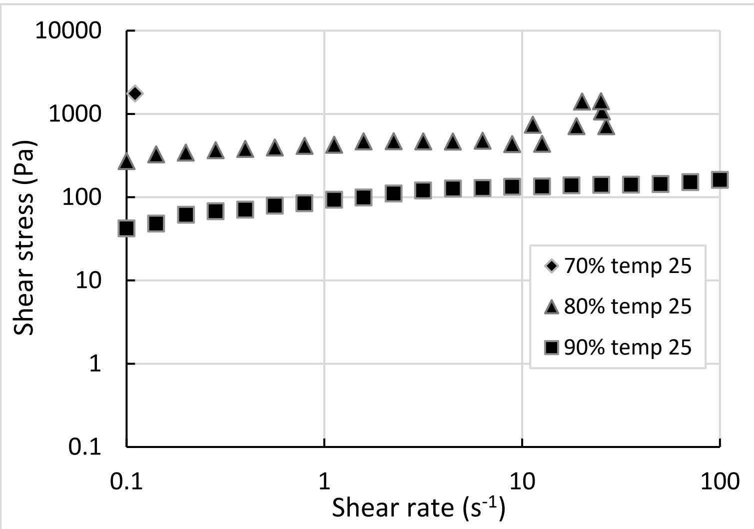
- Increase of moisture content to 70, 80 and 90%wt by the addition of water

Description of Data

Viscosity versus shear rate as a function of moisture content (in log scale) at temperature 25°C

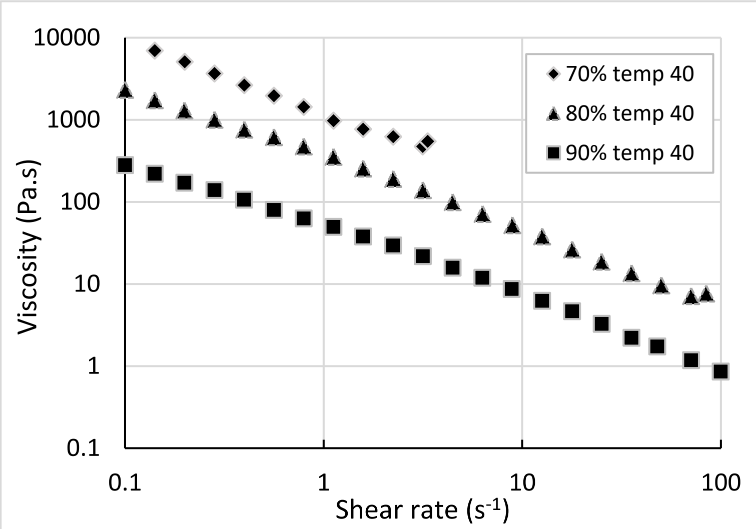
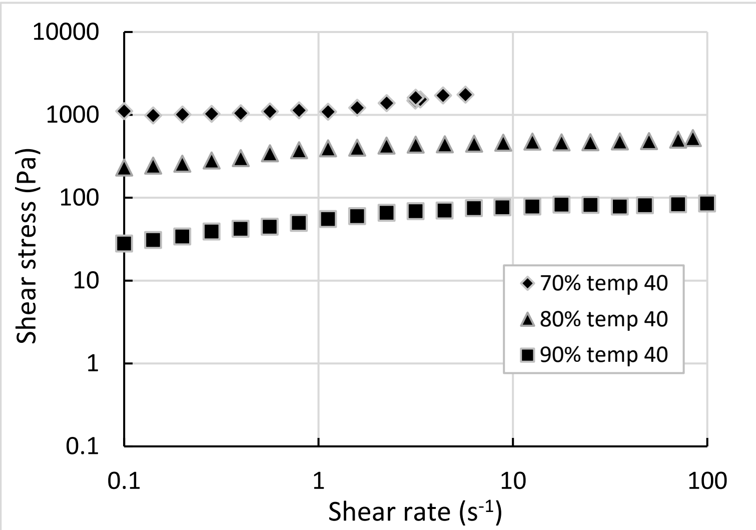


Shear stress versus shear rate as a function of moisture content (in log scale) at temperature 25°C

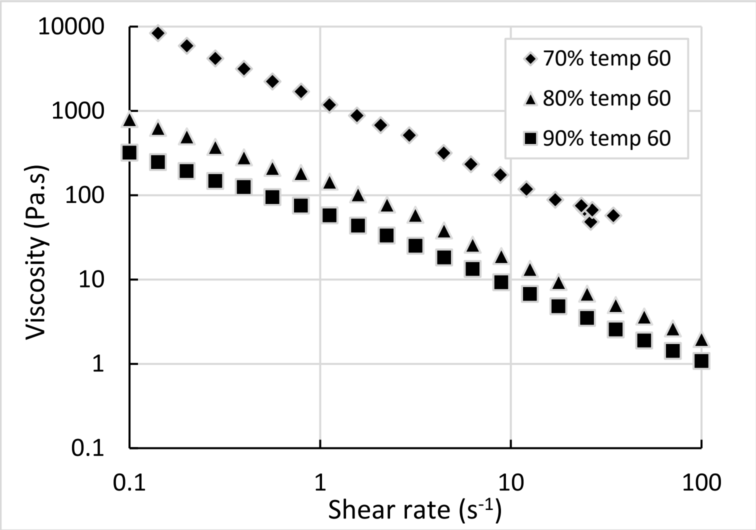


Observations:

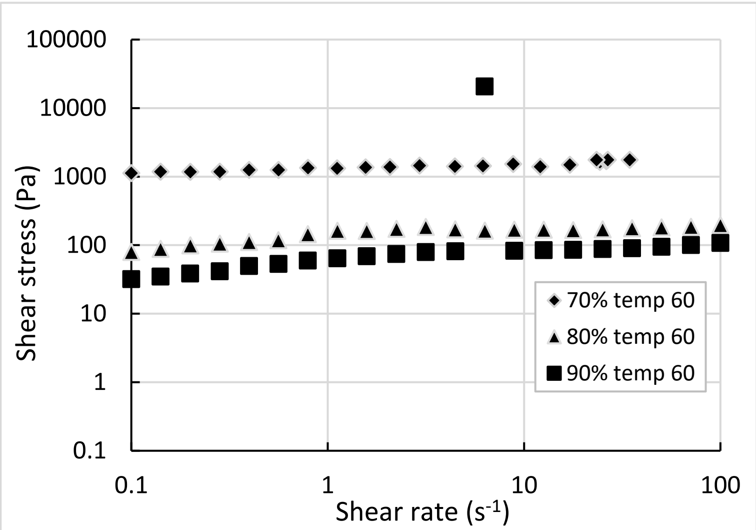
- Shear thinning behavior (decrease of viscosity and increase of shear stress by increasing the shear rate)
- Lower shear stress and viscosity at higher moisture content
- Similar viscosity and shear stress at the different temperatures

Viscosity versus shear rate as a function of moisture content (in log scale) at temperature 40°C 	
Shear stress versus shear rate as a function of moisture content (in log scale) at temperature 40°C 	

Viscosity versus shear rate as a function of moisture content (in log scale) at temperature 60ºC



Shear stress versus shear rate as a function of moisture content (in log scale) at temperature 60ºC



General information	
Type of data	Rheological properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2012 - 2013
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	70 to 90%wt
Total solids content	10 to 30%wt
Volatile solids content	80 to 95%db
Ash content	5 to 20%db
Presence of trash?	No
Pre-treatment	None
Experimental Procedure	
Drying experimental setup	None
Drying time	N.A.
Operating conditions	N.A.
Sample characteristics in the dryer	N.A.
Analysed parameters	Viscosity and shear stress
Employed method	Rotational test in the rheometer *Anton Paar MCR 51* (SOP 8.8.4.1)
Publications	

Woolley, S. M., Buckley, C. A., Pocock, J., & Foutch, G. L. (2014). Rheological modelling of fresh human faeces. *Journal of water, sanitation and hygiene for development*, *4*(3), 484-489.

Woolley, S. M., Cottingham, R. S., Pocock, J., & Buckley, C. A. (2014). Shear rheological properties of fresh human faeces with different moisture content. *Water SA*, *40*(2), 273-276.

Data source files

https://www.dropbox.com/s/952jogm6tcfgraq/Rheoloigcal%20properties%20of%20fresh%20faeces_%282012-2013%29.xlsx?dl=0

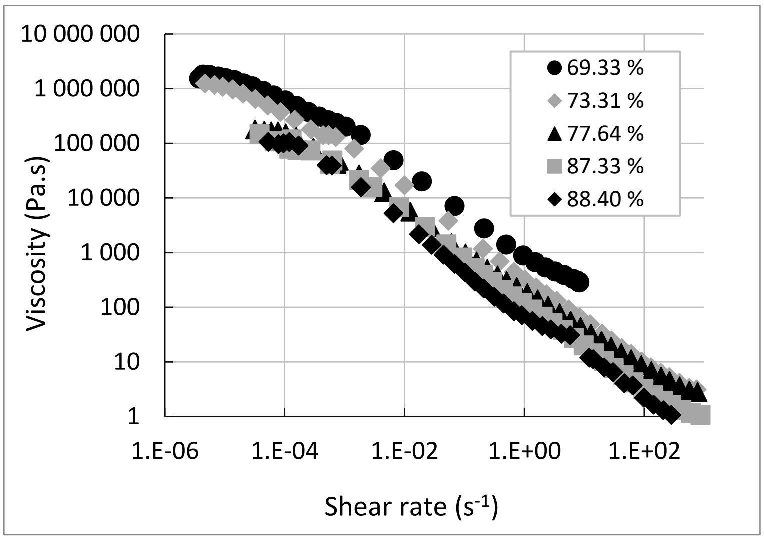
https://www.dropbox.com/s/dzvc8huagzd1qh2/Fresh%20faeces_Viscosity%20vs%20Moisture%20content%20at%20Fixed%20Shear%20Rate%20%282012-2013%29.xlsx?dl=0

Additional Notes

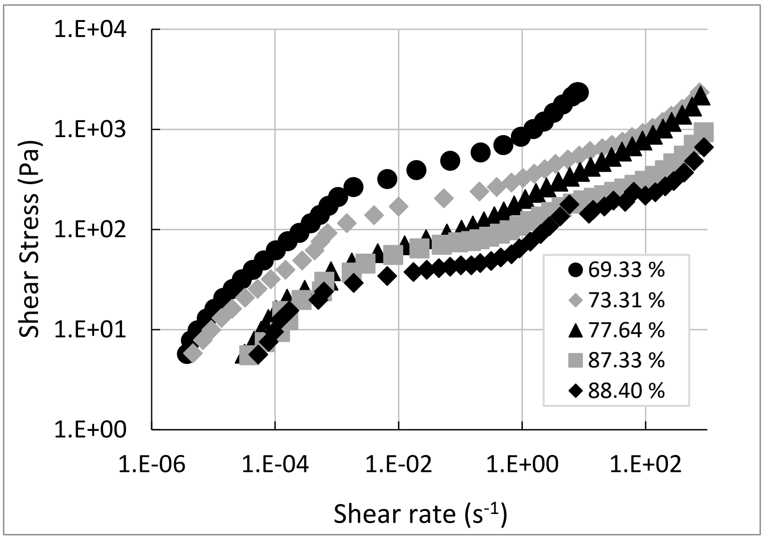
- Fresh faeces collected from voluntary and anonymous donations from healthy young adults
- Rheological tests performed in each of the individual donations

Description of Data

Viscosity versus shear rate as a function of moisture content (in log scale)

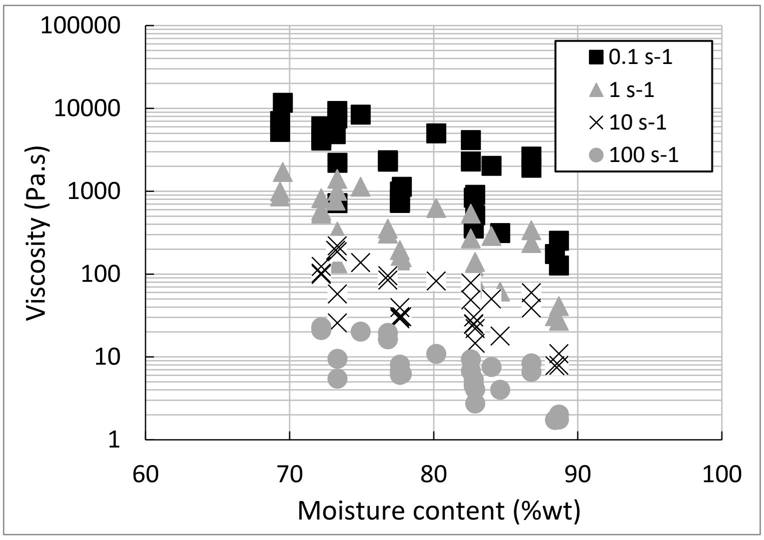


Shear stress versus shear rate as a function of moisture content (in log scale)



Observations:

- Shear thinning behavior (decrease of viscosity and increase of shear stress by increasing the shear rate)
- Lower shear stress and viscosity at higher moisture content

Viscosity versus moisture content as a function of shear rate (in log scale) 	

General information	
Type of data	Rheological properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~80%wt
Total solids content	~20%wt
Volatile solids content	~85%db
Ash content	~15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Natural drying (in the open-air)
Drying time	16 weeks
Operating conditions	○ Ambient temperature (~ 20°C) ○ Ambient relative humidity (~ 60%)
Sample form in the dryer	900 g of sample placed in 1 L plastic bucket
Analysed parameters	Viscosity and shear stress
Employed method	Rotational test in the rheometer Anton Paar MCR 51 (SOP Method 8.8.4.1)
Publications	
-	

Data source files

https://www.dropbox.com/s/xbv6su0jxsipiok/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20the%20open%20air_UKZN%20PRG.xlsx?dl=0

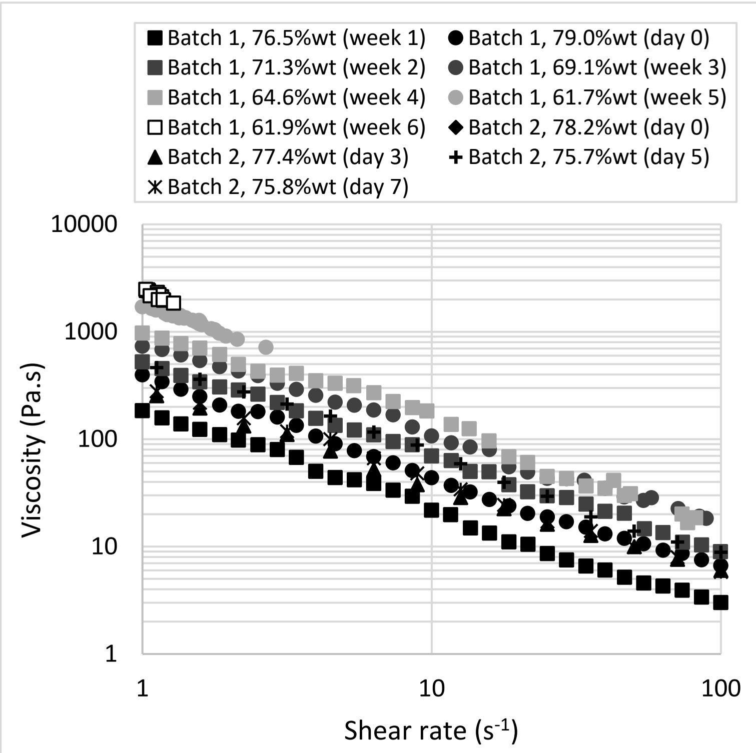
https://www.dropbox.com/s/a0g1023a6uoc5gk/2019-2020%20Natural%20drying%20of%20fresh%20faeces%20in%20open%20air%20Batch%202_%20Rheological%20properties_UKZN%20PRG.xlsx?dl=0

Additional Notes

- Fresh faeces collected from voluntary and anonymous donations
- Containers with sample placed in a ventilated area
- Mesh placed at the opening of the container to avoid the development of maggots
- Samples from batch 1 analysed in a weekly basis for 16 weeks
- Samples from batch 2 analysed at days 0, 3, 5 and 7 during one week

Description of Data

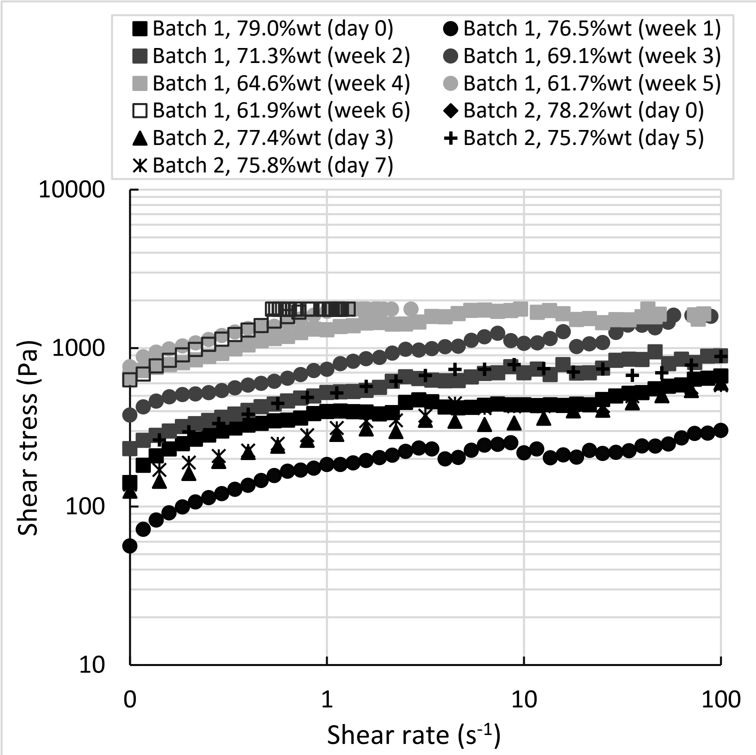
Viscosity versus shear rate as a function of moisture content for the samples from batch 1 and 2 (in log scale)



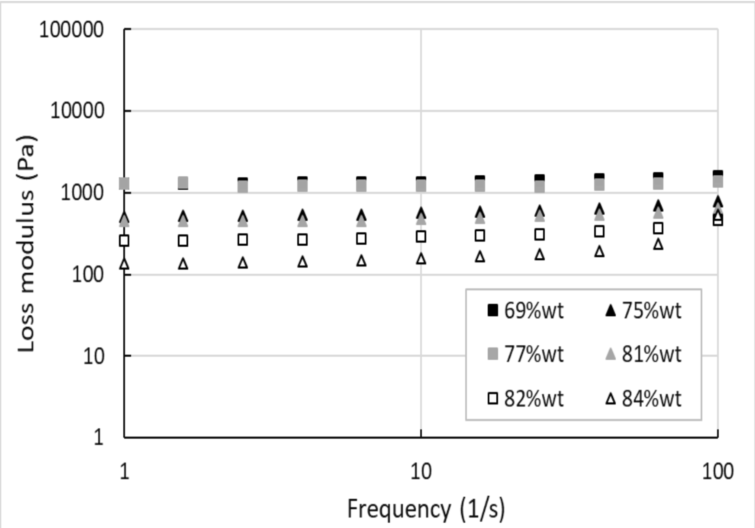
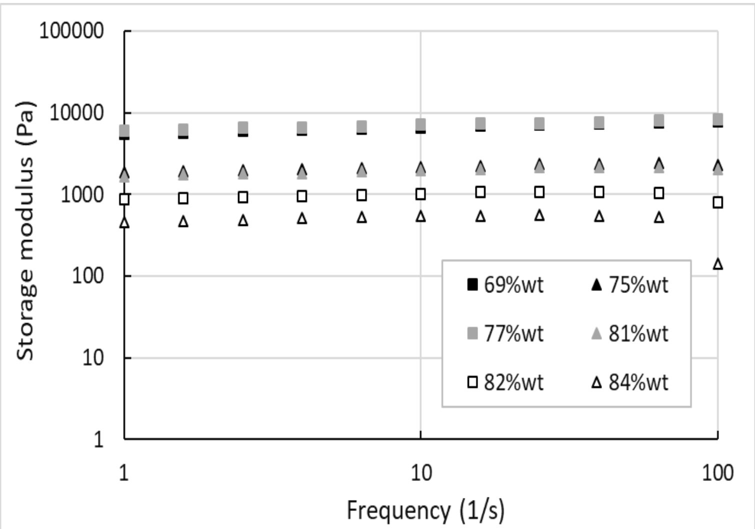
Observations:

- Shear thinning behavior (decrease of viscosity and increase of shear stress by increasing the shear rate)
- Reduction in viscosity and shear stress in week 1
- Increase of shear stress and viscosity by increasing moisture content after week 1
- Not possible to induce a flow below 61.9 %wt moisture content (after six weeks of drying)

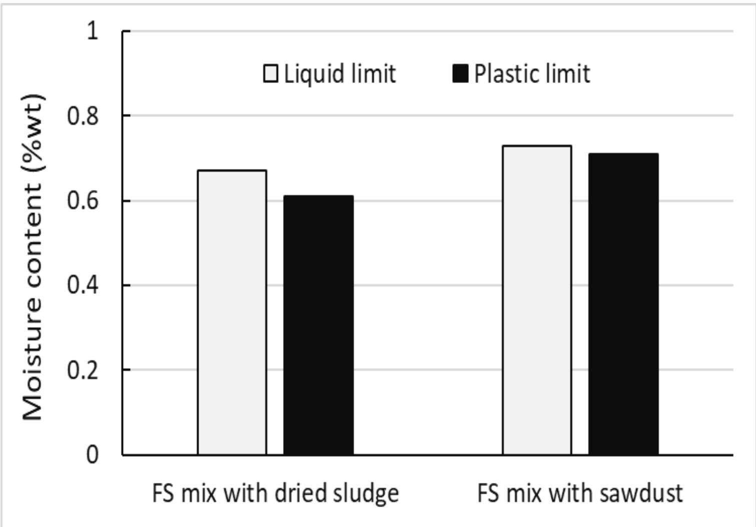
<u>Shear stress versus shear rate as a function of moisture content for the samples from batch 1 and 2 (in log scale)</u>



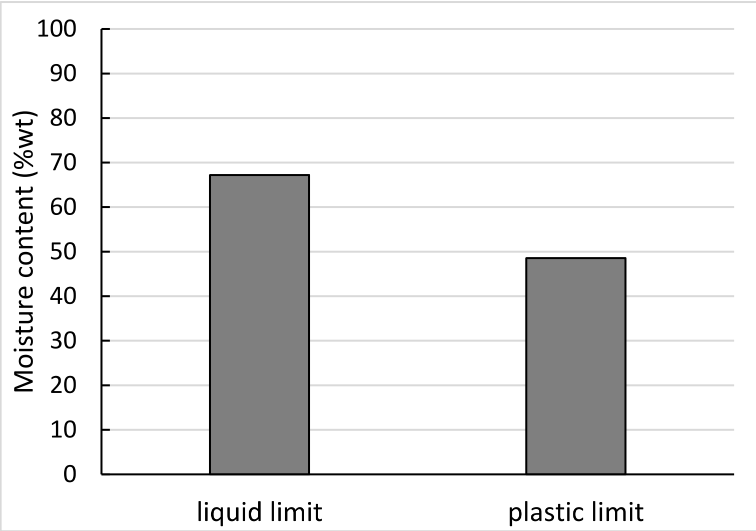
General information	
Type of data	Viscoelastic properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine
Location of collection	Durban, South Africa
Age before collection	A few years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 70%db
Ash content	~ 30%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	Laboratory oven
Drying time	Until achieving 77, 75 and 69%wt moisture content
Operating conditions	105°C
Sample form	Sludge in a crucible
Analysed parameters	Loss and storage modulus
Employed method	Dynamic test in the rheometer *Anton Paar MCR 51* (SOP 8.8.4.1)
Publications	
-	

Data source files	
https://www.dropbox.com/s/pelvw9356fuux11/VIP%20Viscoelastic%20properties_%282014-2015%29.xlsx?dl=0	
Additional Notes	
○ Increase of moisture content to 82 and 84%wt by the addition of water ○ Loss and storage modulus referring to the viscous and elastic component respectively	
Description of Data	
Loss modulus versus frequency as a function of moisture content (in log scale)  	Observations: ○ Linear viscoelastic region (loss and storage modulus constant across the frequency range) ○ Sludge at rest more elastic than viscous (storage modulus > loss modulus)
Storage modulus versus frequency as a function of moisture content (in log scale)  	

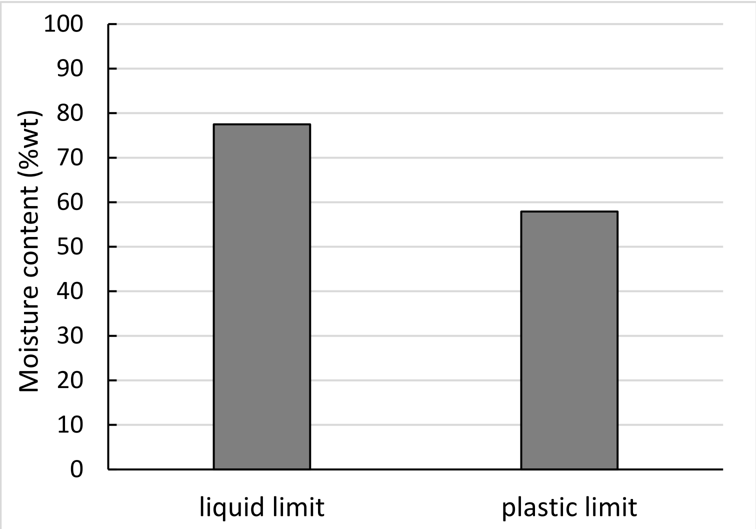
General information	
Type of data	Plastic properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 70%db
Ash content	~ 30%db
Presence of trash?	Yes
Pre-treatment	Screening to remove the large pieces of trash
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Atterberg limits (plastic and liquid limits)
Employed method	Penetrometer (SOP 8.8.4.2)
Publications	
Septien, S., Singh, A., Mirara, S. W., Teba, L., Velkushanova, K., & Buckley, C. A. (2018). 'LaDePa'process for the drying and pasteurization of faecal sludge from VIP latrines using infrared radiation. South African journal of chemical engineering, 25, 147-158.	

Data source files	
-	
Additional Notes	
○ Decrease of moisture content of the sludge by adding dried sludge or wood sawdust	
Description of Data	
Moisture content of the sludge at the liquid and plastic limits 	Observations: ○ Raw sludge beyond the liquid limit ○ Faster transition to semi-solid and solid state using sawdust than dried sludge to lower moisture content (higher liquid and plastic limit)

General information	
Type of data	Plastic properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilet (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 20, 30, 40, 50, 60, 70, 80 and 90%wt moisture content
Operating conditions	105°C
Sample form in the dryer	Faecal sludge spread in a tray
Analysed parameters	Atterberg limits (plastic and liquid limits)
Employed method	Penetrometer (SOP 8.8.4.2)
Publications	
-	

Data source files	
https://www.dropbox.com/s/hknu2xe8ymek4ai/2019-2020%20Cone%20penetrometer%20tests_PRG-UKZN.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Moisture content of the sludge at the liquid and plastic limits  	Observations ○ Liquid limit at around 70%wt moisture content ○ Plastic limit at around 50%wt moisture content

General information	
Type of data	Plastic properties
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine toilet (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 20, 30, 40, 50, 60, 70, 80 and 90%wt moisture content
Operating conditions	105°C
Sample form in the dryer	Faecal sludge spread in a tray
Analysed parameters	Atterberg limits (plastic and liquid limits)
Employed method	Penetrometer (SOP 8.8.4.2)
Publications	
-	

Data source files	
https://www.dropbox.com/s/hknu2xe8ymek4ai/2019-2020%20Cone%20penetrometer%20tests_PRG-UKZN.xlsx?dl=0	
Additional Notes	
-	
Description of Data	
Moisture content of the sludge at the liquid and plastic limits 	Observations ○ Liquid limit at around 80%wt moisture content ○ Plastic limit at around 60%wt moisture content

General information	
Type of data	Stickiness
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal, Durban, South Africa
Dates of the experiments	2019 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilet (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	105°C
Sample form	Faecal sludge in a recipient
Analysed parameters	Adhesive and cohesive forces at 25, 40, 60 and 80°C
Employed method	Use of the *Stable microsystems TA. XT express* texture analyser at different temperatures (25, 40, 60 and 80°C) (SOP 8.8.4.5)
Publications	
-	

Data source files

https://www.dropbox.com/s/6bgaz9t6juefmbz/2019%20-%202020%20UDDT%20Stickiness_PRG.xlsx?dl=0

https://www.dropbox.com/s/ftc2fgreukf5krp/2019-2020%20UDDT%20Stickiness%20at%2040%20degrees%20C_PRG-UKZN.xlsx?dl=0

https://www.dropbox.com/s/6q4u2o9b6ulwkw1/2019-2020%20UDDT%20Stickiness%20at%2060%20degrees%20C_PRG-UKZN.xlsx?dl=0

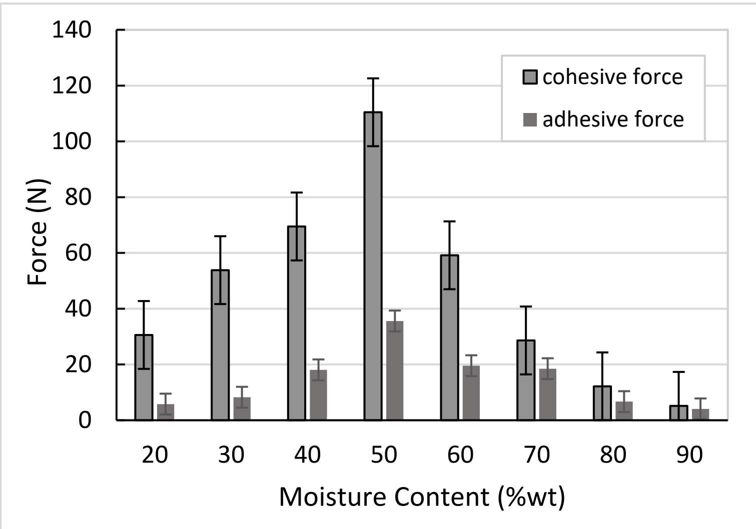
https://www.dropbox.com/s/rbw8oiojh6r05yn/2019-2020%20UDDT%20Stickiness%20at%2080%20degrees%20C_PRG-UKZN.xlsx?dl=0

Additional Notes

- Use of a compression plate probe for the tests in the texture analyser
- The moisture content of the sludge increased by adding water

Description of Data

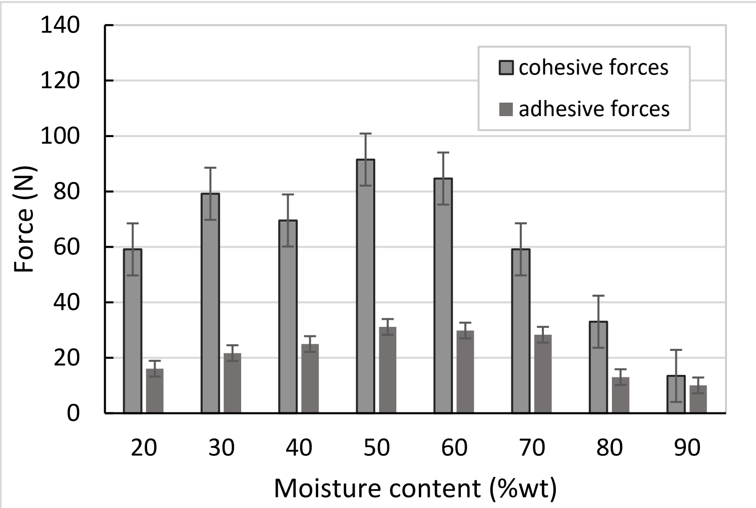
Cohesive and adhesive force versus moisture content at 25°C



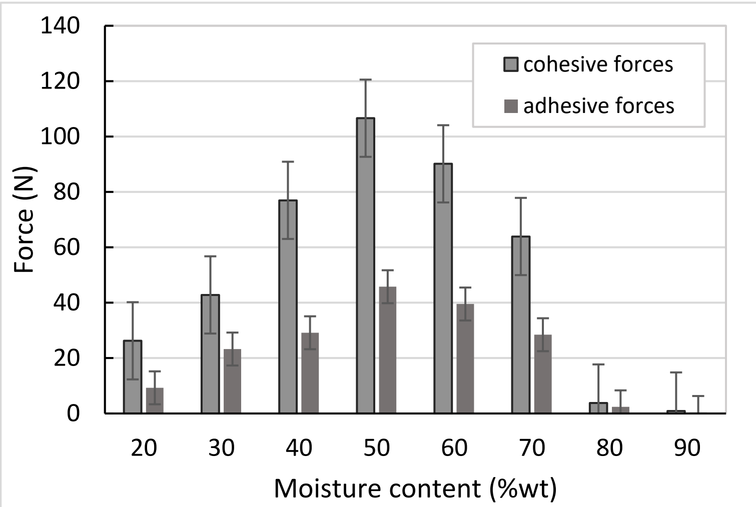
Observations:

- Sticky region between 40 and 60%wt at 25, 40, 60 and 80°C
- Stickiness peak achieved at 50%wt at 25, 40, 60 and 80°C
- Cohesive forces greater than adhesive forces

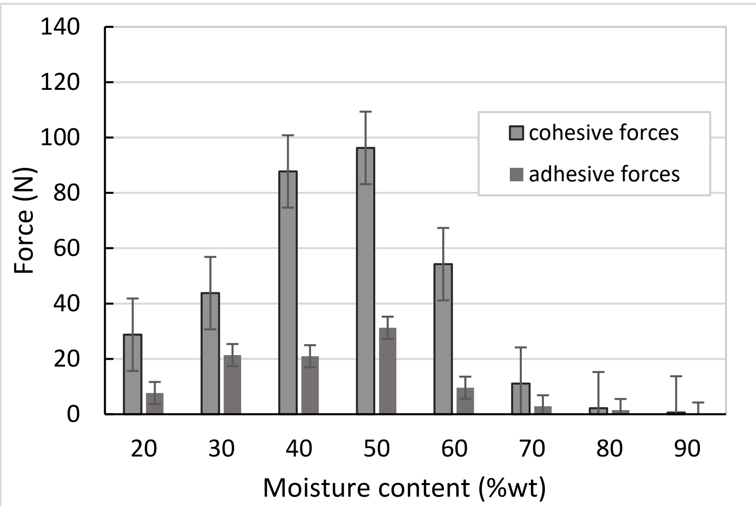
Cohesive and adhesive force versus moisture content at 40°C



Cohesive and adhesive force versus moisture content at 60°C



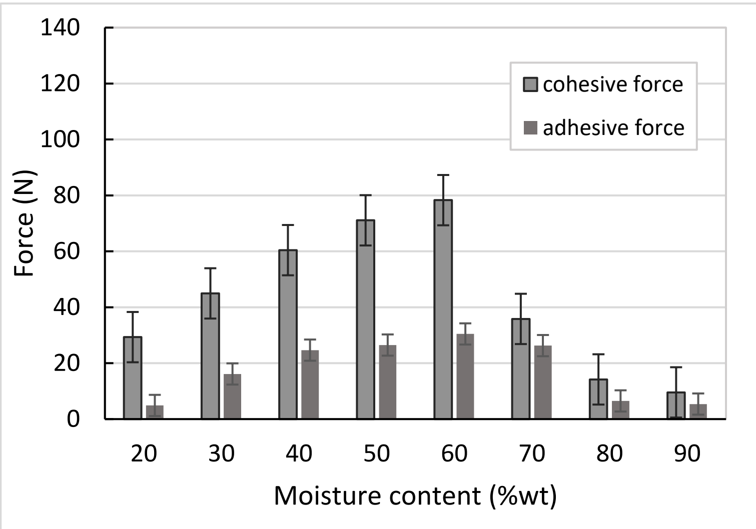
Cohesive and adhesive force versus moisture content at 80°C



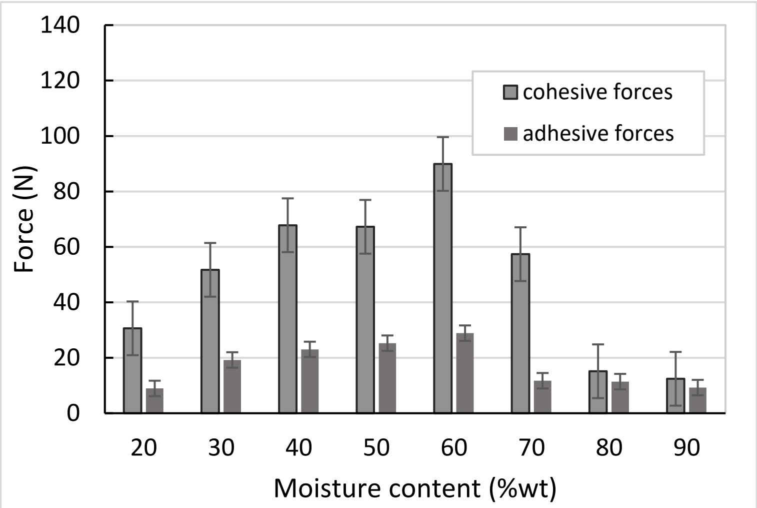
General information	
Type of data	Stickiness
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2019-2020
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine toilet (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Small amounts of trash
Pre-treatment	Trash removal
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	105°C
Sample form	Faecal sludge in a recipient
Analysed parameters	Adhesive and cohesive forces at 25, 40, 60 and 80°C
Employed method	Use of the *Stable microsystems TA. XT express* texture analyser at different temperatures (25, 40, 60 and 80°C) (SOP 8.8.4.5)
Publications	
-	

Data source files
https://www.dropbox.com/s/lvl7yyk47okwtfn/2019%20-%202020%20VIP%20Stickiness%20at%2025%20Degrees%20%28Ambient%20temp%29_PRG.xlsx?dl=0 https://www.dropbox.com/s/hudmu0dbx55rz3o/2019-2020%20VIP%20Stickiness%20at%2040%20degrees%20C_PRG-UKZN.xlsx?dl=0 https://www.dropbox.com/s/yablfax6psqvpn3/2019-2020%20VIP%20Stickiness%20at%2060%20degrees%20C_PRG-UKZN.xlsx?dl=0 https://www.dropbox.com/s/ejk1g2z2k46edwk/Cleaned%20uddt%20temp%2080%281%29.xlsx?dl=0

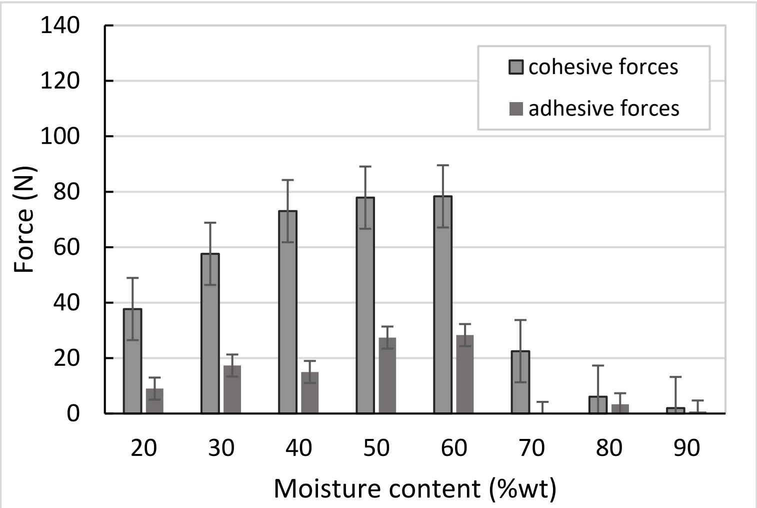
Additional Notes
○ Use of a compression plate probe for the tests in the texture analyser ○ The moisture content of the sludge increased by adding water

Description of Data	
Cohesive and adhesive force versus moisture content at 25°C 	Observations: ○ Sticky region between 40 and 60%wt at 25, 40, 60 and 80°C ○ Stickiness peak achieved at 60%wt at 25, 40, 60 and 80°C ○ Cohesive forces greater than adhesive forces ○ Higher cohesive and adhesive forces at the sticky point at 80°C compared to lower temperatures

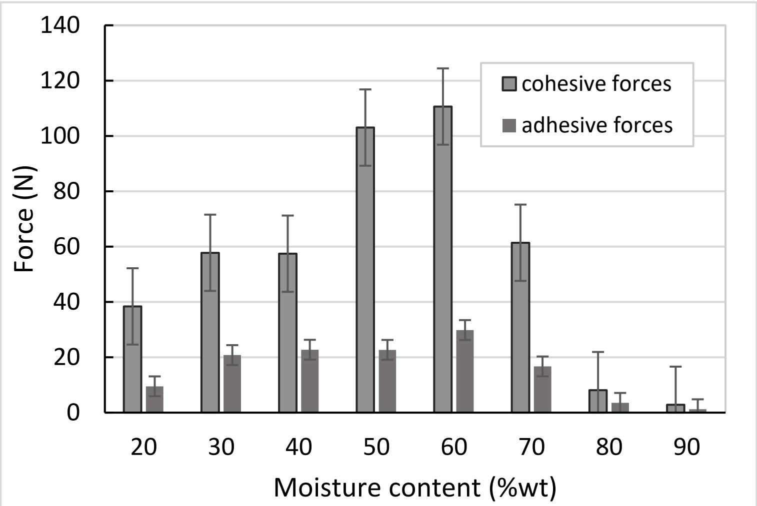
Cohesive and adhesive force versus moisture content at 40°C



Cohesive and adhesive force versus moisture content at 60°C



Cohesive and adhesive force versus moisture content at 80°C

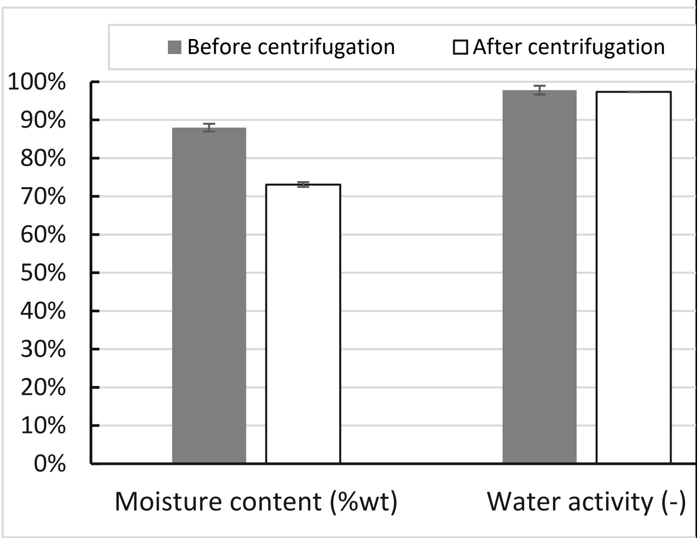


DEWATERING

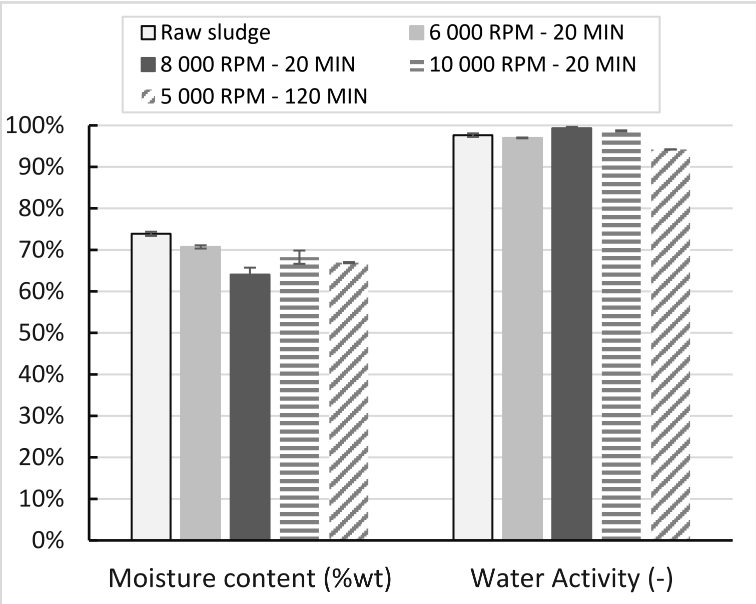
General information	
Type of data	Centrifugation
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reactor (ABR) from a decentralised wastewater treatment plant (DEWAT)
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 75%db
Ash content	~ 25%db
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Moisture content (1) and water activity (2) of the cake after centrifugation
Employed methods	Direct measurement by the moisture analyzer balance *PCE-MB Series* (1) (SOP 8.7.1.5) and the water activity analyzer *AquaLab Tunable Diode Laser-TDL* (2) (SOP 8.8.3.3)
Publications	
Septien, S., Getahun, S., Mirara, S., Makununika, B.S.N., Mugauri, T.R., Singh, A., Pocock, J., Inambao, F., Velkushanova, K., Buckley, C.A. (2019). Investigations of faecal sludge drying from on-site sanitation facilities. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.	

Data source files
https://www.dropbox.com/s/76dejwq7ug1zwqy/Pre-%20and%20Post%20Centrifugation%20data%20for%20FS%20and%20fresh%20faeces%20.xlsx?dl=0

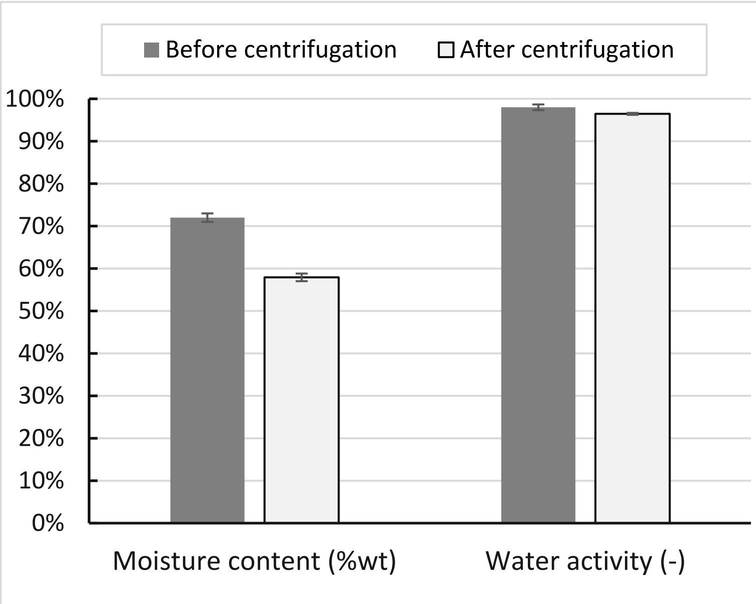
Additional Notes
○ Centrifugation done in a centrifuge *HERMLE Z323*, during 120 minutes at a rate of 5000 RPM, for 40 g of sample per centrifuge tube

Description of Data	
Moisture content and water activity of the cake before and after centrifugation 	Observations: ○ Considerable decrease of the moisture content after centrifugation ○ Similar water activity of the sludge before and after centrifugation

General information	
Type of data	Centrifugation
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 55%db
Ash content	~ 45%db
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Moisture content (1) and water activity (2) of the cake after centrifugation
Employed methods	(1) Use of moisture analyzer balance *PCE-MB Series* (SOP 8.7.1.5) (2) Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Septien, S., Getahun, S., Mirara, S., Makununika, B.S.N., Mugauri, T.R., Singh, A., Pocock, J., Inambao, F., Velkushanova, K., Buckley, C.A. (2019). Investigations of faecal sludge drying from on-site sanitation facilities. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.	

<table>
<tr><th colspan="2"><u>Data source files</u></th></tr>
<tr><td colspan="2">https://www.dropbox.com/s/gszw62ozno10ob2/Centrifugation%20of%20FS.xlsx?dl=0</td></tr>
<tr><th colspan="2"><u>Additional Notes</u></th></tr>
<tr><td colspan="2">○ Centrifugation done in a centrifuge HERMLE Z323, during 20 minutes at a rate of 6000, 8000 and 10000 RPM, for 40 g of sample per centrifuge tube</td></tr>
<tr><th colspan="2"><u>Description of Data</u></th></tr>
<tr><td><u>Moisture content and water activity of the cake before and after centrifugation</u>

</td>
<td><u>Observations:</u>
○ Slight decrease of moisture content after centrifugation
○ Almost no variation of water activity after centrifugation
○ Better dewatering at high RPM or long times</td></tr>
</table>

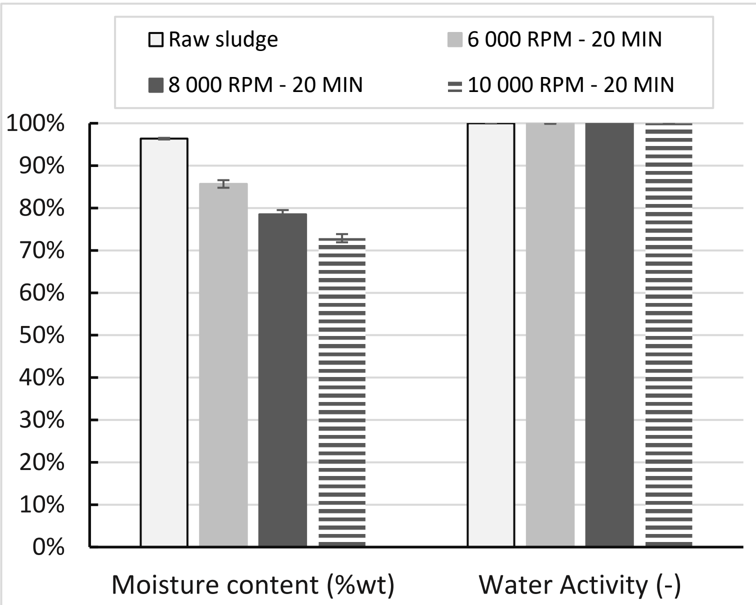
General information	
Type of data	Centrifugation
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from dry ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 75%wt
Total solids content	~ 25%wt
Volatile solids content	~ 40%db
Ash content	~ 60%db
Presence of trash?	Yes (mainly hair extensions, plastic and rocks)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Moisture content and water activity of the cake after centrifugation
Employed methods	(1) Use of moisture analyzer balance *PCE-MB Series* (SOP 8.7.1.5) (2) Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Septien, S., Getahun, S., Mirara, S., Makununika, B.S.N., Mugauri, T.R., Singh, A., Pocock, J., Inambao, F., Velkushanova, K., Buckley, C.A. (2019). Investigations of faecal sludge drying from on-site sanitation facilities. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.	

Data source files	
https://www.dropbox.com/s/76dejwq7ug1zwqy/Pre-%20and%20Post%20Centrifugation%20data%20for%20FS%20and%20fresh%20faeces%20.xlsx?dl=0	
Additional Notes	
○ Centrifugation done in a centrifuge *HERMLE Z323*, during 120 minutes at a rate of 5000 RPM, for 40 g of sample per centrifuge tube	
Description of Data	
Moisture content and water activity of the cake before and after centrifugation 	Observations: ○ Considerable decrease of the moisture content after centrifugation ○ Slight decrease of the water activity of the sludge after centrifugation

General information	
Type of data	Centrifugation
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Faecal sludge from wet ventilated pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	~ 65%db
Ash content	~ 35%db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Moisture content (1) and water activity (2) of the cake after centrifugation
Employed methods	(3) Use of moisture analyzer balance *PCE-MB Series* (SOP 8.7.1.5) (4) Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Septien, S., Getahun, S., Mirara, S., Makununika, B.S.N., Mugauri, T.R., Singh, A., Pocock, J., Inambao, F., Velkushanova, K., Buckley, C.A. (2019). Investigations of faecal sludge drying from on-site sanitation facilities. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.	

Data source files
https://www.dropbox.com/s/gszw62ozno10ob2/Centrifugation%20of%20FS.xlsx?dl=0
Additional Notes
○ Centrifugation done in a centrifuge *HERMLE Z323*, during 20 minutes at a rate of 6000, 8000 and 10000 RPM, for 40 g of sample per centrifuge tube
Description of Data

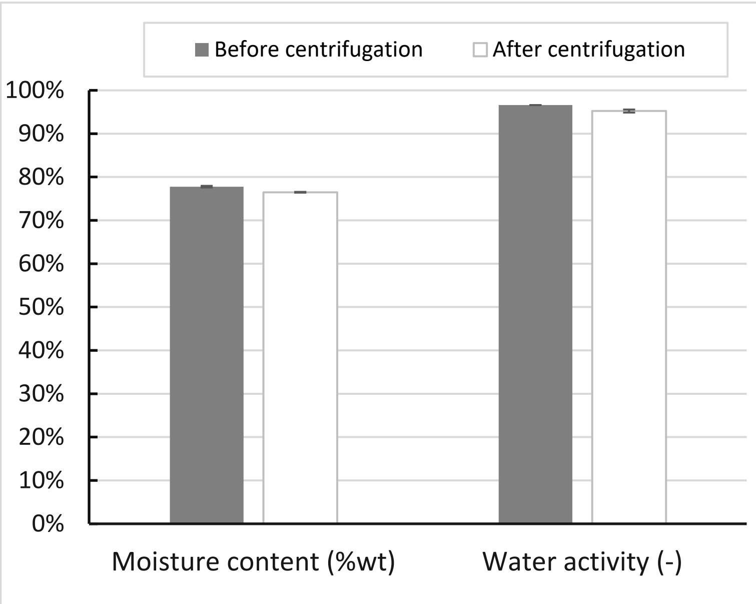
Moisture content and water activity of the cake before and after centrifugation



Observations:

- ○ Considerable decrease of moisture content after centrifugation
- ○ No variation of water activity after centrifugation
- ○ Better dewatering by increasing the RPM

General information	
Type of data	Centrifugation
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2018 - 2019
Feedstock	
Type of faecal material	Fresh faeces
Location of collection	Durban, South Africa
Age before collection	A few days
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 85%db
Ash content	~ 15%db
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Moisture content (1) and water activity (2) of the cake after centrifugation
Employed method	(5) Use of moisture analyzer balance *PCE-MB Series* (SOP 8.7.1.5) (6) Use of water activity analyzer *AquaLab Tunable Diode Laser-TDL* (SOP 8.8.3.3)
Publications	
Septien, S., Getahun, S., Mirara, S., Makununika, B.S.N., Mugauri, T.R., Singh, A., Pocock, J., Inambao, F., Velkushanova, K., Buckley, C.A. (2019). Investigations of faecal sludge drying from on-site sanitation facilities. Proceedings of the 10th Asia Pacific Drying Conference, Vadodara, India, 14-17 December.	

Data source files	
https://www.dropbox.com/s/76dejwq7ug1zwqy/Pre-%20and%20Post%20Centrifugation%20data%20for%20FS%20and%20fresh%20faeces%20.xlsx?dl=0	
Additional Notes	
○ Fresh faeces collected from voluntary and anonymous donations from healthy young adults ○ Centrifugation done in a centrifuge *HERMLE Z323*, during 120 minutes at a rate of 5000 RPM, for 40 g of sample per centrifuge tube	
Description of Data	
Moisture content and water activity of the cake before and after centrifugation  	Observations: ○ Almost no decrease of the moisture content and water activity after centrifugation

General information	
Type of data	Centrifugation
Place of experimentation	○ Sandec: Department Sanitation, Water and Solid Waste for Development, Eawag: Federal Institute of Aquatic Science and Technology (Switzerland) ○ Delvic Sanitation Initiatives, Dakar (Senegal)
Dates of the experiments	2018
Feedstock	
Type of faecal material	Faecal sludge from septic tanks/holding tanks and pit latrines from a variety of sources (incl. households, schools, public toilets, offices, places of worship, and restaurants)
Location of collection	○ Dakar, Senegal ○ Dar es Salaam, Tanzania
Age before collection	Variable (from several weeks to several years)
Moisture content	87.0 – 99.8 %wt
Total solids content	0.2 – 13 %wt
Volatile solids content	26 – 85 %db
Ash content	15 – 74 %db
Presence of trash?	No
Pre-treatment	None
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Total solids content, volatile solids content, total suspended solids, total volatile suspended solids, and extracellular polymer substances concentration of the bulk sludge. Total solids content of the cake after centrifugation.
Employed methods	(1) Weighing the sample before and after oven drying at 105°C for 24 h (2) Weighing the sample before and after ignition at 550°C (3) Weighing the solids after filtration of a known volume of sample followed by oven drying at 105°C

	(4) Weighing the solids after filtration of a known volume of sample followed by ignition at 550°C (5) Extraction by sonication and then analysis using size exclusion chromatography *LC-OCD-OND* for organic carbon detection-organic nitrogen detection

Publications

Ward, B. J., Traber, J., Gueye, A., Diop, B., Morgenroth, E., & Strande, L. (2019). Evaluation of conceptual model and predictors of faecal sludge dewatering performance in Senegal and Tanzania. *Water Research*, *167*, 115101.

Data source files

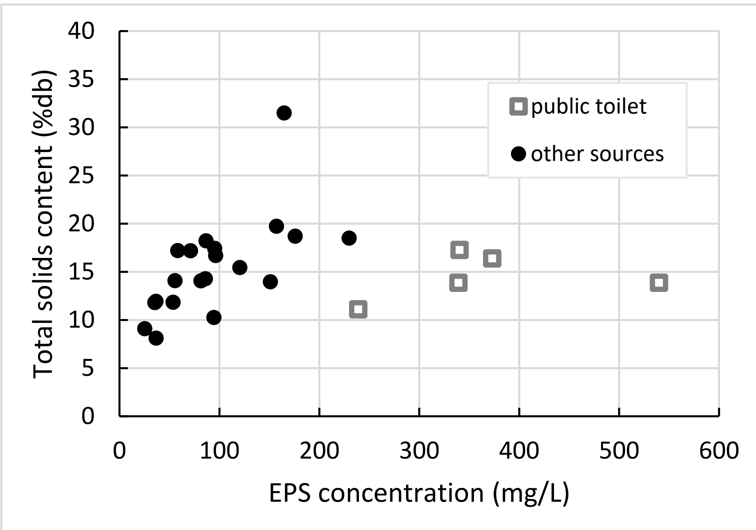
https://data.mendeley.com/datasets/w5y55vf3cn/1

Additional Notes

-

Description of Data

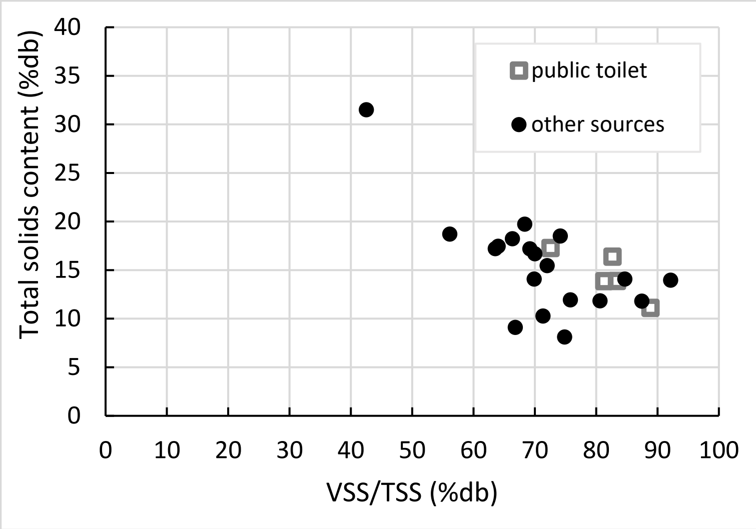
Total solids content of the cake after centrifugation versus the extracellular polymeric substances (EPS) concentration



Observations:

- No apparent relationship between dewatered cake solids after centrifugation with the EPS concentration and the VSS fraction
- No discernible difference in centrifuge dewaterability based on sludge source

Total solids content of the cake after centrifugation versus the ratio volatile suspended solids (VSS) to total suspended solids (TSS)



General information	
Type of data	Capillary suction time
Place of experimentation	○ Sandec: Department Sanitation, Water and Solid Waste for Development, Eawag: Swiss Federal Institute of Aquatic Science and Technology (Switzerland) ○ Delvic Sanitation Initiatives, Dakar (Senegal)
Dates of the experiments	2018
Feedstock	
Type of faecal material	Faecal sludge from septic tanks/holding tanks and pit latrines from a variety of sources (incl. households, schools, public toilets, offices, places of worship, and restaurants)
Location of collection	○ Dakar, Senegal ○ Dar es Salaam, Tanzania
Age before collection	Variable (from several weeks to several years)
Moisture content	87.0 – 99.8 %wt
Total solids content	0.2 – 13 %wt
Volatile solids content	26 – 85 %db
Ash content	15 – 74 %db
Presence of trash?	No
Pre-treatment	None
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Capillary suction time, volatile solids content, total suspended solids, total volatile suspended solids, electrical conductivity, and extracellular polymer substance concentration of the bulk sludge.
Employed methods	(1) Use of the capillary suction time analyser *Triton 319 Multi-CST* (2) Weighing the sample before and after ignition at 550°C (3) Weighing the solids after filtration of a known volume of sample followed by oven drying at 105°C (4) Weighing the solids after filtration of a known volume of sample followed by ignition at 550°C

	(5) Use of an electrical conductivity probe (6) Extraction by sonication and then analysis using size exclusion chromatography *LC-OCD-OND* for organic carbon detection-organic nitrogen detection

Publications

Ward, B. J., Traber, J., Gueye, A., Diop, B., Morgenroth, E., & Strande, L. (2019). Evaluation of conceptual model and predictors of faecal sludge dewatering performance in Senegal and Tanzania. *Water Research*, *167*, 115101.

Data source files

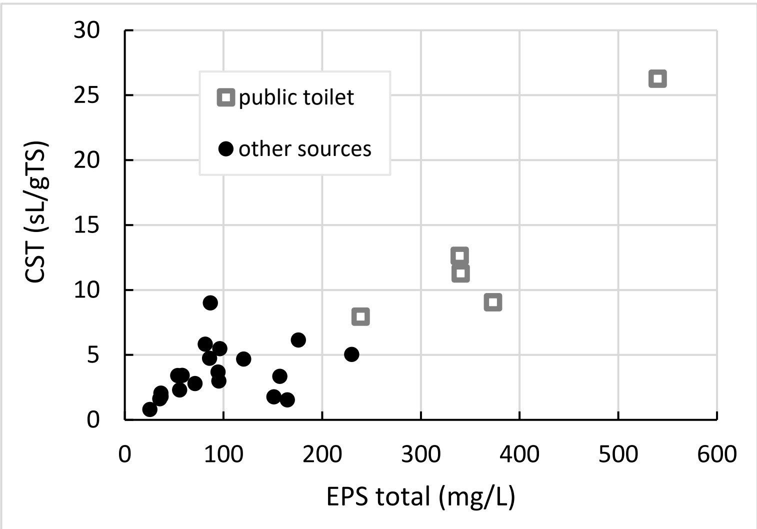
https://data.mendeley.com/datasets/w5y55vf3cn/1

Additional Notes

-

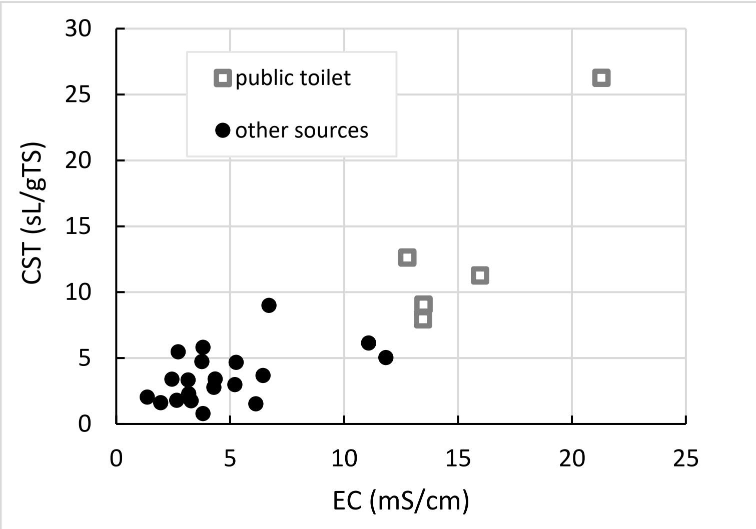
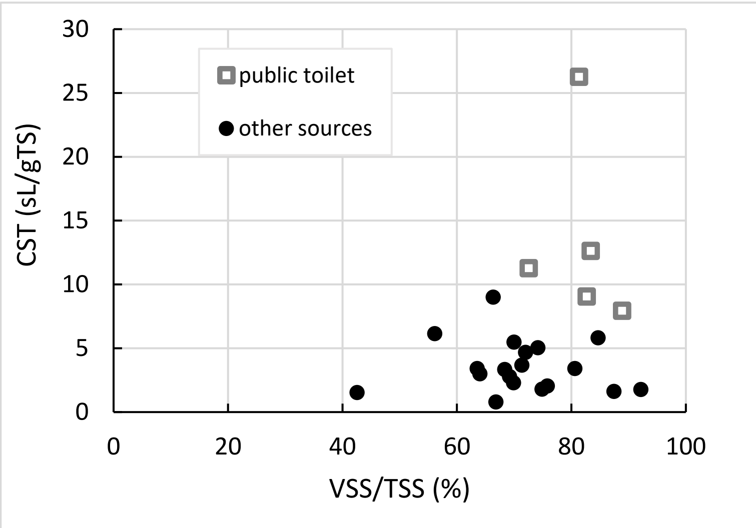
Description of Data

Capillary suction time (CST) versus extracellular polymeric substances (EPS) concentration



Observations:

- CST increases linearly with EPS concentration and EC
- Public toilet sludge had higher EPS concentrations and EC, with correspondingly slower filtration (higher CST)
- No apparent relationship between filtration time (CST) and the VSS fraction

Capillary suction time (CST) versus electrical conductivity (EC) 	
Capillary suction time (CST) versus the ratio of volatile suspended solids (VSS) to total suspended solids (TSS) 	

DISINFECTION

General information	
Type of data	Ascaris eggs viability during infrared drying
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2014 - 2015
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrine (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 70%db
Ash content	~ 30%db
Presence of trash?	Yes
Pre-treatment	o Screening to remove the large pieces of trash o Addition of 3%wt of sawdust for pellets formation
Experimental Procedure	
Drying experimental setup	Laboratory-scale medium infrared (MIR) dryer ('LaDePa')
Drying time	4, 8, 17, 25 min
Operating conditions	o MIR emitters power: 3, 5 and 6.5 kW o Distance between the emitters and the sample: 115 mm o Air stream flowrate: 10.4 m^3/min o Air humidity: ambient (70-80%)
Sample form in the dryer	Pellets of 8 and 14 mm diameter
Analysed parameters	Viability of Ascaris eggs development
Employed method	Extraction of Ascaris eggs from the sludge and count of viable eggs in the microscope (SOP 8.9.3.1)
Publications	

Septien, S., Singh, A., Mirara, S. W., Teba, L., Velkushanova, K., & Buckley, C. A. (2018). ''LaDePa' process for the drying and pasteurization of faecal sludge from VIP latrines using infrared radiation'. *South African journal of chemical engineering,* 25, 147-158.

Mirara, S.W. (2017). *Drying and pasteurization of VIP latrine faecal sludge using a bench-scale medium infrared machine*. Msc thesis, University of KwaZulu-Natal, South Africa.
Mirara, S.W., Singh, A., Septien, S., Velkushanova, K., Buckley. C.A (2015). *Characterisation of On-site Sanitation Material and Products: VIP latrines and pour-flush toilets. Volume 2: LaDePa* (final report K5/2137). Water Research Commission, South Africa.

Data source files

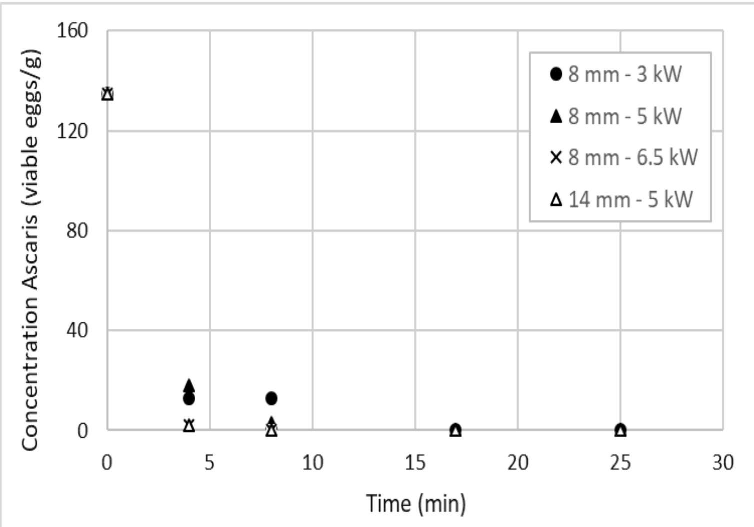
https://www.dropbox.com/s/x8dytnm2jkwibot/2014-2015%20Deactivation%20of%20VIP%20sludge%20%28Ascaris%20eggs%20viability%29.xlsx?dl=0

Additional Notes

- Temperature measured in the drying zone: ~ 90, 140 and 220°C at 3, 5 and 6.5 kW respectively

Description of Data

Ascaris egg viability versus drying time as a function of the MIR emitter power and pellet diameter



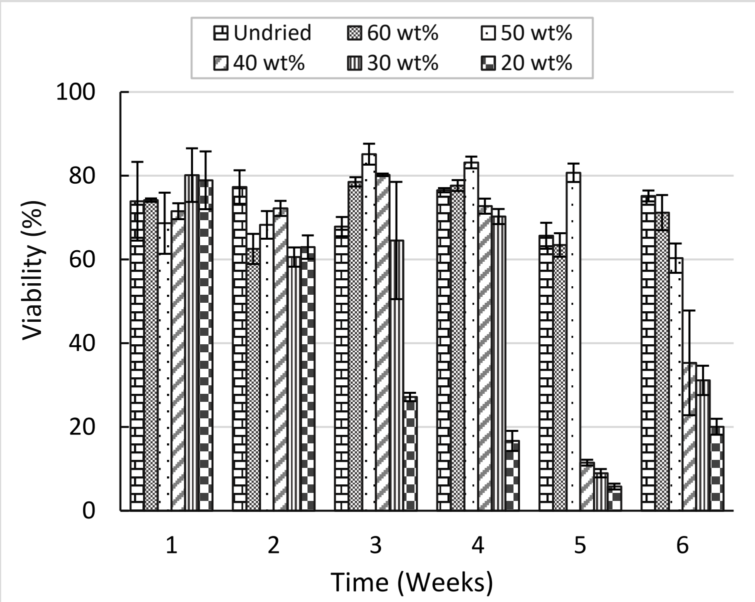
Observations

- Decrease of the viability as a function of the drying time
- Full deactivation above 17 min for all conditions
- Note: high damage observed for the viable Ascaris after processing (so, uncertain if possible development)

General information	
Type of data	Ascaris eggs viability with sludge dryness
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2017 - 2018
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 60%db
Ash content	~ 40%db
Presence of trash?	Yes (mainly hair extensions, plastic, and rocks)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	105°C
Sample form in the dryer	Sludge trays
Analysed parameters	Viability of Ascaris eggs development
Employed methods	Extraction of Ascaris eggs from the sludge and count of viable eggs in the microscope (SOP 8.9.3.1)
Publications	
Naidoo, D., Archer, C. E., Septien, S., Appleton, C. C., & Buckley, C. A. (2020). Inactivation of Ascaris for thermal treatment and drying applications in faecal sludge. *Journal of Water, Sanitation and Hygiene for Development*, 10(2), 209-218.	

Data source files
https://www.dropbox.com/s/q6s7z1mohhfjxuu/2017%20-%202018%20UDDT%20Disinfection%20dryness%20%28Ascaris%20eggs%20viability%29.xlsx?dl=0
Additional Notes
○ Spiking the sludge with approximately 400 Ascaris eggs after drying and thereafter incubation for a period of time from 1 to 12 weeks ○ Weekly analysis ○ Fungi apparition in the sludge from week 7, so results discarded from there
Description of Data

Ascaris eggs viability versus time as a function of the moisture content of the sludge



Observations:

- Clear decrease of the viability of Ascaris eggs development with time below a moisture content of 40%wt
- Stronger decrease of the viability with time at lower moisture content

General information	
Type of data	Ascaris eggs viability with sludge dryness
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2017-2018
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 90%wt
Total solids content	~ 10%wt
Volatile solids content	~ 65%db
Ash content	~ 35%db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Oven
Drying time	Until achieving 20, 30, 40, 50 and 60%wt moisture content
Operating conditions	105°C
Sample form in the dryer	Sludge trays
Analysed parameters	Viability of Ascaris eggs development
Employed methods	Extraction of Ascaris eggs from the sludge and count of viable eggs in the microscope (SOP 8.9.3.1)
Publications	

Naidoo, D., Archer, C. E., Septien, S., Appleton, C. C., & Buckley, C. A. (2020). Inactivation of Ascaris for thermal treatment and drying applications in faecal sludge. *Journal of Water, Sanitation and Hygiene for Development*, 10(2), 209-218.

<u>Data source files</u>

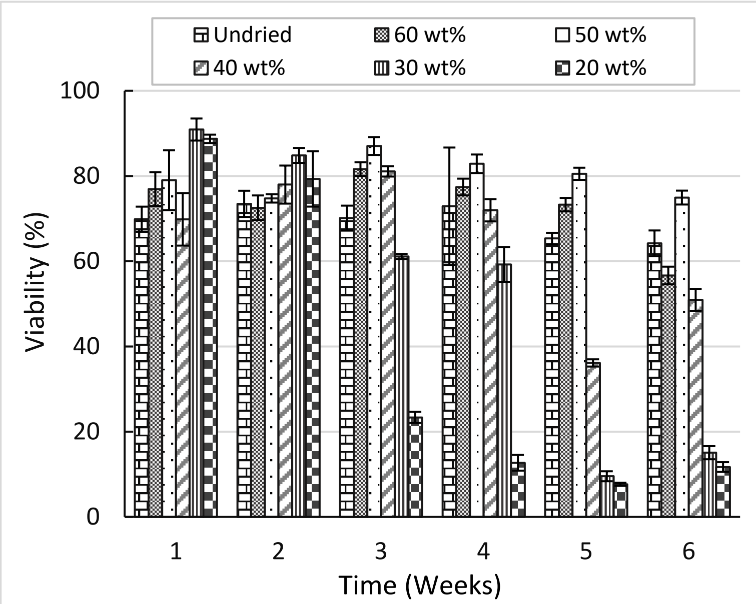
https://www.dropbox.com/s/y8qtun0jzhbxjld/2017%20-%202018%20VIP%20Disinfection%20dryness%20%28Ascaris%20eggs%20viability%29.xlsx?dl=0

<u>Additional Notes</u>

- Spiking the sludge with approximately 400 Ascaris eggs after drying and thereafter incubation for a period of time from 1 to 12 weeks
- Weekly analysis
- Fungi apparition in the sludge from week 7, so results discarded from there

<u>Description of Data</u>

<u>Ascaris eggs viability versus time as a function of the moisture content of the sludge</u>



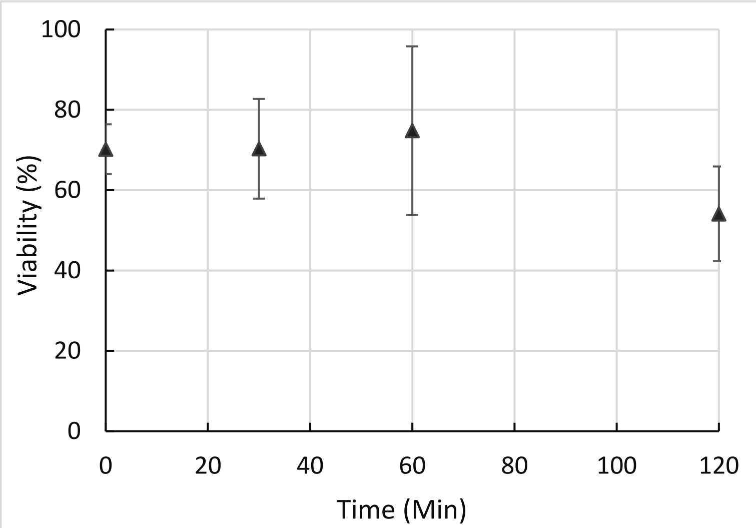
<u>Observations:</u>

- Clear decrease of the viability of Ascaris eggs development with time below a moisture content of 40%wt
- Stronger decrease of the viability with time at lower moisture content

General information	
Type of data	Ascaris eggs deactivation with temperature
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2017 - 2018
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets (UDDT)
Location of collection	Durban, South Africa
Age before collection	Up to 3 years
Moisture content	~ 80%wt
Total solids content	~ 20%wt
Volatile solids content	~ 60%db
Ash content	~ 40%db
Presence of trash?	Yes (mainly hair extensions, plastic, and rocks)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Viability of Ascaris eggs development
Employed methods	Extraction of Ascaris eggs from the sludge and count of viable eggs in the microscope (SOP 8.9.3.1)
Publications	
Naidoo, D., Archer, C. E., Septien, S., Appleton, C. C., & Buckley, C. A. (2020). Inactivation of Ascaris for thermal treatment and drying applications in faecal sludge. *Journal of Water, Sanitation and Hygiene for Development*, 10(2), 209-218.	

Data source files
https://www.dropbox.com/s/78ftqqal40pwfb2/2017%20-%202018%20UDDT%20Thermal%20Disinfection%20%28Ascaris%20eggs%20viability%29.xlsx?dl=0
Additional Notes
○ Sludge heated in a controlled temperature water bath at 40°C during 30, 60 and 120 min; at 60°C during 0.5, 2 and 5 min; and at 60°C during 5, 10 and 60 s ○ Sludge place inside an aluminium crucible (70 x 40 mm) and covered in order to avoid moisture loss (interest in only the effect of temperature)
Description of Data

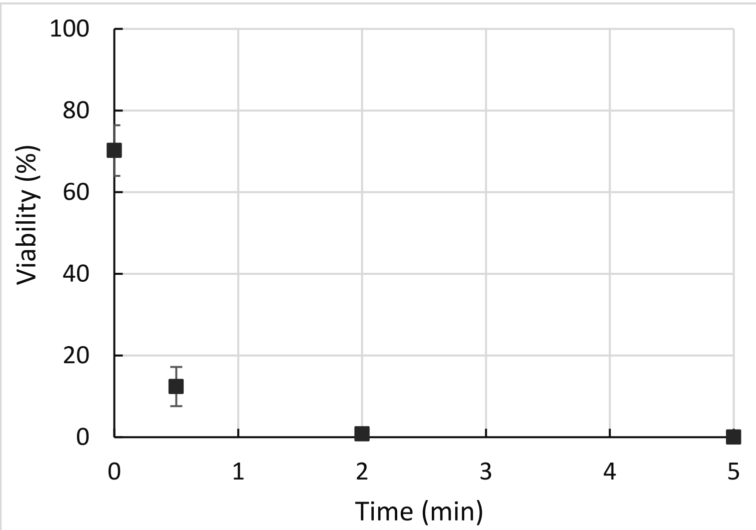
Viability of Ascaris eggs development versus time at 40°C



Observations:

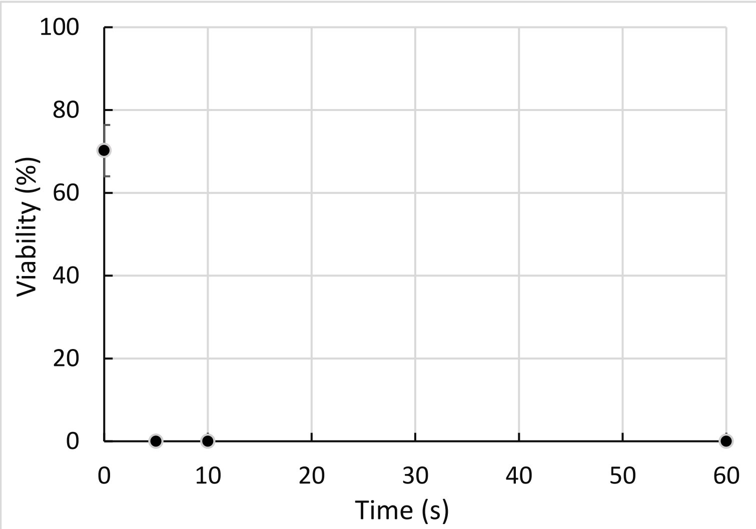
- Low inactivation after 120 minutes

Viability of Ascaris eggs development versus time at 60°C



Observations:

- Fast inactivation (after 2 minutes)

Viability of Ascaris eggs development versus time at 80°C	Observations:
	○ Almost immediate inactivation (less than 5 s)

General information	
Type of data	Ascaris eggs deactivation with temperature
Place of experimentation	Pollution Research Group, University of KwaZulu-Natal (South Africa)
Dates of the experiments	2017 - 2018
Feedstock	
Type of faecal material	Faecal sludge from ventilated improved pit latrines (VIP)
Location of collection	Durban, South Africa
Age before collection	Up to 5 years
Moisture content	~ 90% wt
Total solids content	~ 10% wt
Volatile solids content	~ 65% db
Ash content	~ 35% db
Presence of trash?	No (sludge pre-screened during pit emptying)
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	N.A.
Drying time	N.A.
Operating conditions	N.A.
Sample form in the dryer	N.A.
Analysed parameters	Viability of Ascaris eggs development
Employed methods	Extraction of Ascaris eggs from the sludge and count of viable eggs in the microscope (SOP 8.9.3.1)
Publications	
Naidoo, D., Archer, C. E., Septien, S., Appleton, C. C., & Buckley, C. A. (2020). Inactivation of Ascaris for thermal treatment and drying applications in faecal sludge. *Journal of Water, Sanitation and Hygiene for Development*, 10(2), 209-218.	

Data source files

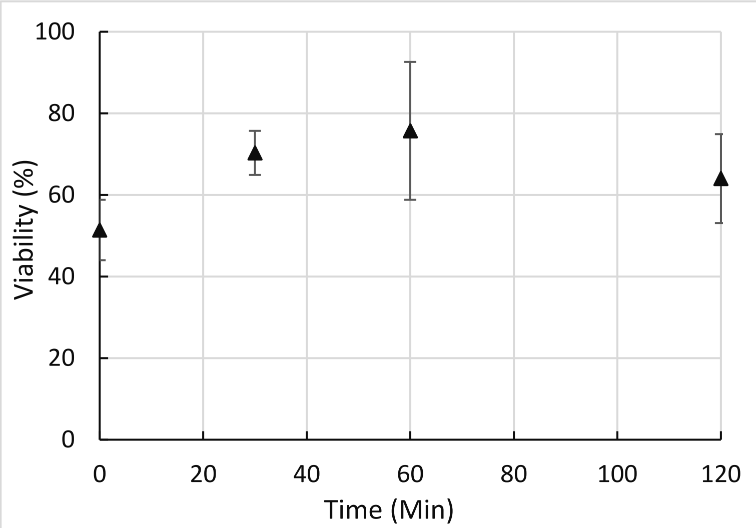
https://www.dropbox.com/s/pi4br70brsasvop/2017%20-%202018%20VIP%20Thermal%20Disinfection%20%28Ascaris%20eggs%20viability%29.xlsx?dl=0

Additional Notes

- Sludge heated in a controlled temperature water bath at 40°C during 30, 60 and 120 min; at 60°C during 0.5, 2 and 5 min; and at 60°C during 5, 10 and 60 s
- Sludge place inside an aluminium crucible (70 x 40 mm) and covered in order to avoid moisture loss (interest in only the effect of temperature)

Description of Data

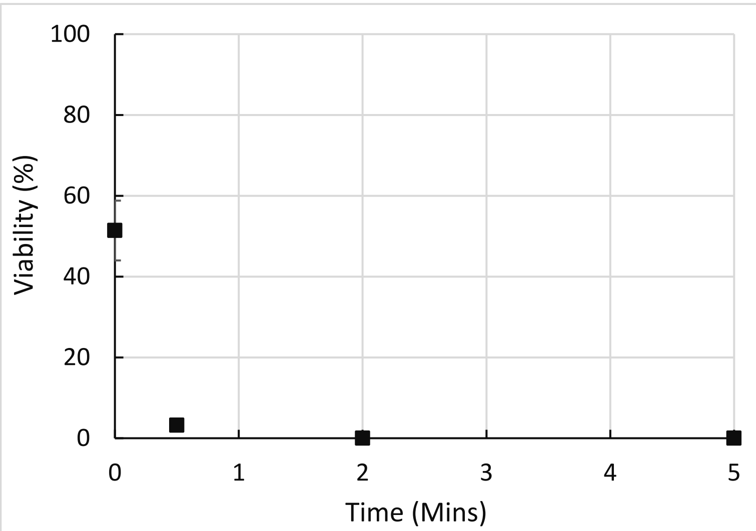
Viability of Ascaris eggs development versus time at 40°C



Observations:

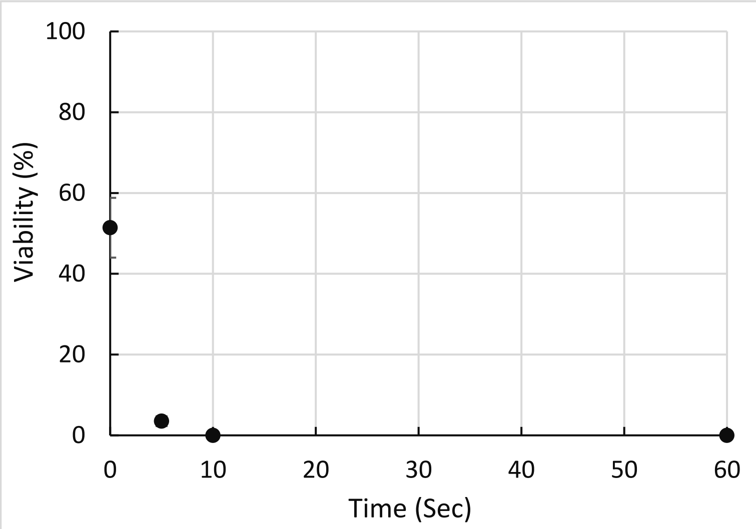
Low inactivation after 120 minutes

Viability of Ascaris eggs development versus time at 60°C



Observations:

Fast inactivation (after 2 minutes)

Viability of Ascaris eggs development versus time at 80°C	Observations:
	Almost immediate inactivation (less than 5 s)

GAS ANALYSIS

General information	
Type of data	Emissions testing
Place of experimentation	Delhi (India)
Dates of the experiments	2018
Feedstock	
Type of faecal material	Fresh faecal waste
Location of collection	Coimbatore, India
Age before collection	1-3 days
Moisture content	N/A
Total solids content	N/A
Volatile solids content	N/A
Ash content	N/A
Presence of trash?	No
Pre-treatment	N/A
Experimental Procedure	
Drying experimental setup	A custom-designed dryer connected to an exhaust system
Holding or residence time	8 hours
Operating conditions	80°C
Sample form in the dryer	Sample produced by a jerky gun
Analysed parameters	ISO 30500 air stack parameters
Employed method	Gas analysis through the ISO 30500 sampling trains Sampling from exhaust pipe and work zone: a nozzle, followed by a thimble filter, sampling probe, sampling kit containing gas specific absorbing solutions for SO_2, H_2S, NH_3, VOC, PAH, and gas meter measuring CO, CO_2, NOx, and O_2, exit via vacuum pump. $PM_{2.5}$: cyclonic setup containing a nozzle at one end, connected to a probe at the other end; a 40 mm glass fibre

	filter to collect particles smaller than 2.5 micron in diameter, then weighed to determine PM2.5 particles in the exhaust air

Publications

-

Data source files

https://www.dropbox.com/s/xq4lwro9hciv40v/Gas%20emissions%20testing_TUV%20Noida_India%20%282018%29.xlsx?dl=0

Additional Notes

- Tests performed to validate testing methods of the ISO 30500 standard
- During first 4 days of drying, gas emissions measured from a sampling port in the exhaust pipeline (photo A).
- During 5th day of operation, gas emissions measured near the exhaust hood of the dryer (photo B).
- 2 drying processes per day.

A

B

Description of Data

Gas emissions from sampling in the exhaust pipeline (n=8)

Parameter	CO	NO_X: $NO+NO_2$	H_2S	VOC (benzene)
Stack Results (mg/Nm^3)	BDL (DL:1.0)	BDL (DL:1.0)	BDL (DL:0.1)	BDL (DL:0.5)
Standard Deviation (mg/Nm^3)	BDL (DL:1.0)	BDL (DL:1.0)	BDL (DL:0.1)	BDL (DL:0.5)

Observations

- Lower concentration of the compounds measured from the pipe line (probable because dilution with air)
- Compounds detected during drying: CO, NO_x, SO_2, NH_3, particles $PM_{2.5}$

Parameter	SO_2	$PM_{2.5}$	NH_3	PAH
Stack Results (mg/Nm^3)	10	BDL (DL:1.0)	BDL (DL:0.1)	BDL (DL:0.0001)
Standard Deviation (mg/Nm^3)	5.9	BDL (DL:1.0)	BDL (DL:0.1)	BDL (DL:0.0001)

*BDL: below detectable limit

Gas emissions from sampling near the exhaust hood (n=2)

Parameter	CO	NO_X ($NO+NO_2$)	H_2S	VOC
Average (mg/m^3)	1.145	14.1	BDL (DL:0.1)	BDL (DL:0.5)
S.D. (mg/m^3)	0.810	3.960	BDL (DL:0.1)	BDL (DL:0.5)
Range (LL –HL) mg/m3	0.335 – 0.955	10.14 – 18.06	BDL (DL:0.1)	BDL (DL:0.5)

Parameter	SO_2	$PM_{2.5}$	NH_3	PAH
Average (mg/m^3)	2.85	16.5	0.0031	BDL(DL:0.0001)
S.D. (mg/m^3)	0.354	2.121	0.001	BDL(DL:0.0001)
Range (LL – HL) mg/m3	2.49 – 3.2	14.37 – 18.62	0.003 – 0.004	BDL(DL:0.0001)

General information	
Type of data	Gas analysis
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from anaerobic baffled reaction from a decentralised wastewater treatment system
Location of collection	Durban, South Africa
Age before collection	Unknown
Moisture content	~ 85%wt
Total solids content	~ 15%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly small pieces of paper after pre-screening during pit emptying)
Pre-treatment	Screening to remove trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Holding or residence time	~ 40 - 80 min
Operating conditions	○ Set temperature: 55 and 155°C ○ Heating rate: 10°C/min ○ Carrier gas: nitrogen ○ Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Identification of chemical compounds in the gas stream
Employed method	Use of the Fourier transform infrared (FTIR) spectroscopy analyser *Perkin Elmer Spectrum 100*
Publications	
-	

Data source files

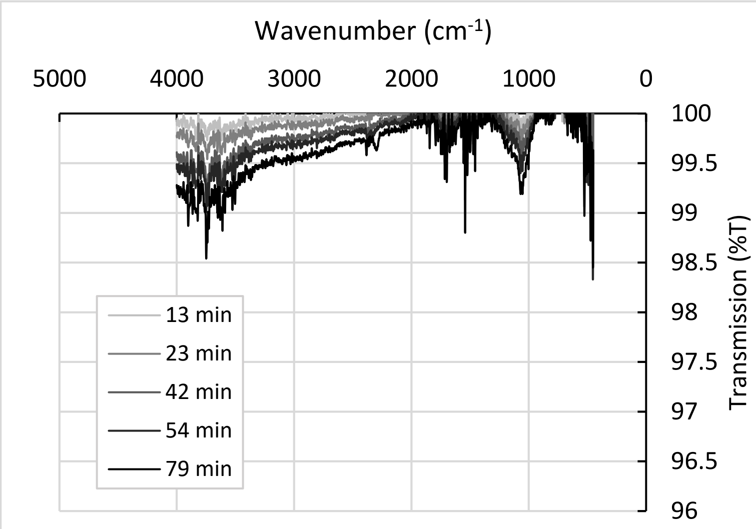
-

Additional Notes

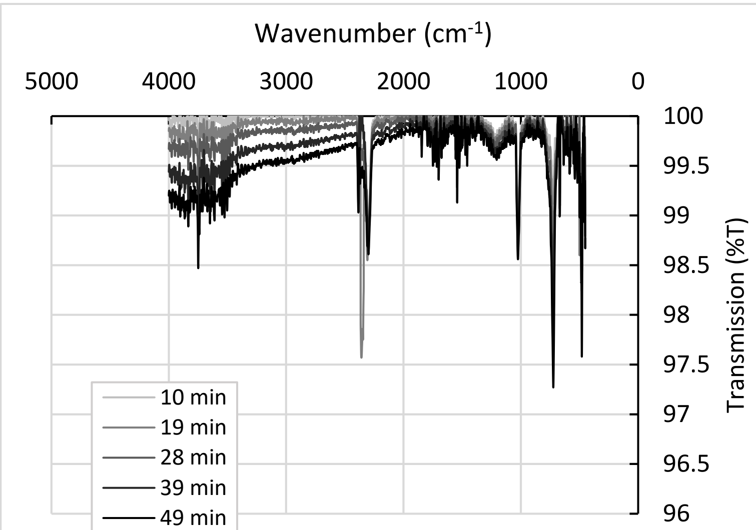
- Samples couriered from South Africa
- FTIR analyser hyphenated to the STA
- No quantification of the concentration of the identified compounds
- Considerable drying of the sample before reaching the set temperature at 155°C

Description of Data

FTIR spectrum during drying up to 55°C at different times of analysis



FTIR spectrum during drying up to 155°C at different times of analysis



Observations

- Main regions identified:
  4000 – 3400 cm^{-1} → H_2O (O-H stretch)
  2400 – 2250 cm^{-1} → CO_2
  1800 – 650 cm^{-1} → possible organic compounds (ether, ester, alcohol, aromatic, amine, alkene) and H_2O scissoring
- Gas from drying composed by water (as expected), carbon dioxide and organic compounds

General information	
Type of data	Gas analysis
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets
Location of collection	Durban, South Africa
Age before collection	1 – 3 years
Moisture content	~ 70%wt
Total solids content	~ 30%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Holding or residence time	~ 40 - 80 min
Operating conditions	○ Set temperature: 55 and 155°C ○ Heating rate: 10°C/min ○ Carrier gas: nitrogen ○ Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Identification of chemical compounds in the gas stream
Employed method	Use of the Fourier transform infrared (FTIR) spectroscopy analyser *Perkin Elmer Spectrum 100*
Publications	
-	

Data source files

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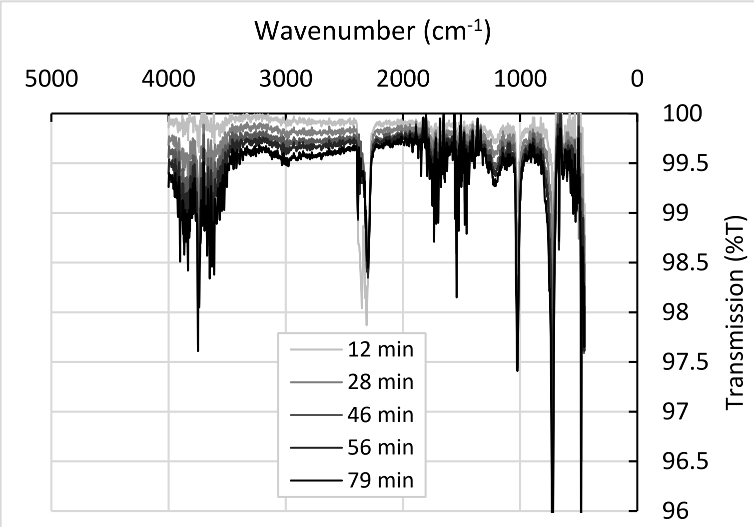
Additional Notes

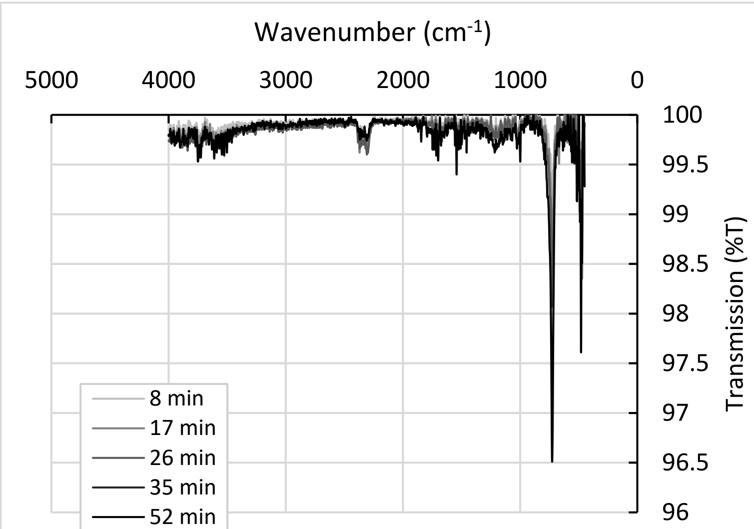
- Samples couriered from South Africa
- FTIR analyser hyphenated to the STA
- No quantification of the concentration of the identified compounds
- Considerable drying of the sample before reaching the set temperature at 155°C

Description of Data

FTIR spectrum during drying up to 55°C at different times of analysis



FTIR spectrum during drying up to 155°C at different times of analysis



Observations

- Main regions identified:
  4000 – 3400 cm^{-1} → H_2O (O-H stretch)
  2400 – 2250 cm^{-1} → CO_2
  1800 – 650 cm^{-1} → possible organic compounds (ether, ester, alcohol, aromatic, amine, alkene) and H_2O scissoring
- Gas from drying composed by water (as expected), carbon dioxide and organic compounds

General information	
Type of data	Gas analysis
Place of experimentation	Materials Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Faecal sludge from urine diversion dry toilets
Location of collection	Durban, South Africa
Age before collection	1 – 3 years
Moisture content	~ 95%wt
Total solids content	~ 5%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	Yes (mainly stones, hair and plastics)
Pre-treatment	Screening to remove the trash
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Holding or residence time	~ 40 - 80 min
Operating conditions	o Set temperature: 55 and 155°C (during 80 and 40 minutes respectively) o Heating rate: 10°C/min o Carrier gas: nitrogen o Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Identification of chemical compounds in the gas stream
Employed method	Use of the Fourier transform infrared (FTIR) spectroscopy analyser *Perkin Elmer Spectrum 100*
Publications	
-	

Data source files

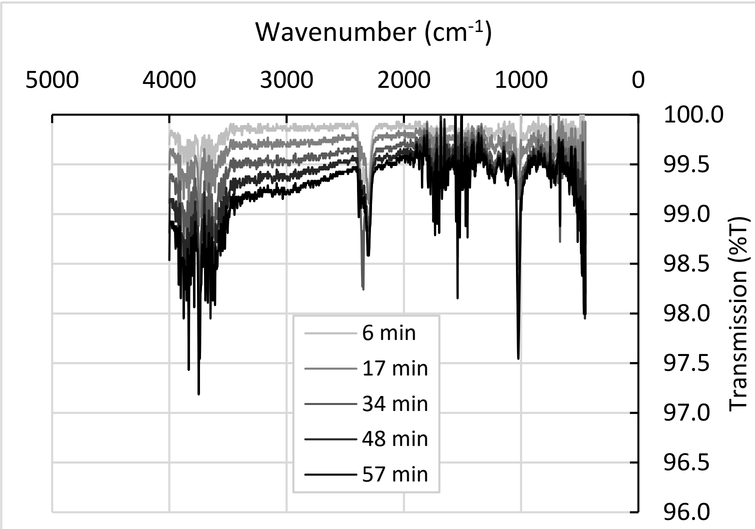
-

Additional Notes

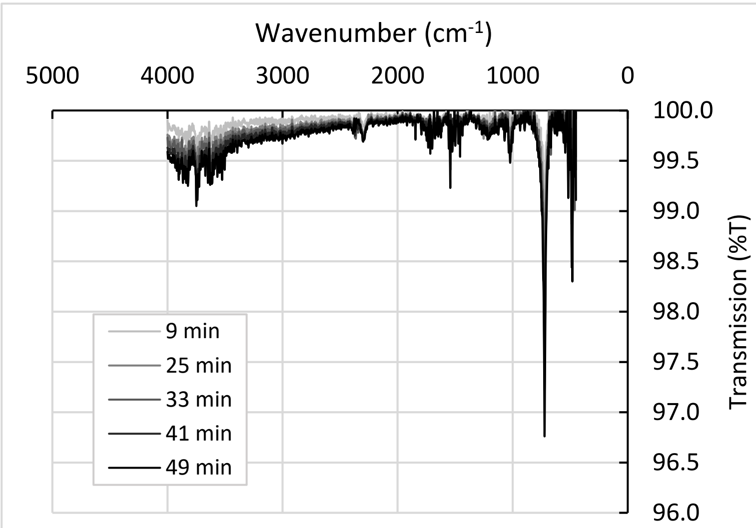
- Samples couriered from South Africa
- FTIR analyser hyphenated to the STA
- No quantification of the concentration of the identified compounds
- Considerable drying of the sample before reaching the set temperature at 155°C

Description of Data

FTIR spectrum during drying up to 55°C at different times of analysis



FTIR spectrum during drying up to 155°C at different times of analysis



Observations

- Main regions identified:
  4000 – 3400 cm^{-1} → H_2O (O-H stretch)
  2400 – 2250 cm^{-1} → CO_2
  1800 – 650 cm^{-1} → possible organic compounds (ether, ester, alcohol, aromatic, amine, alkene) and H_2O scissoring
- Gas from drying composed by water (as expected), carbon dioxide and organic compounds

General information	
Type of data	Gas analysis
Place of experimentation	Material Engineering Department (SPECIFIC), Swansea University Prifysgol Abertawe
Dates of the experiments	2018 - 2020
Feedstock	
Type of faecal material	Human faeces
Location of collection	Cranfield, UK
Age before collection	Fresh
Moisture content	~ 60%wt
Total solids content	~ 40%wt
Volatile solids content	Not measured
Ash content	Not measured
Presence of trash?	No
Pre-treatment	Mixing
Experimental Procedure	
Drying experimental setup	Thermogravimetric analyser - simultaneous thermal analysis *Perkin Elmer STA 6000*
Holding or residence time	~ 40 - 80 min
Operating conditions	o Set temperature: 55 and 155°C o Heating rate: 10°C/min o Carrier gas: nitrogen o Flow rate: 30 mL/min
Sample form in the dryer	~ 40 mg in a crucible
Analysed parameters	Identification of chemical compounds in the gas stream
Employed method	Use of the Fourier transform infrared (FTIR) spectroscopy analyser *Perkin Elmer Spectrum 100*
Publications	
-	

Data source files

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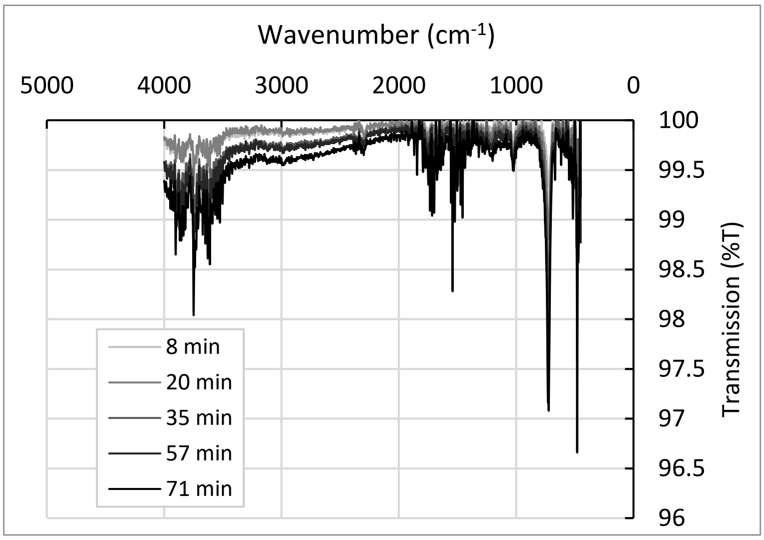
Additional Notes

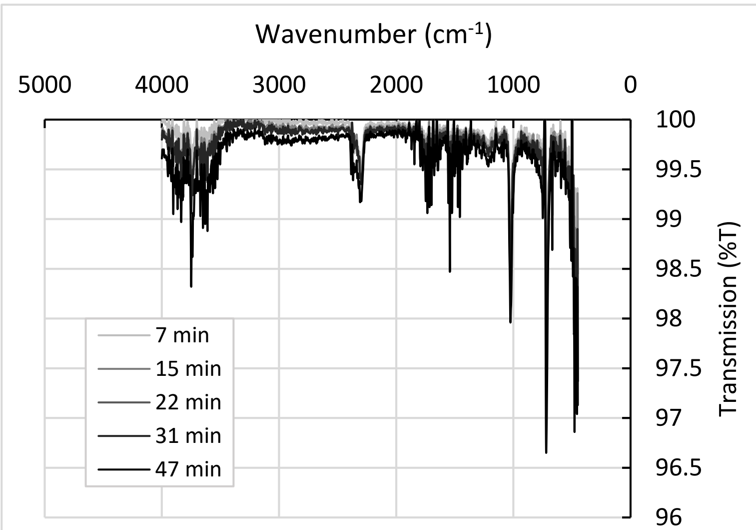
- Fresh faeces collected from voluntary and anonymous donations
- FTIR analyzer hyphenated to the STA
- No quantification of the concentration of the identified compounds
- Considerable drying of the sample before reaching the set temperature at 155°C

Description of Data

FTIR spectrum during drying up to 55ºC at different times of analysis



FTIR spectrum during drying up to 155ºC at different times of analysis



Observations

- Main regions identified:
  4000 – 3400 cm^{-1} → H_2O (O-H stretch)
  2400 – 2250 cm^{-1} → CO_2
  1800 – 650 cm^{-1} → possible organic compounds (ether, ester, alcohol, aromatic, amine, alkene) and H_2O scissoring
- Gas from drying composed by water (as expected), carbon dioxide and organic compounds