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Optimization of Mercury Remediation from a Contaminated Industrial Park Soil via Thermo Desorption: An Experimental Approach

Andrea Pacini[1], Alessandra De Folly D'Auris[1], Alessandro Conte[1]
[1]Eni S.p.A.
Via Felice Maritano 26, San Donato Milanese (MI) - Italy
andrea.pacini@eni.com; alessandra.de.folly.dauris@eni.com; alessandro.conte2@eni.com

Extended Abstract

Environmental contamination caused by mercury - due to its mobility and long residence time in the soil and atmosphere [1] - is an emerging problem worldwide [2].

To treat and remove the contaminant from the soil, different techniques have been implemented, both in laboratory, pilot and full-scale applications. One of the most promising approach for mercury removal is thermal desorption, a treatment technology that utilizes heat to increase the volatility of contaminants which are subsequently removed from the solid matrix and treated in an off-gas treatment system [3].

In this work we analysed and treated a soil from an industrial area with high levels of mercury contamination, mostly in the forms of elemental mercury (24-67%) and insoluble inorganic mercury (32-73%). To understand the most effective remediation strategy, a series of tests have been performed on a different number of soil samples.

The soil was collected via core drilling up to a depth of 5 metres, and each 1 metre layer was characterized in terms of total mercury contamination, dry residue, humidity, sieve fraction (less than 2 cm and more than 2 mm), and a mercury speciation was performed.

After a first characterization, the layer with the highest mercury contamination was identified and 10 kg of material was selected for the subsequent analysis. A composite sample was obtained via mixing of the whole layers cored, including the high polluted stratum, and 30 kg of material was collected for analysis.

A series of laboratory tests were performed on the samples from both the most contaminated layer and the composite, with the aim of investigating the most efficient strategy for the thermal desorption, In Situ Thermal Desorption (ISTD) or Ex-situ Thermal Desorption (ESTD), using a rocking oven.

Small fractions of the samples were analysed through thermogravimetry (TGA) tests. The tests were performed on both unaltered state (14.5% humidity) and dry samples. In the first step of thermogravimetric analysis (TGA), the sample was continually weighted while heated between 25°C and 700°C, as an inert gas atmosphere was passed over it. Characteristic temperatures for the desorption of the different mercury species present in the soil were identified through the analysis of the thermogram – specifically the temperature intervals that show the highest weight loss and the differential scanning calorimetry (DSC) analysis.

A second thermogravimetry analysis in isothermal conditions for a duration of 2 hours was performed, to investigate the mercury losses at the inflection temperature identified with the DSC analysis. The total mercury analysis showed a drastic reduction of the contamination, that fell under the Italian CSC (Contamination Threshold Concentrations) for mercury in sites suitable for industrial or commercial use (5 mg/kg) [4].

A series of desorption tests with rotating oven were performed to scale up the process and recreate the real treatment conditions, and to investigate the two different remediation strategies: semi-static mode for the in-situ thermal treatment and rocking mode for the off-site treatment. From preliminary tests, both the advantages of the joint laboratory analysis and pilot approach, as well as the efficacy of the thermal treatment of mercury contaminated soils are evident.

References

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