The Steam Stripping Process: A Remediation Technique for TBT- and PAH-Contaminated Dredged Sediments and Soils

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Abstract
The contamination of dredged sediments by PAH, residues of mineral oils and organotin-compounds (TBT-tributyltin) is a topic of high importance because contaminated sludges occurring all over the world by dredging activities for example at harbors, shipyards or docks. Up to now no technologies are available which can treat and decontaminate TBT-containing dredged sludges. In a case study extremely high TBT-concentrations were detected at a shipyard site in the north of Germany (Baltic Sea aera). TBT-concentrations of about 18.000 – 22.000 µg/kg dry matter were detected at that site. In a research and development study we have investigated the decontamination of PAH- and TBT-contaminated soils and sediments. A newly developed steam stripping process has become an efficient way for the treatment of contaminated fine-grained particles. In general cleaning performances of more than 95% for mineral oil, PAH and also TBT have been realized.

Introduction

Many contaminants are adsorbed or bound to the fine fractions of soil as silt, clay and humic matter, which tend to be attached to sand and gravel and form larger soil aggregates. These adsorbed contaminants are often not available to recent clean-up techniques. Therefore new techniques should be developed which are able to treat these fine grained materials and which can successfully separate contaminants from the soil particles. High concentrations of contaminants like mineral oil hydrocarbons (MHC), PAH and tributyltin (TBT) cause the toxicity of materials.

TBT is one of the major contaminants of dredged harbor sludges. TBT is still used as the biocidal component in boat antifouling paints on vessels over 25 m (the use on vessels less than 25 m was banned in 1987). The highest concentrations of TBT and other organotin compounds could be detected in sediments close to docks and shipyard sites. TBT has a wide range of harmful effects (sub-lethal to mortal) to numerous organisms at differing scales, it is a highly toxic compound with biocide effects and causes endocrine (hormone-like) effects to mussels and marine snails which result in local extinctions.

As we know there are no remediation techniques available which are able to decontaminate TBT-containing sediments. In this research and development study we have investigated the cleaning efficiency of a newly developed steam stripping process.

Results

In a case study the TBT-contents of two different sites in the north of Germany were analyzed (i) dredged material of a harbor in the North Sea area and (ii) sediments near a shipyard in the Baltic Sea area. Extremely high TBT-concentration of about 18.000 – 22.000 µg/kg dry matter were detected at the shipyard site. The dredged harbor sludge was less contaminated (1130 µg/kg dry matter).

The steam stripping process is based on the spontaneous vaporization due to the change of temperature and pressure conditions, as described by Höhne et al. (2000). The alteration of the physical-chemical conditions within the process results in a desagglomeration of the aggregates, a desorption of the contaminants and a vaporization of contaminants and water. Afterwards the steam phase contains the contaminants and the clean solid material is separated by a cyclone unit (Fig. 1).

It was proven that this technique is able to decontaminate different materials almost completely (Fig. 2). Drilling muds contaminated with mineral oils (MHC) were cleaned with an efficiency of 99 up to 100% (Höhne & Niemeyer 1999). The decontamination of e.g. mercury and PAH from soil washing residues was as effective.

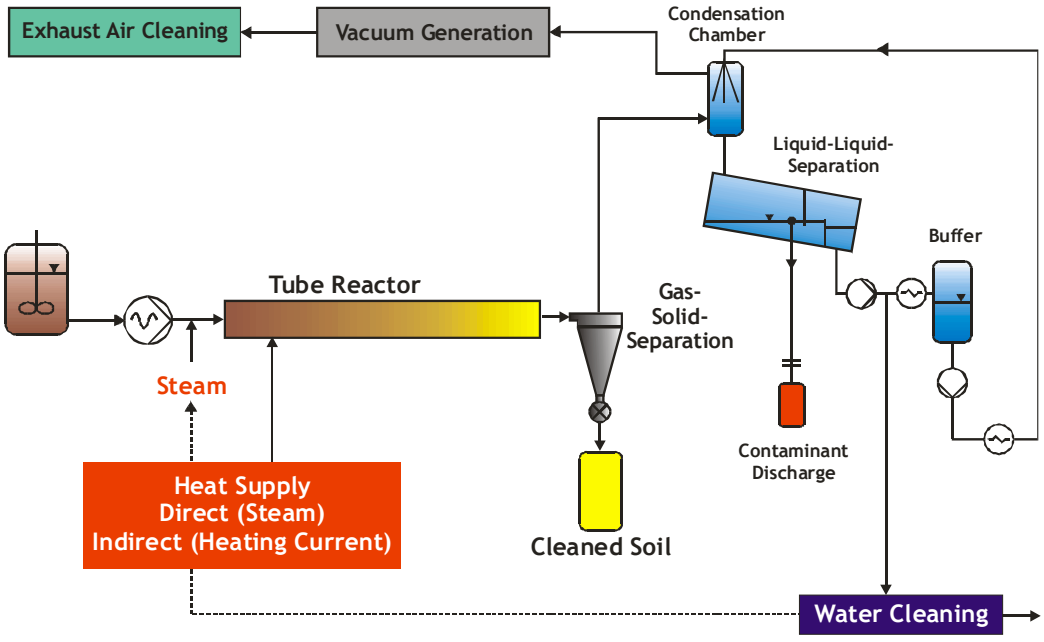

Fig. 1: Flowsheet of the pilot plant of the Steam Stripping Technique

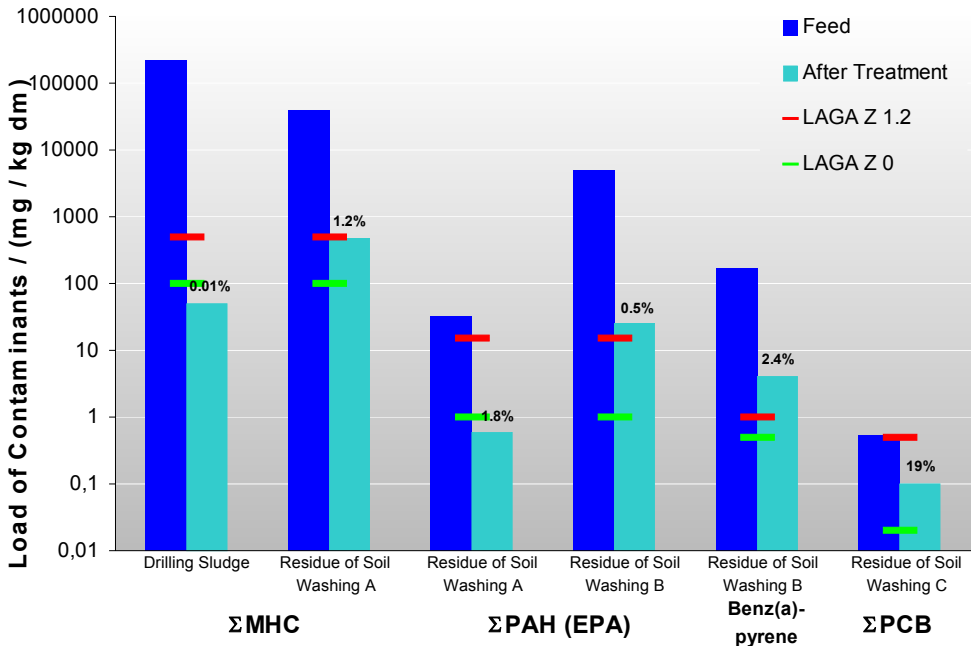

Fig. 2: Efficiency of the Steam Stripping Process to clean up different soils and sluges

The first results with TBT-contaminated dredged material have shown high cleaning efficiencies as well (Table 1). The performance obtained was more than 98% for TBT. For all treated sediments the steam stripping process lead to TBT-contents far less than all discussed legal limits. These results will be discussed in terms of functionality and economy.

Tab. 1: Cleaning efficiency of Steam Stripping Process for TBT-contaminated sediments

Dredged Sediments	Substances		before Treatment µg/kg	after Treatment µg/kg	Cleaning Performance %
Sediment A	Dibutyltin	DBT	176	31	82
	Tributyltin	TBT	580	7	99
Sediment B	Dibutyltin	DBT	527	100	81
	Tributyltin	TBT	2766	21	99

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