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Thermal desorption: From laboratory scale to full-scale application

Contaminated Sites 2015, Bratislava

Thermal desorption

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Principle

⇒ separation of contaminants from contaminated materials by heating it up and their volatilisation

Contaminants

⇒ VOC, SVOC as well as volatile inorganics (mercury)
Typical contaminants are petroleum hydrocarbons, PAHs,pesticides, other POPs, etc.

Advantages

High efficiency, no need of any agents, continuous and batch feed, process speed.

Disadvantages

Energy demands, off-gas treatment – condensation or incineration.

Thermal desorption in DEKONTA

- In Dekonta we have a set of devices for testing of feasibility of thermal desorption:

- Laboratory testing furnace
- Research microwave chamber
- Laboratory semi-pilot unit

- And one mobile pilot unit capable to treat 1-2 t/hr that was built according to the results of the prior research

Laboratory testing retort

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Parameters

- 50 mL batch
- max. 500 °C
- electrical heating
- ambient pressure

Output data

- condensate distribution (water/oil)
- decontamination efficiency

Too small batch for getting full-scale process parameters !

Research microwave chamber

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Parameters

- original patented mobile unit (CZ 26360)
- 200 L batch
- 350 °C
- 20 - 100 kPa
- direct microwave heating 0.6 – 6 kW

- On-line data recording.
- Continuous/discontinuous dosing of inert gas to condensation system.
- Continuous off-gas measuring of TOC, SO_2, NO_x, O_2, CO, CO_2, CH_4, H_2; other analyses from off-gas sampling.

Research microwave chamber

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Use

- POPs, PCB, Hg, crude oil sediments, polar compounds; drying

Output data

- decontamination efficiency
- energy and mass balance
- off-gas quality

Laboratory semi-pilot unit

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Parameters

- 100 L batch
- 20 to 100 kPa
- indirect heating (electrically heated silicone oil)
- max. jacket temperature 395 °C
- mixing speed 0 – 100 rpm

- On-line data recording.
- Continuous/discontinuous dosing of inert gas or gaseous/liquid agents into chamber/condensation system.
- Continuous off-gas measuring of TOC, SO_2, NO_x, O_2, CO, CO_2, CH_4, H_2; other analyses from off-gas sampling.

Laboratory semi-pilot unit

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Use

- POPs, PCB, petroleum hydrocarbons, process oils, Hg

Output

- verification/optimizing of full-scale process parameters
- energy and mass balance
- decontamination efficiency
- off-gas quality
- condensate fractions quality
- material characterization (particle size, crusting …)

Dryer

Condensation unit

Chiller for cooling water

Thermal unit

Pilot unit

Modular system – rotary kiln, off-gas pre-treatment system, inertization system, control room, fuel tank

Parameters

- 1 to 2 t/hr
- 80 - 100 kPa
- indirect heating (oil burners)
- min. temperature 450 °C
- 0 to 10 rpm
- particle size < 50 mm

Pilot unit

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Use

- POPs, PCB, petroleum hydrocarbons

Output

- verification of designed process parameters
- decontamination efficiency
- off-gas quality

- **Can be used at smaller sites as a full scale unit.**
- **Ideal for demonstration projects.**

Pilot unit – rotary kiln + off-gas pretreatment

Pilot unit – off-gas pretreatment

Pilot unit – system check

Pilot unit – control cabinet

Results

Tested matrices

- oil sludge, filter cake, rubble

Material	Contamination	Concentration	Type of process	Efficiency
Filter cake	petroleum hydrocarbons	297 g TPH / kg	laboratory test	65 %
			semi-pilot test	76 %
Oil sludge	petroleum hydrocarbons	220 g TPH / kg	laboratory test	88 %
			semi-pilot test	94 %
Rubble	pesticides (HCH)	240 mg HCH / kg	laboratory test	95 %
			semi-pilot test	99 %

Results

Filter cake

- laboratory tests: not very optimistic results
- semi-pilot tests: operational parameters were estimated, methane presence detected

Oil sludge

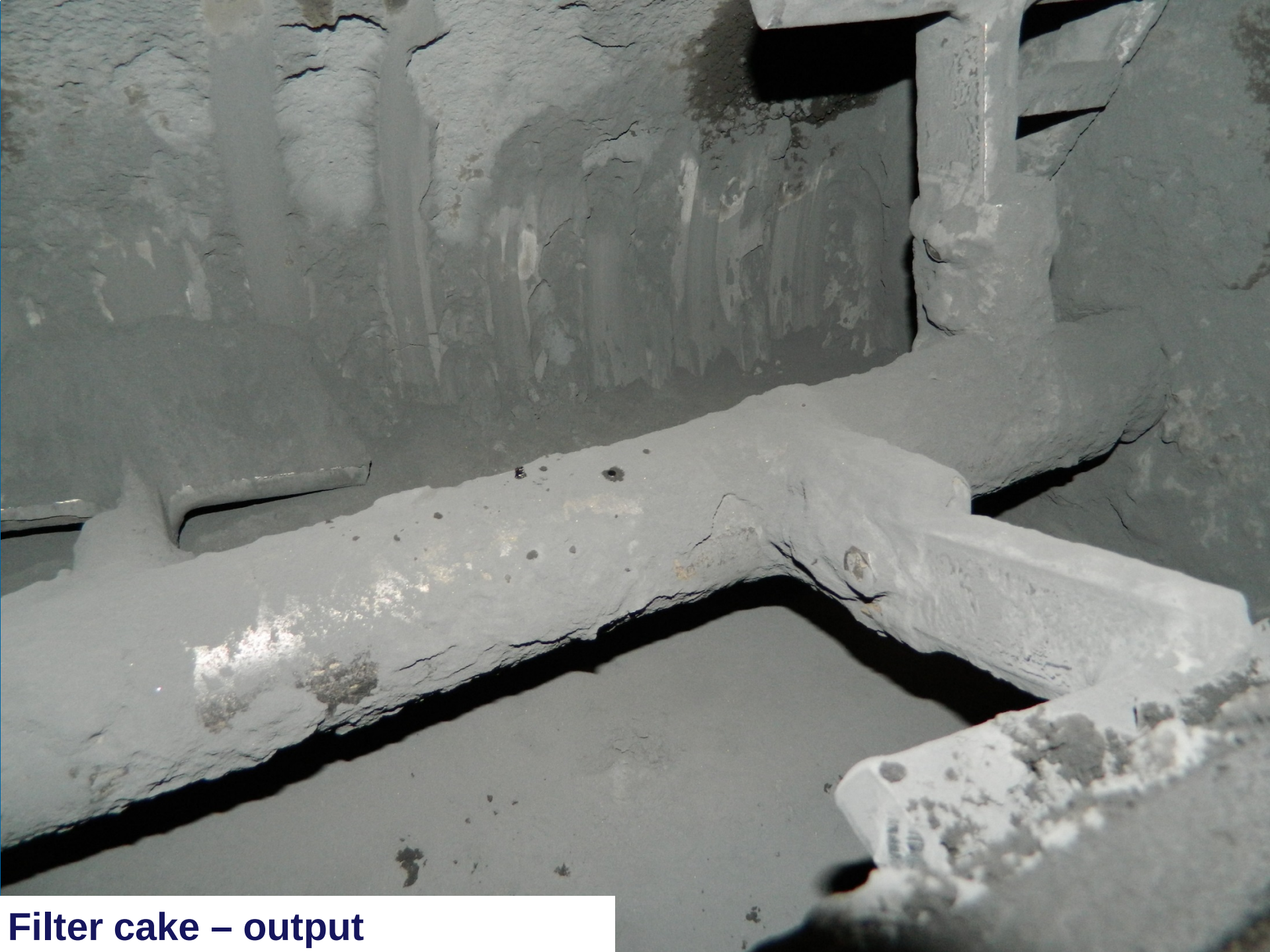
- laboratory tests: good results, sintering occurred
- semi-pilot tests: good results, operational problems as problematic condensation, sintering, high concentration of toxic and explosive gases were detected

Rubble

- no difference between laboratory and semi-pilot tests: good results, crystallization of pesticides

Filter cake – input sample

Filter cake – dust filter after trial



Filter cake – output

Oil sludge – input sample

Oil sludge – condensate

Oil sludge – condenser

Oil sludge – output

Pilot test design – filter cake

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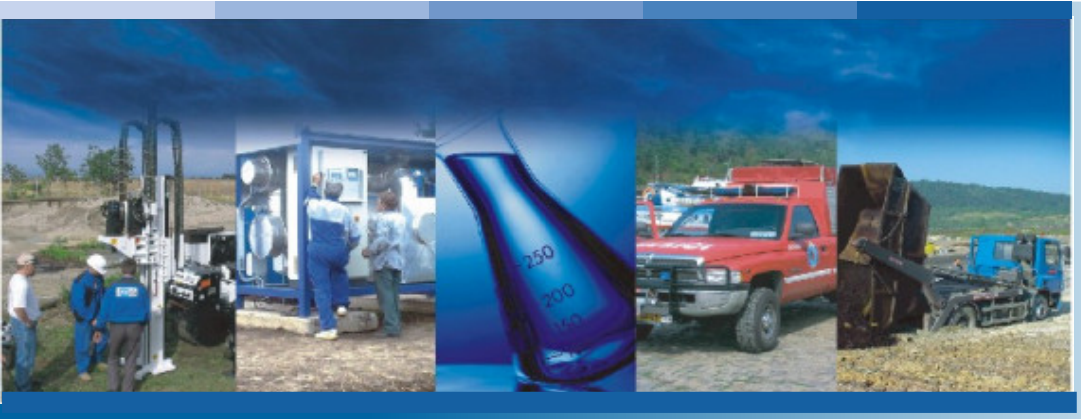
Process parameters

- target temperature: min. 450 °C

Aim of the pilot test

- determination of process efficiency at different parameters
- to find optimal residence time (rotates of the kiln)
- off-gas analyses for off-gas treatment (catalytic incinerator or condensation system) design
- regarding methane presence consider safety precautions
- economical study
- delivery of the functional system for filter cake treatment and utilization



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