CONVERSION OF FECAL SLUDGE TO LIQUID FUELS. WHY AND HOW COULD IT WORK FOR SMALL-SCALE APPLICATIONS?

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AI3D
AI3D - Who are we?

Aliance for the innovation in infrastructure and pipeline integrity

• Education and Research on
  – Fluids transport infrastructure integrity management.
    • Water and Waste water
    • Oil and gas

• Strategic alliance with
  – Universities and research institutes = education and research
  – Private companies = projects execution
Why are we here?

• Grand Challenges Explorations Round 7.
  Bill and Melinda Gates Foundation

• Objectives of the proposal:
  – Harness the energy contained in fecal sludge.
  – Storing it in the form of a high value fuel.
  – Turn fecal sludge into something valuable.
  – Make pit emptying more profitable and safe.
Outline

• Why liquid fuels from fecal sludge?
• How can it be done?
• Water content issues
• Fischer Tropsch process scaling
• Results of model
• Business model
Why liquid fuels?

Organic Matter in sludge = Energy

Liquid fuels (Diesel and Gasoline)

- High value
- Easy to transport
- Easy to store
- High demand

Value to Fecal sludge
How can it be done?

Fecal sludge → Gasifier → Syngas → Syngas cleaning → Fischer Tropsch → Fuel

Syngas: Mixture of CO + H₂

Fischer Tropsch: \((2n + 1) \, H_2 + nCO \rightarrow C_n H_{(2n+2)} + nH_2O\)
What about the water?

Excess energy

- Heat
- Electricity
- Storage

Energy needed for drying!

Dried sludge

Liquid fuels
What about the water?

• Energy for drying available from:
  – Process heat
  – Mixing sludge with other combustible waste

A way of getting rid of:
• Solid waste
• Fecal sludge
Fischer Tropsch Process Scaling

- Large industrial plants: thousands of barrels per day of liquid fuels

Economically viable for production capacity above 30,000 bbls/day

Process Intensification

Target production around 100 - 1000 L/day
Fischer Tropsch intensification options

- Microchannel reactor (Velocys):

- Micro tubular reactor:

- Ceramic Monolith Reactor
Fischer Tropsch Refining

- Syngas
- FT reactor
- Distillation column
- N₂, CO₂, CO, H₂, C₁ - C₃ → Returned to process as fuel
- C₄ - C₁₀ (gasoline) → isomerisation
- C₁₁ - C₂₀ (Diesel) → Hydrotreating
- C₂₁+ (Wax) → Returned to gasifier as fuel
- Water → Purification
How much fuel can we obtain?

• According to our mass and energy balance of the process:
  
  – 11 - 31 Liters of gasoline and diesel per Ton of waste mixture.

  – Preliminary Energy Efficiency: 4 - 14 %

• Yield can be improved by:
  
  – Drying sludge below 22 % water content
  – Drying household waste
Business model

• Target capital cost: 750,000 USD/plant
• Target time to investment return: 3 to 6 years

• This will need:
  – 80 TPD of mixed MSW and Fecal Sludge
  – Central (mobile) processing plant
  – Satellite supplying vehicles (300 m radius)