Thermal sludge treatment

Emergency Sanitation Workshop
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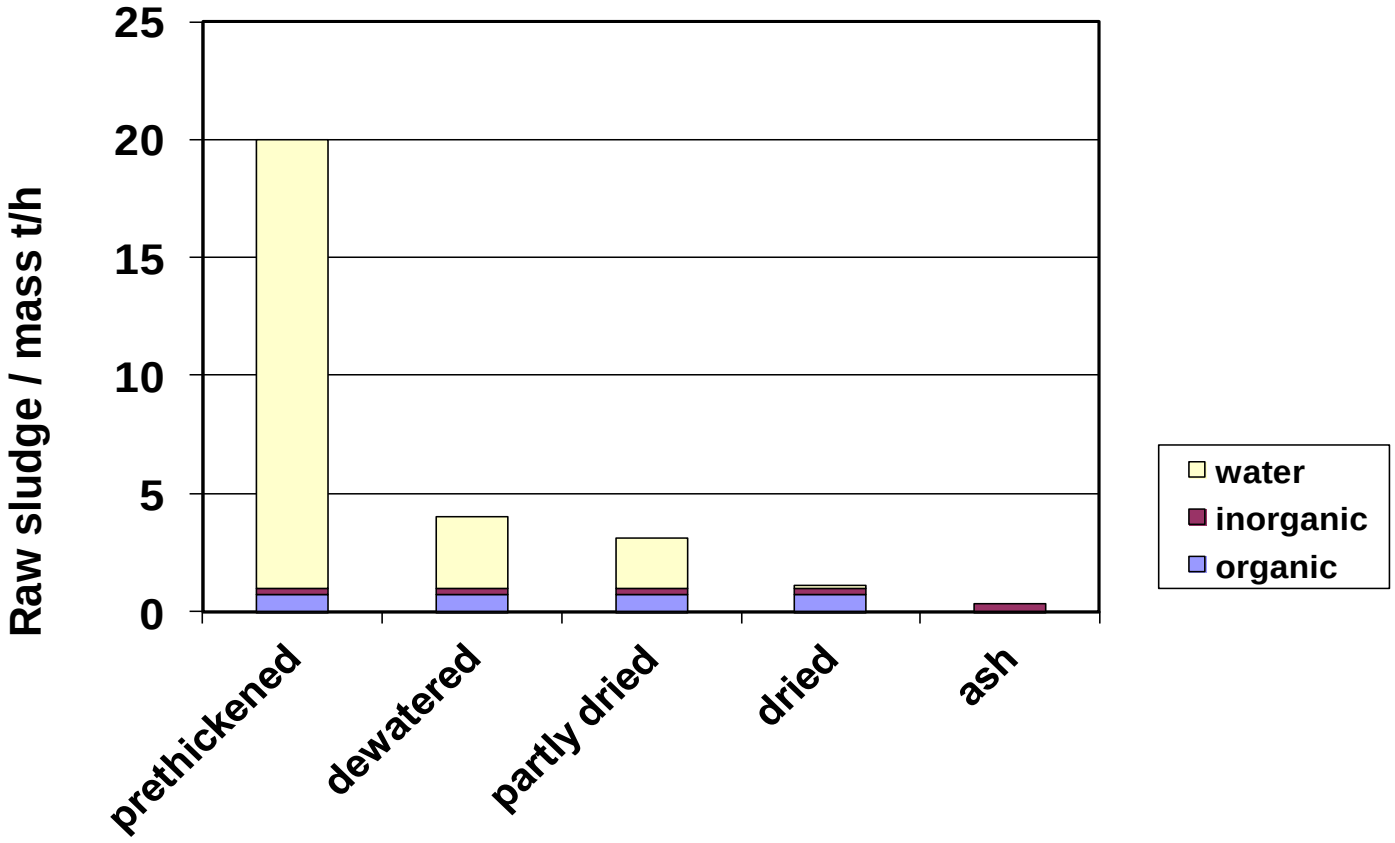
The Unloved Rest
The Unknown Thing

Sludge types

• Raw Sludge	30 % Ash from DS
• Digested Sludge	45 % Ash from DS
• Thickened Sludge	3 - 7 % DS
• Dewatered Sludge	20 - 30 % DS
• Partly Dried Sludge	30 - 50 % DS
• Dried Sludge	80 - 95 % DS

Raw sludge,
Reduction of mass from 20 t to 0.3 t



Sludge incineration plant

- Dewatering
- Drying
- Incineration
- Heat Recovery
- Flue Gas Treatment
- Ash Handling

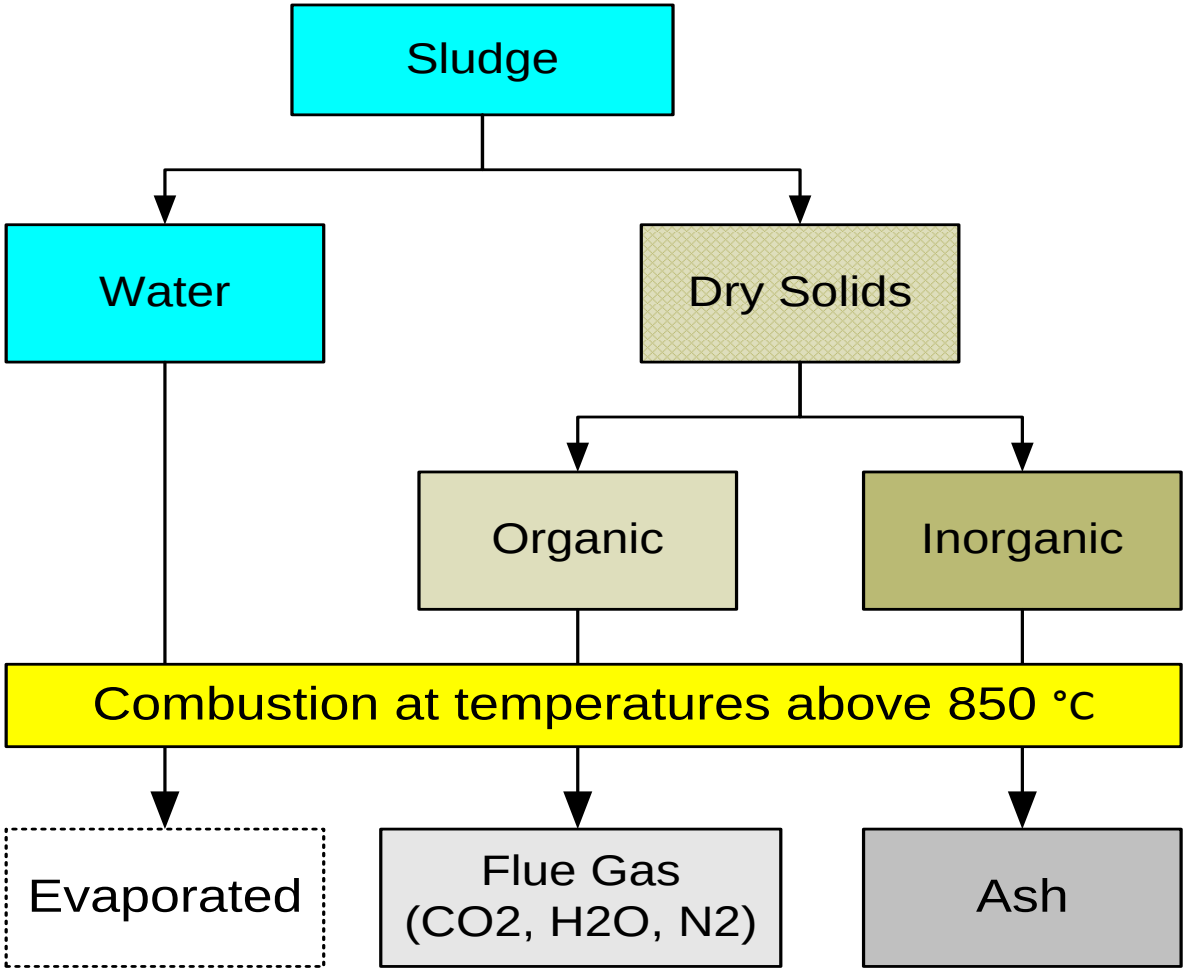
Dewatering

- Centrifuges
- Belt Presses
- Membrane Presses

Drying

- Thin Film Dryer
- Disc Dryer
- Paddle Dryer

Incineration



Typical composition of organic

	Sewage Sludge	Paper Sludge	Wood	Lignite Coal
C	55,4 %	50,4 %	50,4 %	69,5 %
H	7,2 %	7,0 %	6,2 %	5,6 %
N	6,0 %	2,7 %	0,1 %	1,0 %
O	30,3 %	39,5 %	43,3 %	22,7 %
Cl	0,1 %	0,1 %	< 0,5 %	0 %
S	1,0 %	0,3 %	0 %	1,2 %

Calorific values and composition

Equation Vondràcek:

hu = (78,6 + 2,8 (100- C)0,25) C + 215 (H - 0,1 O) + 25 S [kcal/kg]

High and Medium Part Volatile

„Verbandsformel" of Dulong:

hu = 81 C + 290 (H - 0,125 O) + 25 S [kcal/kg]

Low Part Volatile

Equation of Boie (Waste):

hu = 34,8 C + 93,9 h + 10,5 s + 6,3 n - 10,8 o - 2,5 w [MJ/kg]

Ash composition

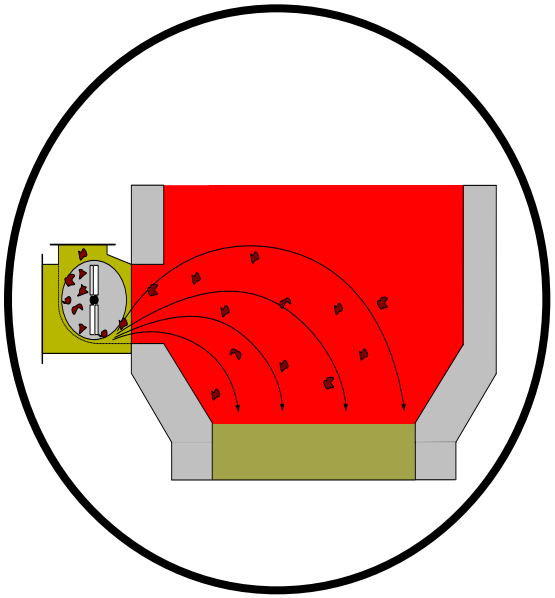
• CaO	15 % – 40 %
• SiO_2	11 % – 35 %
• P_2O_5	10 % – 16 %
• Al_2O_3	11 % – 15 %
• Fe_2O_3	3 % – 9 %
• SO_3	1 % – 3 %
• K_2O	0.5 % – 1.5 %
• Na_2O	0 % – 5 %
• MgO	0 % – 2 %

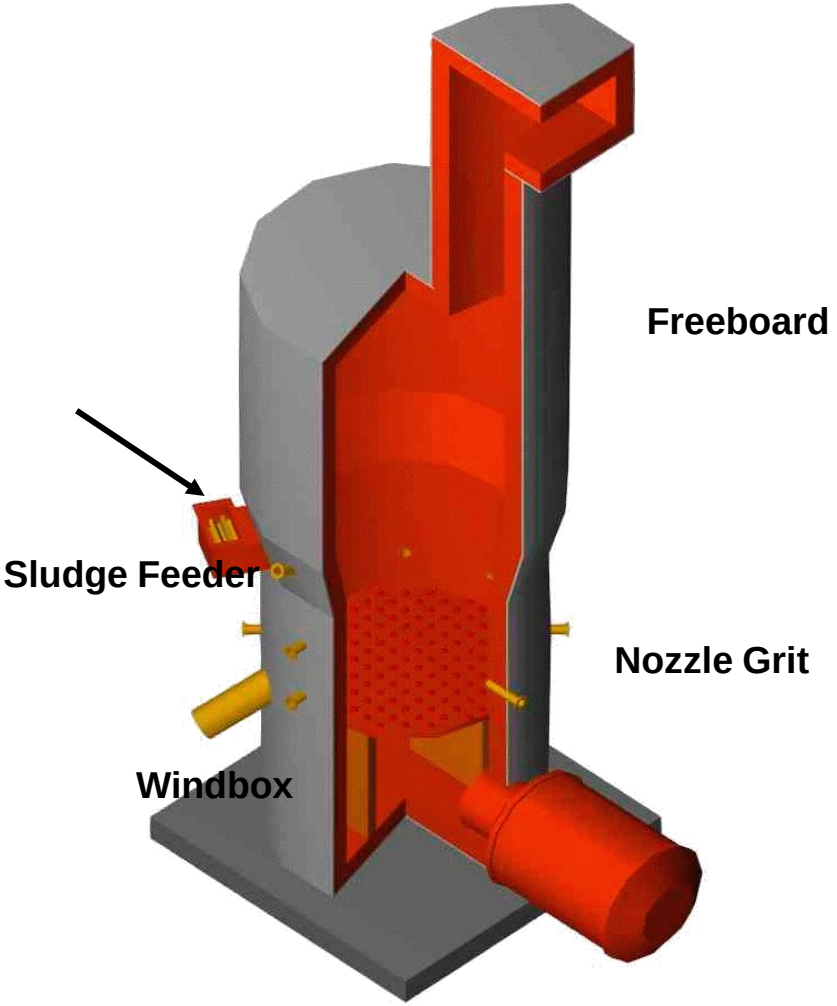
Melting point > 1050 C!!!!

Combustion technologies

- Fluidised Bed Incinerator
- Multiple Hearth Furnace
- Cyclone Burner
- Grate Furnace

Fluidised bed incinerator

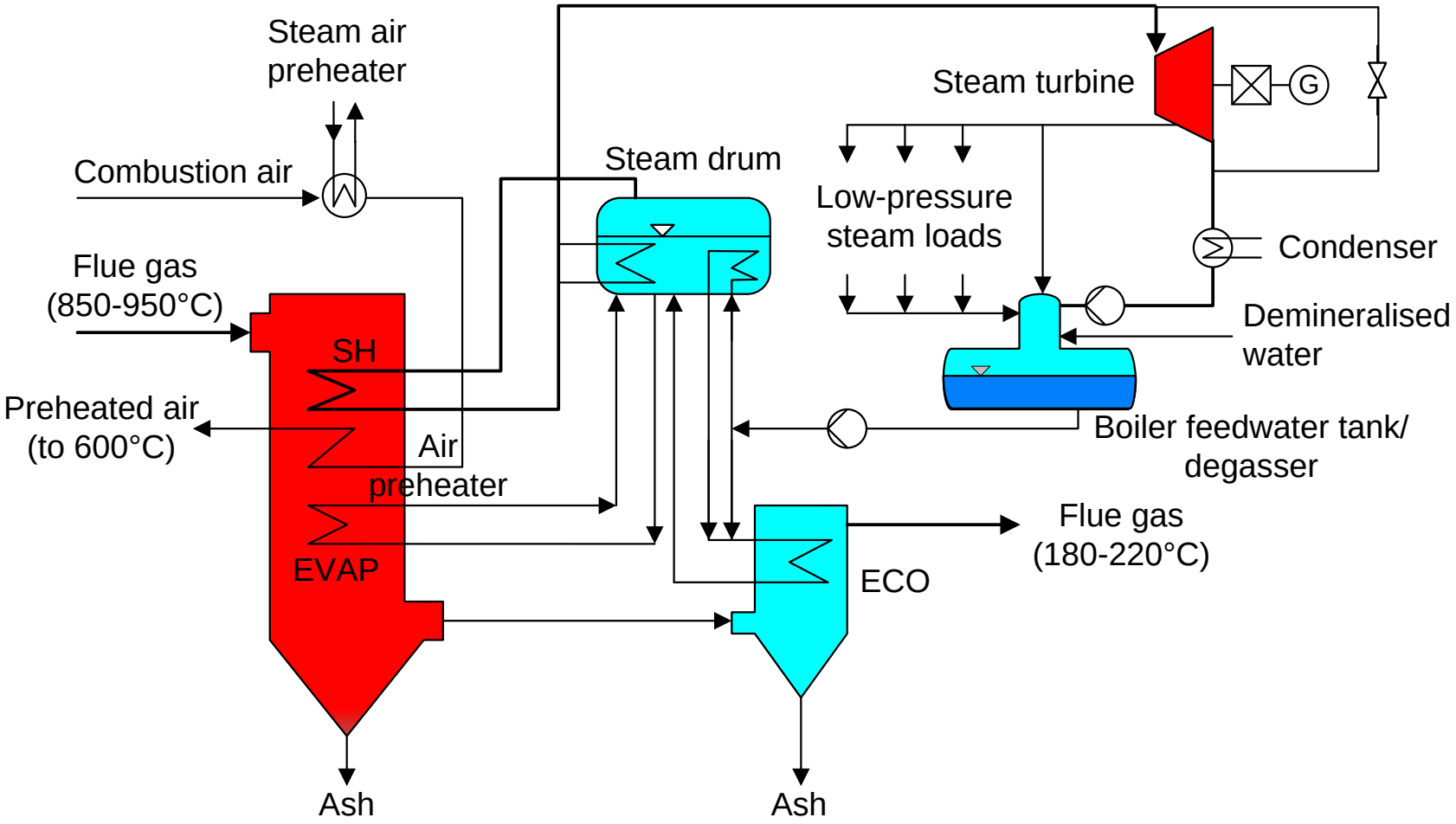




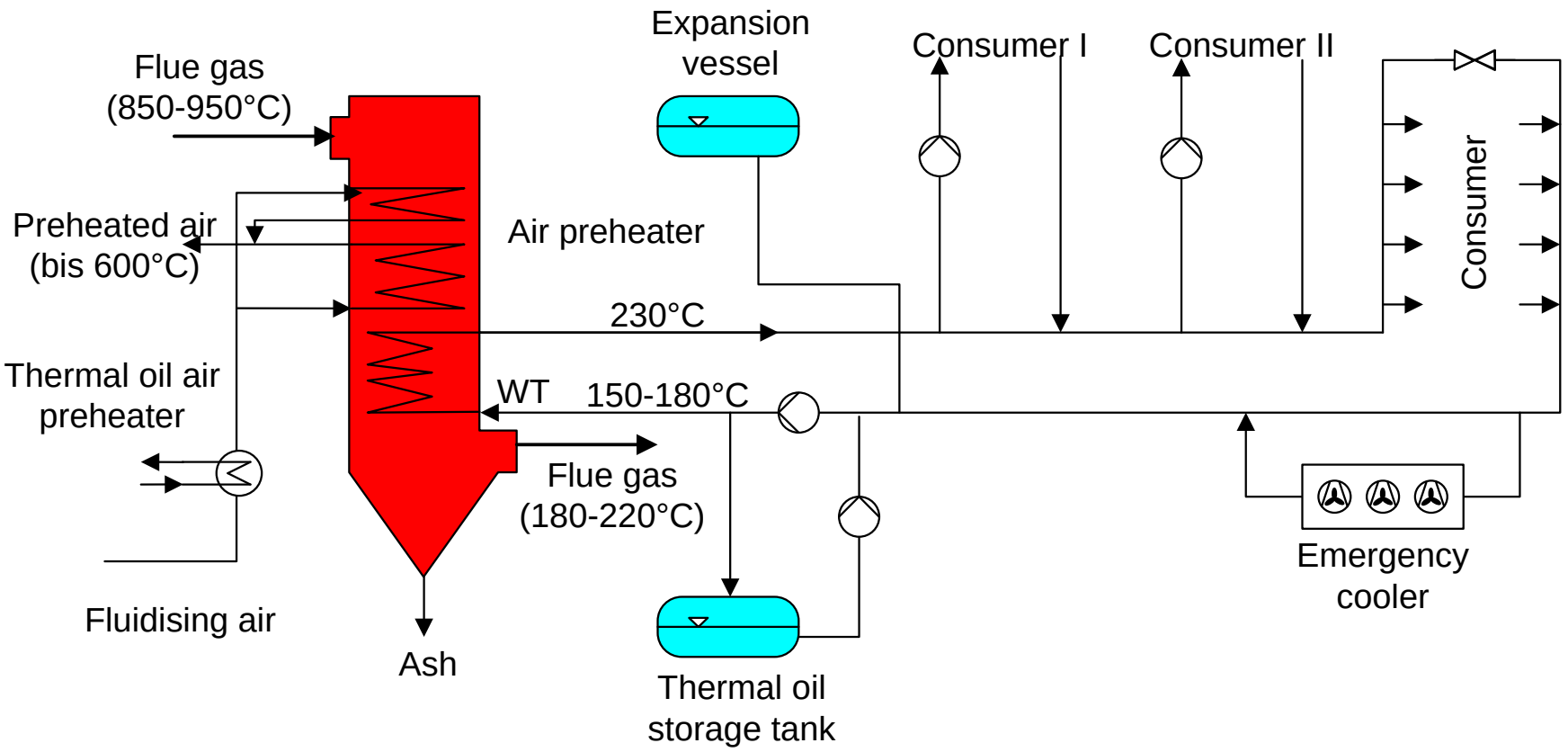
Heat Recovery

- Steam
- Hot Water
- Thermal Oil
- Air Heating

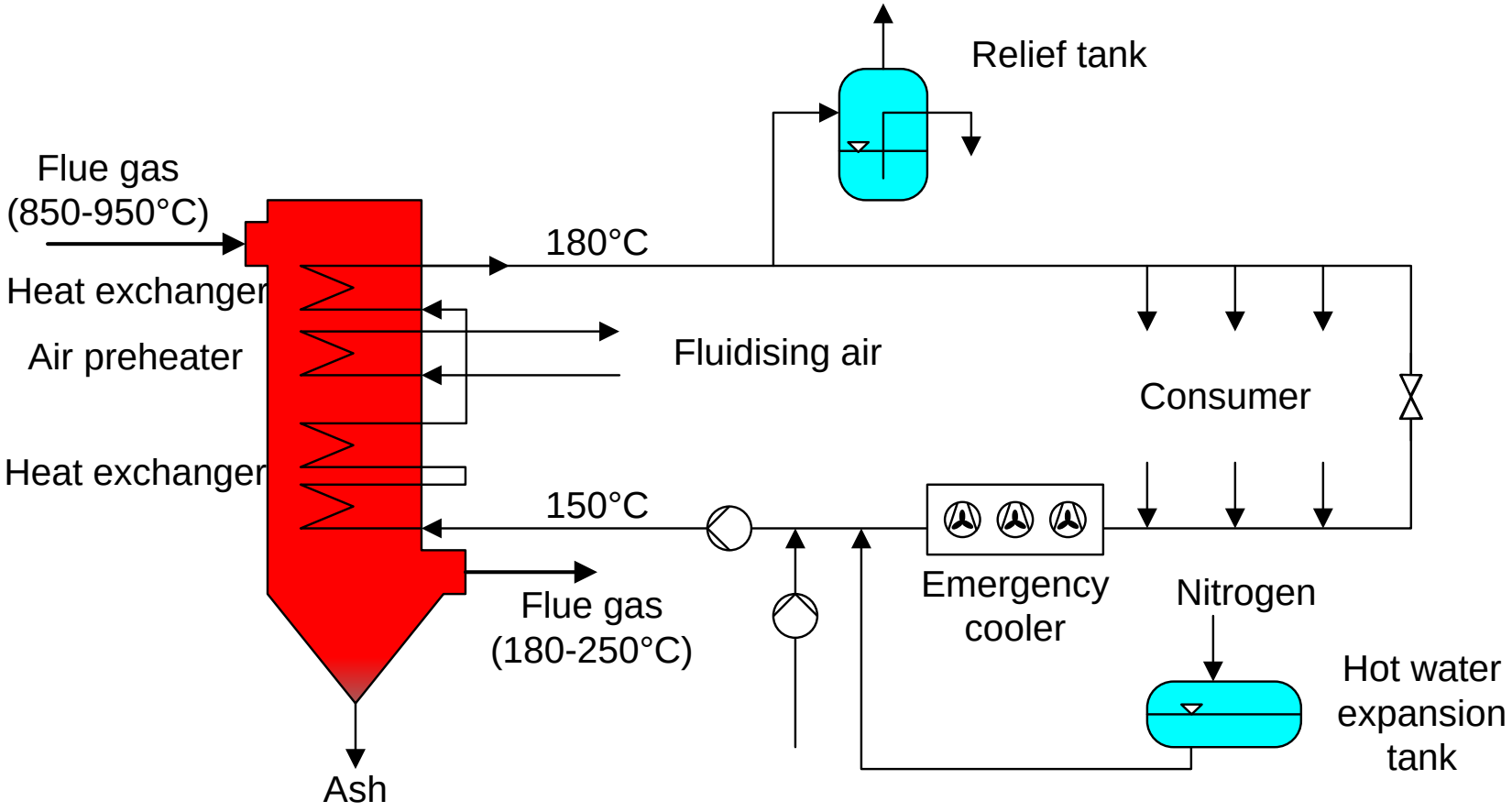
Heat recovery, steam



Heat recovery, thermal oil



Heat recovery, hot water



Flue gas cleaning

Flue gas cleaning

		Raw Gas Values of Incineration Plants at 11 Vol.-% O_2		
		Waste Incineration	**Special Waste Incineration**	**Sludge Incineration**
Dust	[mg/Nm³$_{dry}$]	3000 - 8000	8000 - 15000	15000 - 70000
SO_2	[mg/Nm³$_{dry}$]	300 - 600	400 - 1000	1500 - 5000
NOx	[mg/Nm³$_{dry}$]	300 - 450	250 - 400	80 - 800
HCl	[mg/Nm³$_{dry}$]	1000 - 2000	3000 - 8000	50 - 100
HF	[mg/Nm³$_{dry}$]	10 - 20	150 - 400	-
CO	[mg/Nm³$_{dry}$]			10
Pb	[mg/Nm³$_{dry}$]			
Hg	[mg/Nm³$_{dry}$]	0,4 - 1,0	0,4 - 1,0	0,5 - 1,0
Cd	[mg/Nm³$_{dry}$]			
PCDD	[mg/Nm³$_{dry}$]	(4 up to 10) *10^{-6}	(2 up to 10) *10^{-6}	< 0,1 * 10^{-6}
PCDF	[mg/Nm³$_{dry}$]			

German stipulated emission limits
Waste Incineration Directive, daily averages

	1962, first German sludge incineration plant mg/m³	TA-Luft 74 mg/m³	TA-Luft 86 mg/m³	17th BImSchV 1990 mg/m³	17th BImSchV 1999 mg/m³	Waste Incineration Directive 2000/76/EC mg/m³
Dust	150	100	30	10	10	10
C org	-	-	20	10	10	10
HCl	-	100	50	10	10	10
HF	-	5	2	1	1	1
CO	-	1000	100	50	50	50
SO_2	-	-	100	50	50	50
NO_x	-	-	500	200	200	200
Cd, Tl	-	Class I: 20	Class I: 0.2	0.05	0.05	0.05
Hg	-	Class II: 50		0.05	0.03	0.05
Sb, As, Pb, Cr, Cu, Co, Mn, Ni, V, Sn	-	Class III: 50	Class II: 1 Class III: 5	0.5	0.5	0.5
PCDD/PCDF	-	-	-	0.1 [ng/m³]	0.1 [ng/m³]	0.1 [ng/m³]

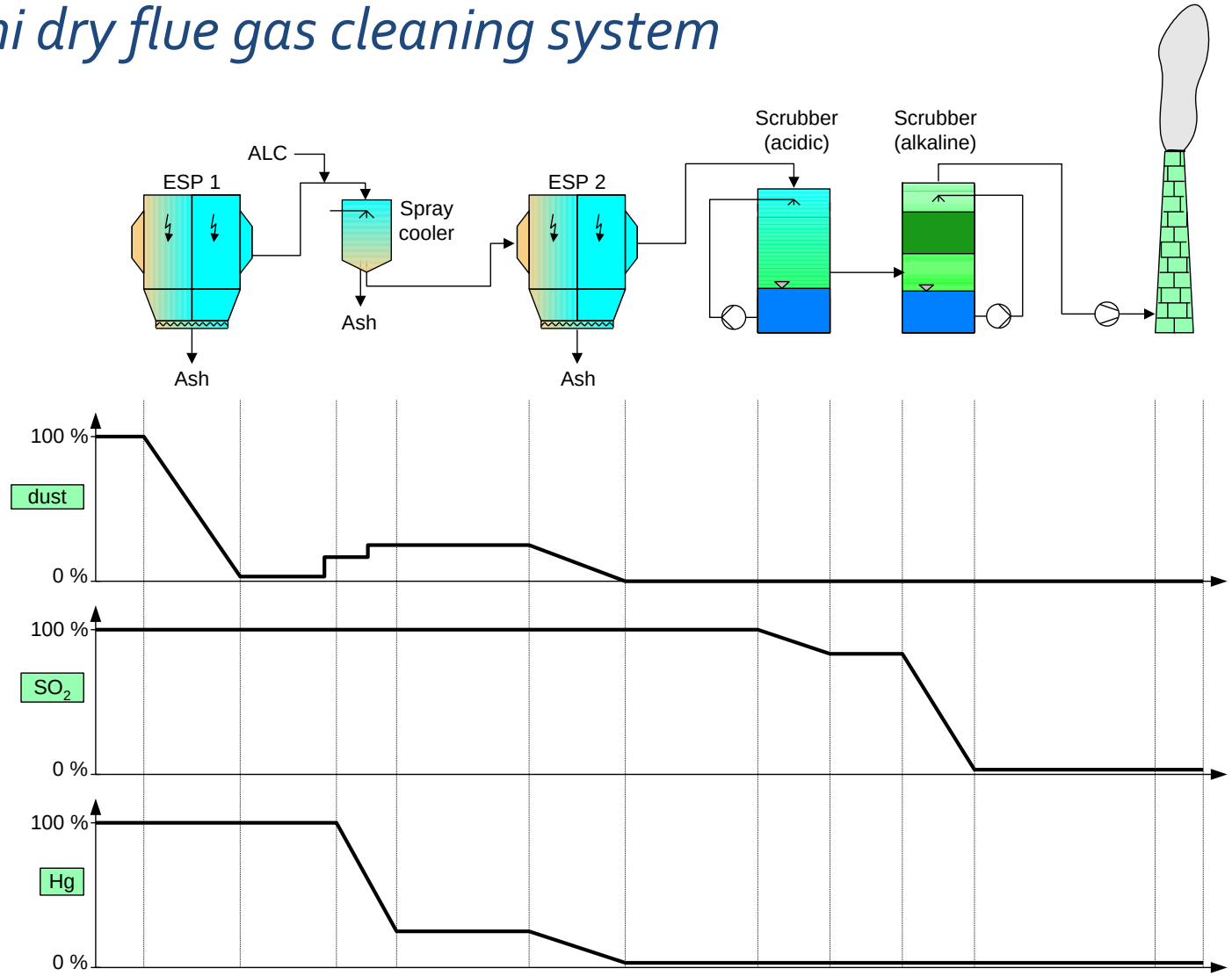
Controlling emissions of NOx, CO and CH

- Continuous furnace feeding
- Bed temperatures < 810 C
- Head temperatures > 880 C
- O2 level 3 - 10 %
- SNCR with ammonia or urea

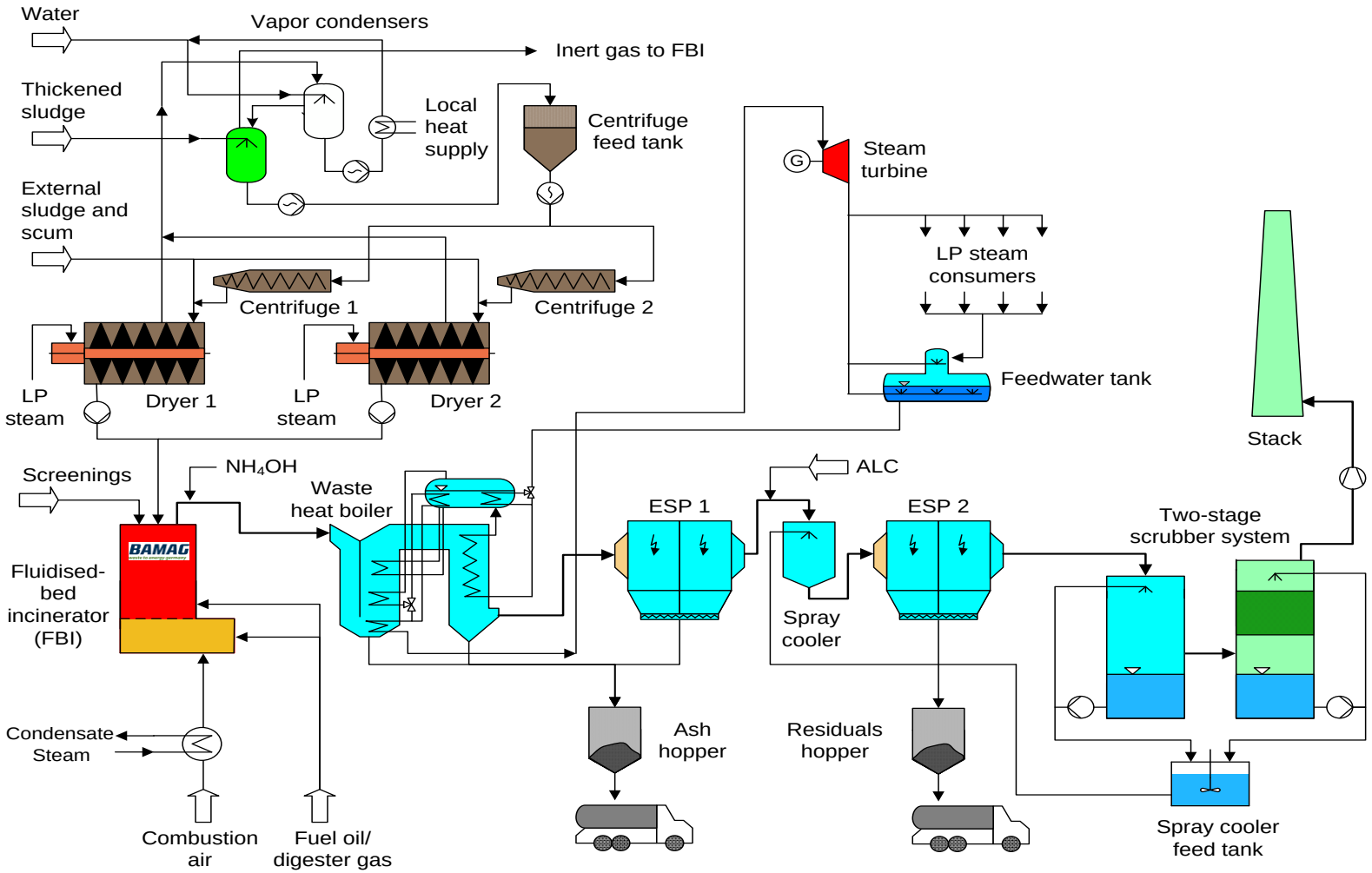
Components of municipal sewage sludge

- S = 0,5 - 2 % from DS
- Cl = 0,2 % from DS
- F = 0,02 % from DS
- Ash/Dust = 30 - 50 % from DS
- Hg = 1 - 2 mg/kg from DS

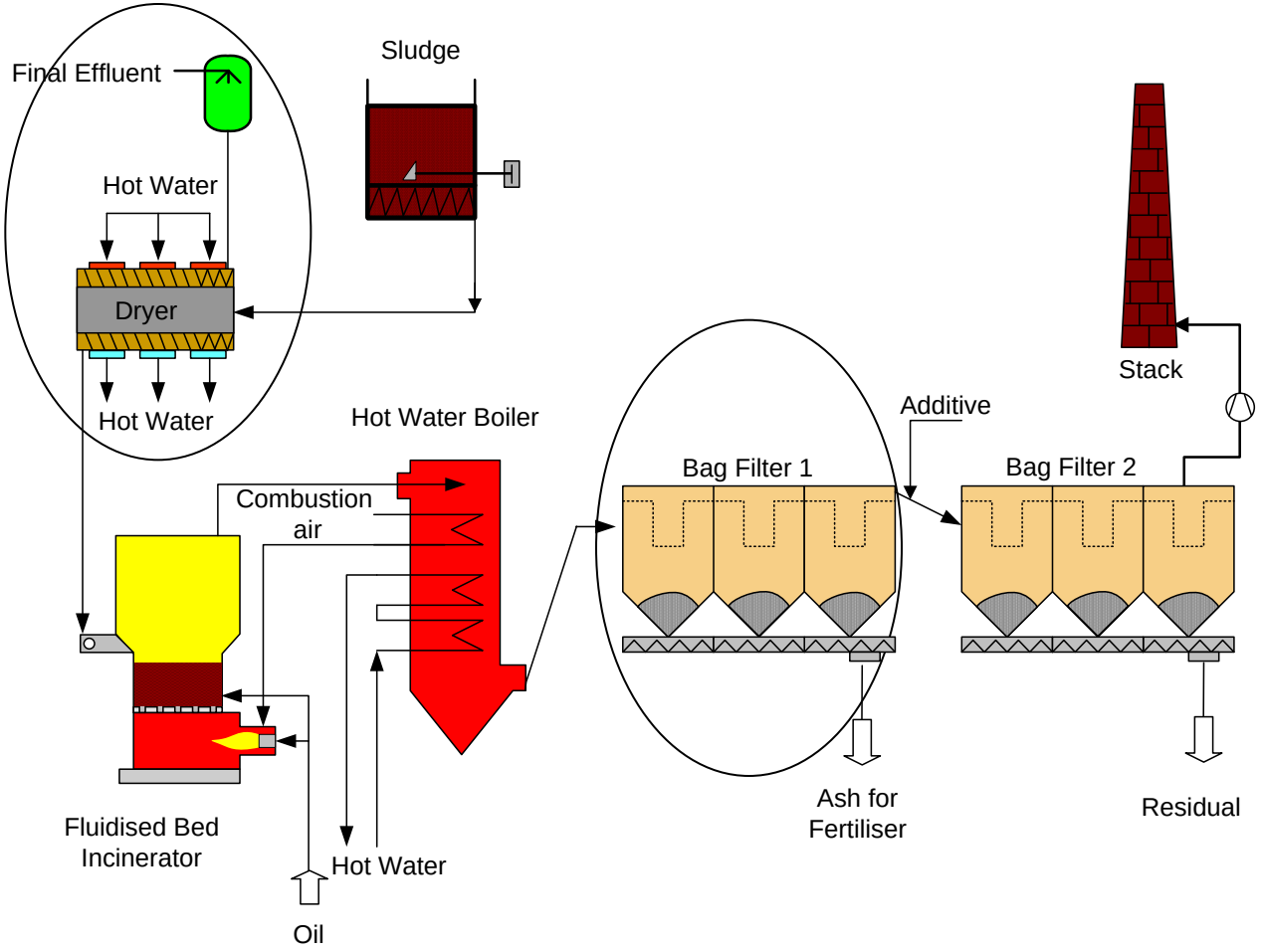
Semi dry flue gas cleaning system



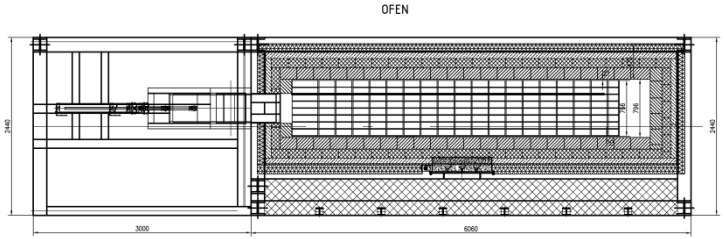
Sludge incineration plant, Stuttgart, Germany

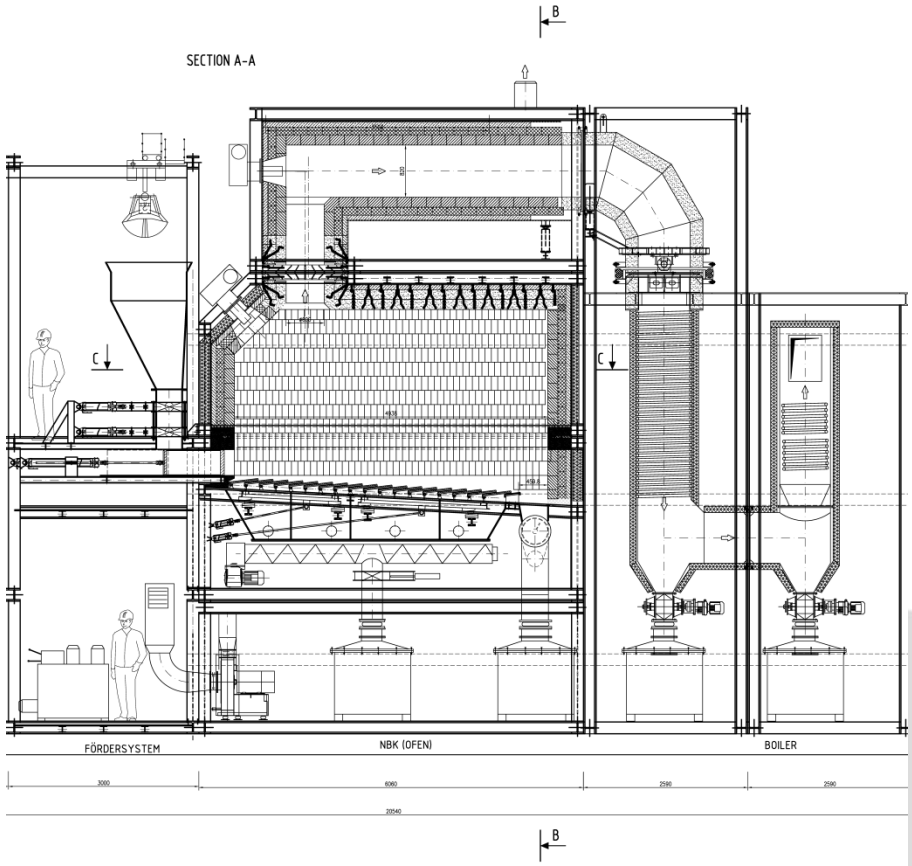


Small size sludge incineration plant



Layout of incinerator





Thank you
for your attention!

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