CASE STUDY

# FIRST IN SITU CHEMICAL OXIDATION USING PEROZONE® AT AN EX-RATED INDUSTRIAL SITE, ANTWERP, BELGIUM

## Background

Vopak Chemical Terminals Belgium NV (Vopak) operates a site in Antwerp where 107 tanks provide more than 200,000 m³ of storage for chemicals before their distribution by road, rail and sea. The company is part of the world's largest independent tank terminal operator.

Vopak wanted to reduce the environmental and human-health risks associated with soil and groundwater contaminated with volatile total petroleum hydrocarbons (TPH); benzene, toluene, ethylbenzene and xylene (BTEX); and chlorinated aliphatic hydrocarbons (CAH) in the southern part of the terminal.

RSK and Badeco, a local remediation specialist, joined with Vopak to form the ExperO3 project, which is funded by the European Commission's LIFE+ programme. The project aims to demonstrate the effectiveness and cost, time and energy efficiency of an innovative, in situ chemical oxidation (ISCO) remediation technique.

## Challenges

A mixture of TPH, BTEX and CAH contaminants, each with different chemical and physical characteristics and different means of biodegradation, makes remediation challenging, expensive and time-consuming. Consequently, the threshold for starting remediation is high and such projects are often postponed. An additional challenge in this case is that the terminal is an explosion-sensitive (EX-rated) site, so any remediation technique needed to be suitably safe.

## Project description

After a pilot test, ISCO using Kerfoot Technologies Inc.'s Perozone system, which will oxidise all types of organic contaminant, was selected as the preferred remediation method because of safety, technical and financial criteria.

ISCO for remediation is widely applied. However, the use of Perozone, a mixture of explosive hydrogen peroxide liquid and corrosive ozone gas, is less frequent and it had not been tried on an EX-rated industrial site.

The aim of the ExperO3 project was to demonstrate the feasibility of using these chemical oxidants in EX-rated industrial areas in a safe and controlled manner. To ensure safety, the system continuously monitors oxygen, ozone and volatile organic compound levels in soil gas and ambient air.

The project began by developing an extensive health and safety plan for a pilot test, which covered all the safety-related aspects of using this type of ISCO in an EX-rated area. This health and safety plan and the resultant safety measures have been reviewed regularly throughout the project.

ISCO remediation was achieved by injecting Perozone peroxide-coated ozone microbubbles directly into the contaminated soil and groundwater through Kerfoot Technologies' Laminar Spargepoints®. The use of microbubbles creates large surface contact areas, which speeds the breakdown of contaminants into harmless compounds and increases contaminant mobilisation from the soil matrix. The process also creates oxygen that stimulates aerobic biodegradation.

The pilot test gathered the information necessary to design full-scale remediation, including the number and location of the injection filters and the amount of oxidant needed. The full-scale remediation phase was designed to minimise disruption to the site's operation.

## Outcome

The project has demonstrated that ISCO using Perozone can be

- an effective solution for the remediation of multiple-parameter soil and groundwater contamination with high contaminant concentrations
- used on explosion-sensitive sites, providing the necessary safety measures are taken and there is suitable flexibility in the design of these safety measures
- used safely in areas with corrosion and tanks at risk of subsidence.

The contaminant migration zones in the aquifer have been treated successfully. However, the groundwater sources zones need more time for ISCO treatment than predicted because the contaminant mass load in the soil and its dissolution to the groundwater and vadose soil are high and safety constraints limit Perozone injection rates.

The project is ongoing and has still to assess the technique's effectiveness for pure product zones and its effectiveness and safety in previously excavated zones. Its cost and time efficiency, and environmental benefits also need to be verified compared with conventional techniques.

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