Group 2

Oil Waste Processing Using Combination of Physical Pre-Treatment and Bioremediation - Case Study

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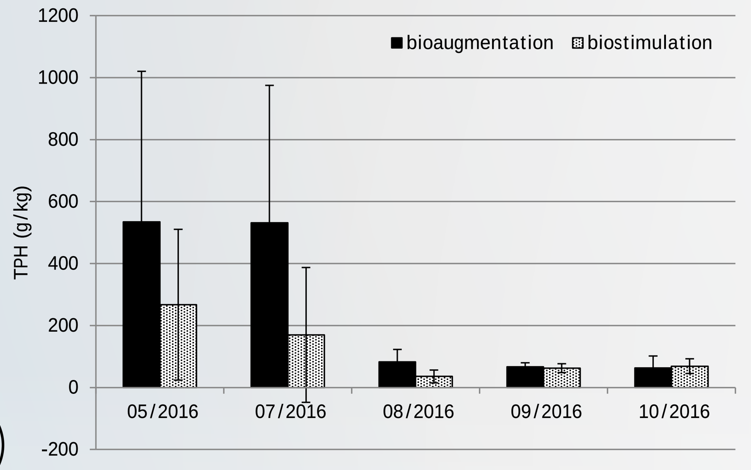
Background/Objectives

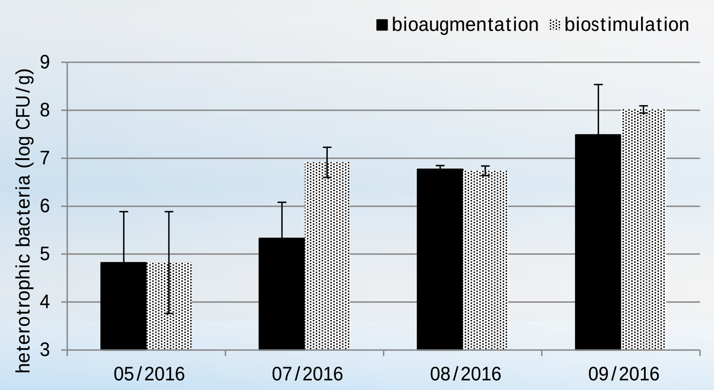
Waste emerging from upstream oil industry, usually contains a mixture of contaminated soil, drilling muds and oil in various states of weathering. A massive contamination level of 10% petroleum hydrocarbons, excludes direct processing by bioremediation technology. A new technology for the removal of petroleum hydrocarbons from oil waste was used at the historical oilfield in Kazakhstan. This technology is based on the combination of physical pre-treatment (gravity separation in heavy suspensions), followed by bioremediation.

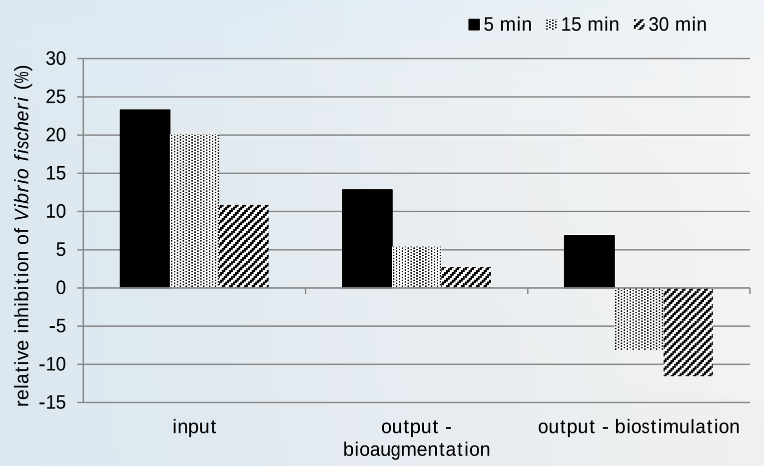
Pilot Scale Test of Bioremediation

Based on the positive results of lab test, the pilot scale test was suggested:

- → Construction of decontamination plate
- → Equipment preparation, transport and installation on site
- → Soil excavation - approx. 150 m^3
- → Test duration – 5 months (with monthly monitoring)
- → Suggested technology – ex-situ biodegradation using bacterial strains for long alkyl chains (bioaugmentation and biostimulation)
- → Despite a promising 80% efficiency of the bioremediation, the output concentrations (approx. 6–7g/kg) were still very high and achievement of target limits (2% of TPH) would be costly, even if possible.







Pilot Scale Test of Physical Pre-Treatment

Major limitations /challenges of bioremediation

- → Level of contamination: Very high for bioremediation
- → Character of material: Extremely heterogeneous
- → Character of contamination: Heavy hydrocarbons (over 80%)
- → Increased salinity of treated material
- → Limited availability of freshwater

Technological scheme proposed to improve treatment efficiency

Based on separating of highly contaminated parts of sludge and soil with lower contamination

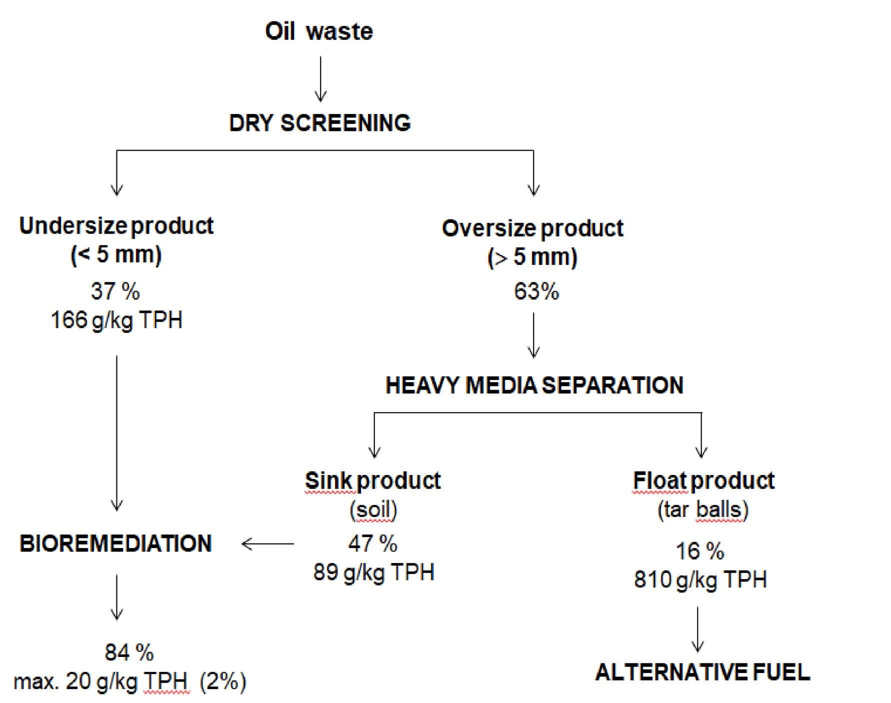
1. Screening (removal of fine fractions – below 5 mm)
2. Heavy media separation (removal of „tar balls")
3. Bioremediation

Material	Description of a mixture of contaminated materials	Content (% w/w)
sand	yellow-brown colour; fine-grained with pebbles; week hydrocarbon smell	5
soil	grey colour; fine-grained with pebbles; week to intense hydrocarbon smell	30
drilling cuttings	dark grey to black colour; hard grain size and agglomerates; intense hydrocarbon smell	30
tar	black colour; hard grain size, melting at higher temperature; intense hydrocarbon smell	30
construction debris	white-grey colour; hard pieces; week hydrocarbon smell	5

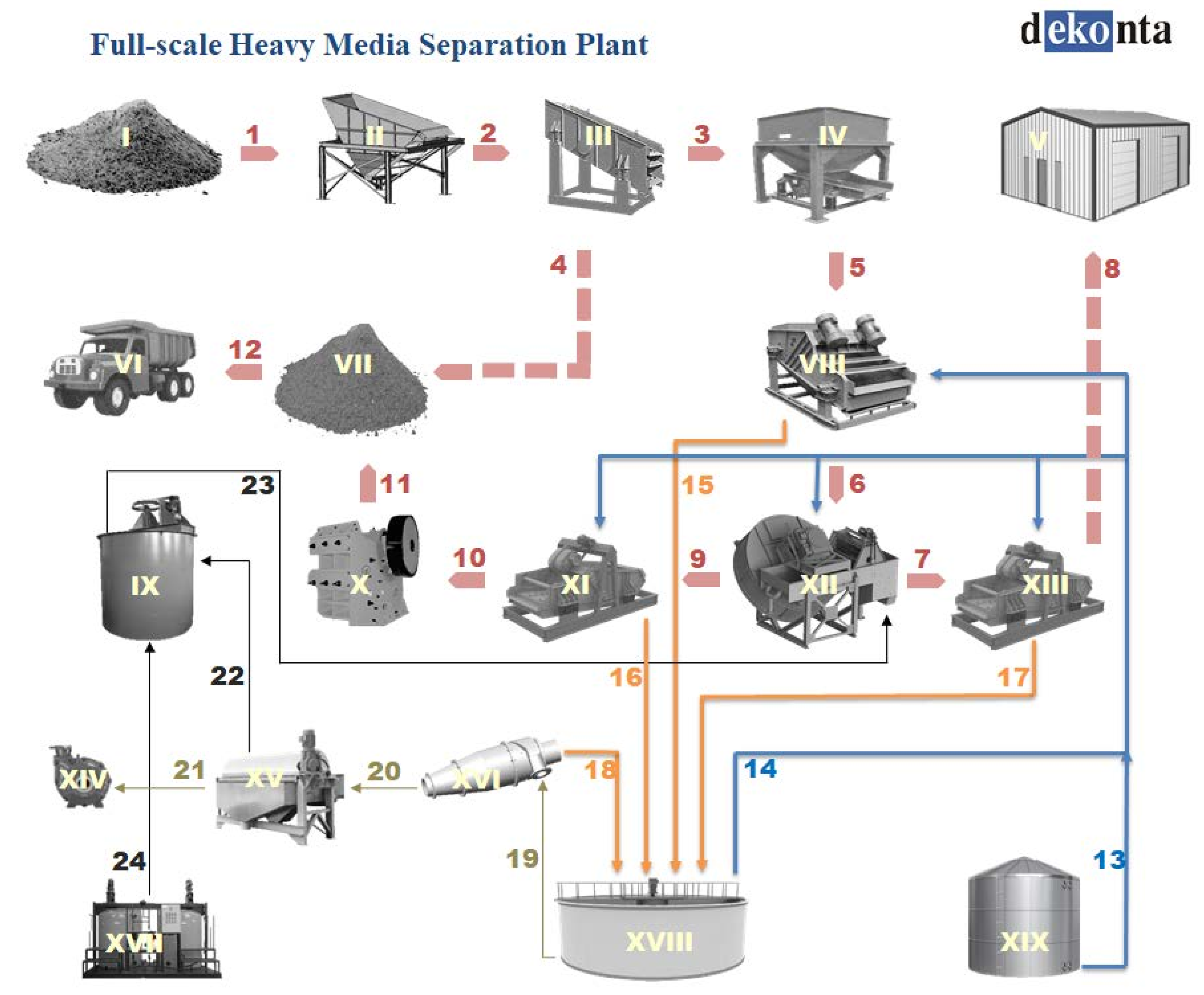
Dense Media Separation

- → Dense medium: Solution of sodium silicate (water glass) - specific gravity 1.5 g/cm^3 (specific gravity of tar: 1.1 g/cm^3, specific gravity of sand: 2.7 g/cm^3)
- → Performed on-site using 4.4m x 2.3m x 0.9m container; 20m^3 of contaminated material

Product	Yield (% w/w)	TPH content (% w/w)
Floating part - tar balls	25	81.0
Sinking part - soil	75	8.9



Dense Media Separation Technology



Equipment:

- I. Contaminated material storage
- II. Storage hopper with sloping grizzly and vibrating feeder
- III. Dry vibrating screen
- IV. Storage hopper with belt feeder
- V. Separated tar storage
- VI. Shipment of pre-treated soil to a bioremediation facility
- VII. Storage of pre-treated soil
- VIII. Vibrating screen for washing material before heavy media separation
- IX. Tank for preparation of magnetite suspension
- X. Crusher
- XI. Vibrating screen for sink product washing
- XII. Heavy media separator
- XIII. Vibrating screen for float product washing
- XIV. Pump for delivery of slurry to a bioremediation facility
- XV. Magnetic separator
- XVI. Hydrocyclone
- XVII. Magnetite storage tank
- XVIII. Sedimentation tank
- XIX. Process water tank

Material streams:

1. Input material (mixture of weathered oil sludge and soil/ sand / clay/ stones)
2. Input material after removal of oversized particles (+ 300 mm) om sloping grizzly
3. Coarse fraction of input material
4. Fine fraction of input material
5. Coarse fraction of input material fed by belt feeder
6. Coarse fraction of input material after washing
7. Float product of dense media separation (weathered oil particles and conglomerates)
8. Dewatered float product
9. Sink product of dense media separation (sand / soil / stones)
10. Dewatered sink product
11. Crushed sink product (sand / soil / stones)
12. Sink product shipped to a bioremediation facility
13. Technological water
14. Clarified water
15. Sludge from input material washing
16. Sludge from sink material washing
17. Sludge from float material washing
18. Hydrocyclone overflow
19. Sediment from a sedimentation tank (input to a hydrocyclone)
20. Hydrocyclone underflow
21. Sludge after magnetite separation
22. Magnetite concentrate
23. Heavy suspension ready for use
24. Fresh magnetite

References

Raschman, R., Najmanova, P., 2017. A method of decontamination of soils contaminated with petroleum substances and a line for implementing this method; Patent No. 307139.

Acknowledgments

This work was supported by Grant No. TE01020218 of the Technology Agency of the Czech Republic, and in part by Grant No. VI20162019017 of the Ministry of the Interior of the Czech Republic

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