Inorganic reactive gels for the in-situ stabilization-solidification of mercury contaminated subsoils

Keywords

solidification-stabilization; in situ treatment; injection; sludge; propagation; shallow subsoils; mercury mobility; treatability tests; physical and chemical trials; geophysical monitoring

Context

Many contaminated sites display persisting pollutions, especially those dealing with trace metal elements contaminations. Although mercury has been banished from products and industrial processes, many historical sites remain contaminated and subject to use restrictions. Although soil excavation can be used to manage hot spots of pollution, diffuse pollutions over large areas require other remediation techniques. In this context, a partnership has been built between a chemical company, a depollution firm, a design office for engineering and two research laboratories to develop a technology able to deal with this kind of pollution over large areas at low cost.

Goals

The project aims to develop an in-situ treatment technology for shallow soils (0-3 m) with low level of mercury contamination (< 1000 ppm). The method of treatment will consist in injecting a reactive suspension able to ensure long lasting mercury immobilization, regardless of the mercury speciation, using solidification-stabilization and preserving permeability of the treated soils. Electric tomography will be assessed as a low invasive tool for treatment monitoring in 3D. An involvement in field assessments is anticipated in the last part of the PhD-thesis.

Description

Technical aim of the project is the set-up of a new technology for the remediation at competitive cost of secondary pollutions over large areas at moderate mercury concentrations. These zones remained in place after excavation of hot spots of contaminated soils near the pollution source. The typical mercury concentration is few hundreds of ppm.

The aim is to set-up and assess a reactive suspension which is:

- injectable for a treatment using impregnation instead of mixing to face the presence of underground structures,
- viscous to control its migration in soils,
- inorganic (or stable organic) agents to prevent the release of organic mercury compounds,
- able to immobilize mercury physically and chemically,
- does not affect the soil geotechnical properties,
- able to limit transfers from smaller pores while keeping macro-pores open.

Then, the injection method of the fluid will be optimized. The most important issue is the ability to treat large areas at competitive cost. In particular, the new technology is expected to be attractive compared to confinement method while allowing advantages such as site reuse.

An additional aim will be to assess electric tomography methods for the monitoring of the treatment during the injection step and after. A Final goal is to set-up a technology that can be applied over a large range of geologies, mercury concentrations and mercury speciation.

Method

The project will combine the expertise of two research teams. First, using the state of the art, a work on chemical formulation will aim to set-up a reactive aqueous suspension able to achieve requirements for the solidification-stabilization of contaminated soils. Hydraulic and pozzolanic binders, geopolymers, clays and mercury-immobilizing reagents will be studied. The use of inert wastes will be assessed to lower costs and favour recycling. Then, injection tests (pressure-flow rate, breakthrough curves in 1D) and treatability tests (in 2D and 3D tanks), mechanical tests and Hg-mobility tests on treated matrices will be performed.

Research teams

The PhD-thesis will be performed at ESTP (École Spéciale des Travaux Publics, du Bâtiment et de l'Industrie, Cachan, France) and at IC2MP (Institut de Chimie des Milieux et Matériaux, University of Poitiers, UMR CNRS 7285, France). ESTP is specialized in hydraulic binders and geopolymers, and the chemical and geotechnical characterization of treated matrices. The research carried out at IC2MP is at the interface between chemistry and geosciences. IC2MP has expertise in fluid injection into soils and treatment processes. It will be involved mainly in injection and treatability tests in relation with depollution goals.

The recruited applicant will perform the first part of the PhD-thesis at ESTP, then will carry on at IC2MP. The PhD student will be associated to field trials. Reliable and motivated candidates holding a Master's degree in chemistry, physical chemistry or chemical engineering are welcome. Finally, the recruited person will have excellent synthesis capabilities, communication and writing skills. He/She will be skilled for teamwork and has appetite for DIY.

Financial terms

The work is funded by ADEME (French Agency for Management of Energy and environment) for 36 months. Gross monthly salary will be 2044euros at the start of the PhD-thesis.

How to apply

Candidates will provide their CV, academic transcripts (MSc), a cover letter describing their interest and expertise and the contact information for two references.

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