LIFE+ project Vopak ExperO3

Newsletter nr. 2 – May 2014

Abstract

At the Vopak terminal ACS a soil and groundwater contamination with chlorinated aliphatic hydrocarbons, BTEX and petroleum hydrocarbons is present. Since September 2012, remediation works are on-going. After the initial civil works, comprising excavation of the topsoil in the heavily contaminated source area just outside the tank farm, in-situ remediation is now in progress. Due to the environmental agency's decision that zero emission is applicable during air treatment by activated carbon, it was decided to change the initial plan (remediation by a combination of multi phase extraction and ISCO) and treat both source and plume areas with ISCO. In November 2013, the first phase of the in-situ remediation, using perozone (a combination of ozone and hydrogen peroxide), regarding the former drum storage area was successfully completed, both with respect to health and safety as to effectiveness of the technique. The treatment of the second area, the area around the former excavation, is on-going. Based on the (monitoring) results of the first phase, it was decided to test the effectiveness of ozone injections alone (without hydrogen peroxide). Due to the emissions of ozone and VOC, the injections have been stopped in February 2014 and tests have been conducted to determine an injection regime that minimizes emissions to the unsaturated area and eliminates emissions to the atmosphere. The renewal of the liquid tight concrete is ongoing and will be finished in May 2014. This will also have a positive effect on the ozone and VOC emissions.

Project description

Given the different physical and chemical characteristics of the contaminants in the soil and groundwater at the Vopak terminal ACS, remediation using traditional techniques would result in a time-consuming and expensive process. ISCO therefore offers a promising alternative for the simultaneous remediation of a cocktail of organic contaminants. With this technique, an oxidant is injected in the subsoil, causing oxidation of the contaminants into harmless products. Perozone, a mixture of hydrogen peroxide and ozone, is capable of oxidizing all types of organic contaminants.

Since the presence of strong oxidants causes major issues with regard to health and safety on explosion sensitive (EX-rated) sites, the development of an extensive health and safety plan and continuous monitoring of health and safety parameters during the remediation activities are of prime importance for the project.

This LIFE project focuses on a cost efficient, energy efficient and environmental advantageous innovative remediation technology that can be the solution for in situ remediation of complex contaminations in industrial and high risk areas where it is usually difficult and expensive to remediate using traditional techniques.

Remediation progress

The initial remediation concept comprises a combination of excavation, ISCO and MPE, as shown in the map.

Altogether 61 ISCO injection wells, 32 MPE wells and 5 drains were installed.

The civil works, including the excavation works at the heavily contaminated source area outside the tank farm and the installation works of the in-situ infrastructure in the whole target area, were carried out between October 2012 and March 2013. The in-situ installation is operational since April 2013.

The general progress of the remediation works is visualized in the figure. Areas in which the remediation works have been completed, are indicated in green; those where remediation is still in progress are shown in orange and the areas where the treatment still needs to be started are in red.

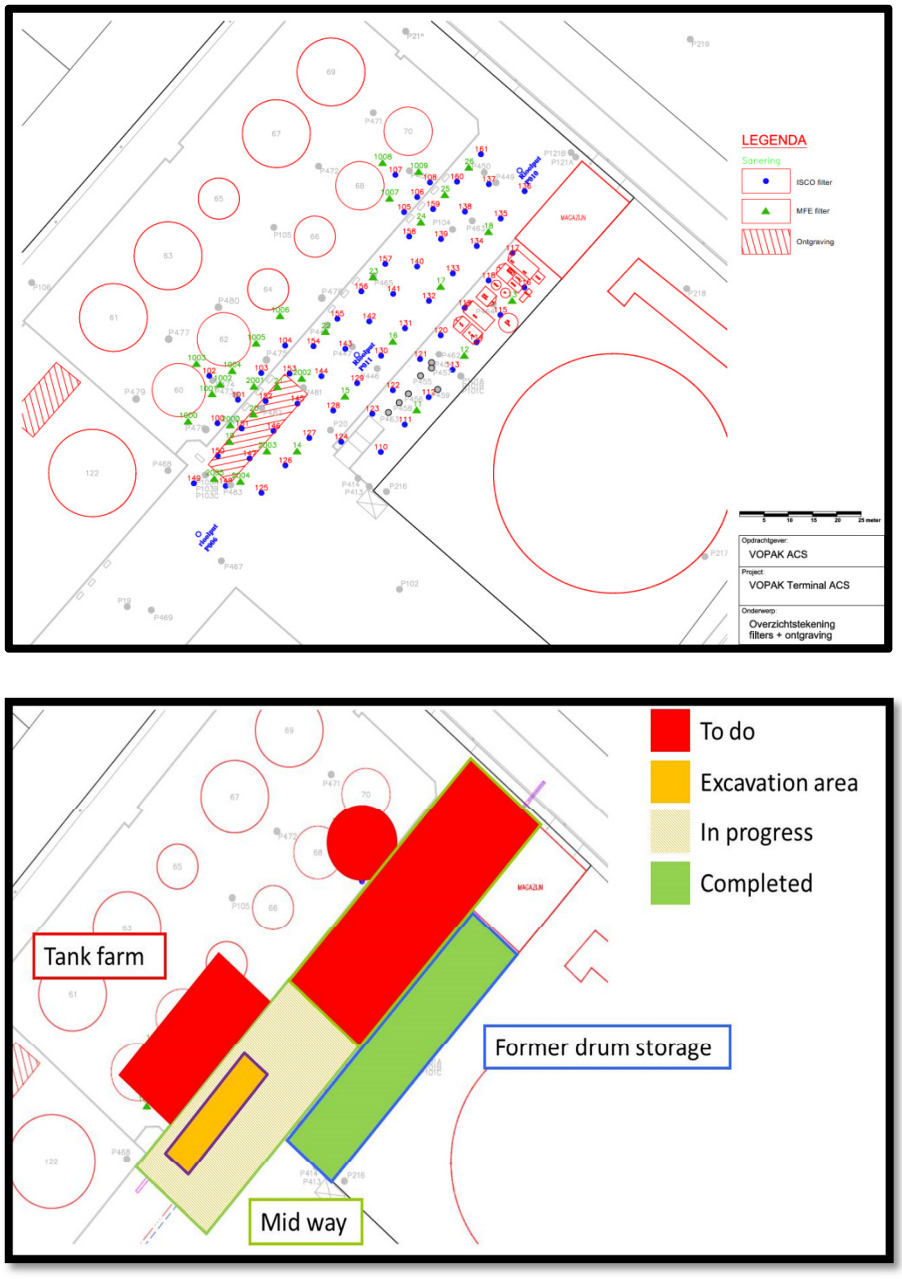


Figure 1. Remediation concept and overview of remediation progress

Former drum storage area

The in-situ remediation was started in April 2013. Initially, soil vapour was extracted from all drains, multiphase extraction (MPE) was activated in the area around the excavation pit and in the tank farm and perozone injections combined with soil vapour extraction (SVE) were started in the former drum storage area (alternating injections of 200 g/h of O_3 and 15 l/h of H_2O_2 (7%) in 5 clusters of 3 filters each).

In July 2013 the MPE was temporarily shut down owing to the fast saturation of the vapour phase activated carbon filters. Discussion with the local authorities resulted in the decision that no emissions towards the atmosphere were allowed. In order to reach this goal, either frequent active carbon renewals (4 m³ or more per week) or the use of an alternative air treatment technique would be necessary. Since this is not feasible without excessive costs, the project team decided to stop the MPE and to treat the source area directly with ISCO.

Meanwhile, the perozone injections and SVE remained operational in the former drum storage area.

During the in-situ remediation, regular monitoring of process parameters, field parameters and contamination levels was executed. The perozone treatment functioned flawlessly and no safety issues occurred. Ozone and PID measurements showed no elevated values near the surface, in the container and in the sewer system. No augmentations in groundwater level or temperature due to the injection of oxidantia were observed.

Since the start of the ISCO, a significant decrease of the contamination level was observed in the monitoring wells. The evolution of groundwater concentrations of the most important constituents in time is illustrated in the charts below.

The red lines indicate the remediation goals as defined in the remedial action plan. The blue lines are the groundwater concentrations in the different monitoring wells. The monitoring results show that for several parameters the remediation goals were already reached after 4 months. The final goals were reached in October 2013, about half a year after the start of the in-situ remediation. No emissions of ozone and/or VOC's and no subsidences have been detected during the perozone injections. There were no H&S-issues during the remediation of the drum area.

The ISCO and SVE in the former drum storage area were terminated in November 2013. Monitoring of the groundwater concentrations will be continued to ensure that the situation is stable.

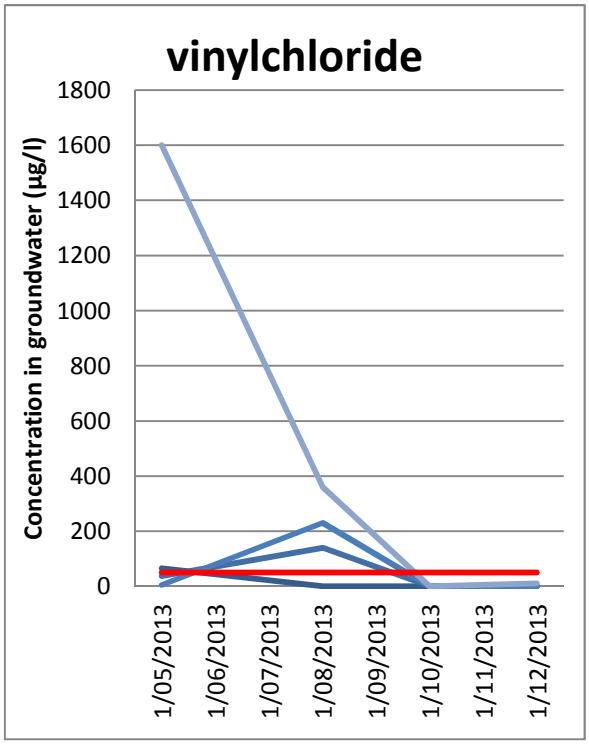
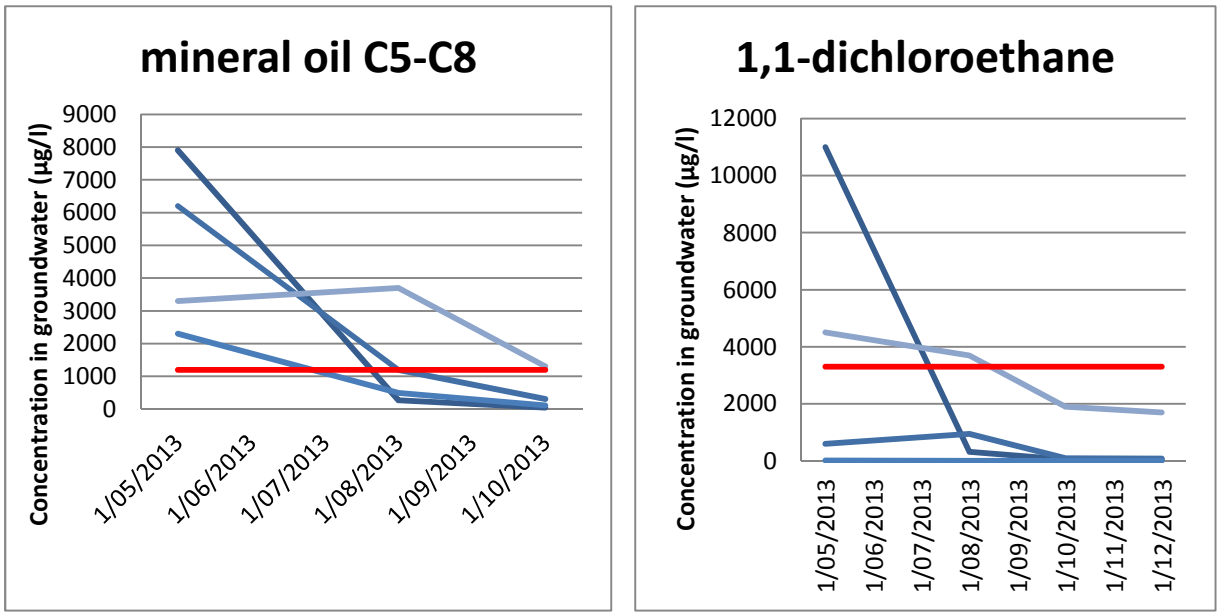


Figure 2. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in-situ remediation in the former drum storage area. The blue lines indicate the concentrations in the 4 monitoring wells. The red lines show the remediation goals.



Source area near the excavation zone

After the successful completion of the remediation works in the former drum storage area, ISCO combined with SVE was started in the source area near the excavation zone. The project team decided to test the injection of only ozone instead of perozone.

- The first motive for this test was the limited development of O_2 and high redox potential in the groundwater during the injections of perozone in the former drum storage area. This effect can most likely be explained by the formation of OH radicals. As these radicals react very quickly and non-selectively with all kinds of organic compounds, they can also convert the peat and humus in the soil to additional organic compounds consuming both ozone and oxygen, resulting in lower oxygen concentrations and redox potential.

- Furthermore, the capacity of hydrogen peroxide to desorb contaminants to become available for ISCO, offers little benefit while working in a source area where a significant amount of contaminants is already present in the groundwater phase. In such situations, the addition of hydrogen peroxide may have little added value.

The ozone injections in this area started in November 2013 (alternating injections of 200 g/h of O_3 in 5 clusters of 3 filters each).

The first groundwater monitoring results (December 2013 and January 2014) already show decreases of contaminant levels in most of the monitoring wells. Based on the encouraging results, the ozone injections combined with SVE will be continued. Nevertheless, given the high contamination levels in this area, a long-term remediation can still be expected before reaching the remediation goals.

In January 2014 an ozone odour was detected during periods of rainfall. Since the concrete cover has not yet been completely repaired after the installation of the in-situ infrastructure, the surface is no longer liquid tight. The saw lines and cracks make it possible for rain water to infiltrate. Because of the long period of rainfall, the groundwater level is very high and the SVE drains were found to be flooded and not working properly. Elevated PID-values were measured locally at the surface near the saw lines in the concrete. At a height of 10 cm above ground level and at breathing height, no values above the background value were measured.

Frequent ozone and VOC measurements were carried out in order to follow up the situation and take correcting measures. Elevated ozone concentrations near the surface and at breathing height were detected. Elevated concentrations of 1,1,1-trichloroethane and volatile TPH (total petroleum hydrocarbon) were observed in the fissures in the concrete (concentrations lower than MAC-values).

Due to these observations, the ISCO installation has been temporarily shut off. The renewal of the concrete floor has been initiated and is currently on-going. Once the new cover will be finished and again liquid tight (foreseen in May 2014), the ozone injections will be restarted. It is expected that the SVE will continue to work properly and no more emissions towards the atmosphere will occur.

Field tests to optimize injection regime

However, knowing that ISCO will be undertaken inside the tank farm (with corrosion sensitive storage tanks) in a later phase, it is important to determine an injection regime that prevents or limits ozone emissions into the unsaturated area of the soil. With the aim to determine this injection regime, field tests are currently on-going. These tests investigate the influence of the injection rate and the ozone concentrations in the injected air on the emitted ozone (and VOC) concentrations at the surface. The findings of the tests and the results of the ozone injections in the source area will be published in the next newsletter.

More information

More information can be found on the project website www.vopak-experO3.be.