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LIFE+ project Vopak ExperO3

Newsletter nr. 3 – July 2014

Abstract

At the Vopak terminal ACS a soil and groundwater contamination with chlorinated aliphatic hydrocarbons, BTEX and petroleum hydrocarbons is present. The contamination is being treated by means of in situ remediation using ISCO since April 2013. The first phase of the in situ remediation, regarding the former drum storage area, was successfully completed in November 2013. The second phase, focusing on the source area around the former excavation zone, is on-going since then. Due to emission issues, the remediation works were temporarily halted begin 2014. Field emission tests were carried out and, based on the results, optimal injection regimes that eliminate emissions were defined. Also, the liquid tight concrete cover was restored. The injections have been resumed in June 2014. At the same time, the treatment of the plume area in the midway was initiated.

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.

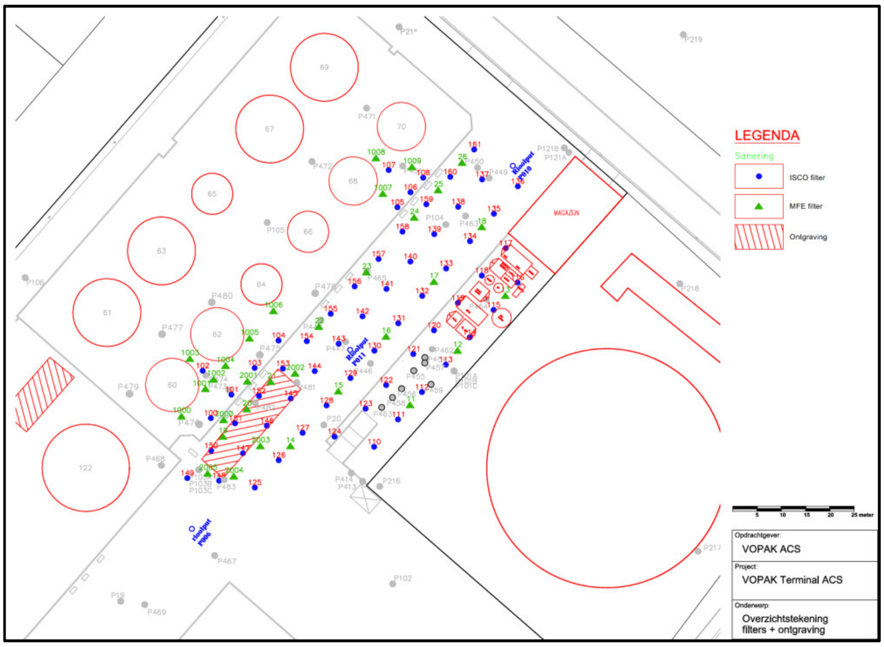
Remediation progress

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

Since the start of the in situ remediation works, some changes have been made to the original concept. As the MPE was shut down due to environmental permit issues, the contamination is now being treated by only ISCO combined with SVE.

In the source area around the excavation zone, a test phase is currently on-going, applying injections of only ozone instead of perozone. The goal is to investigate the effectiveness of ozone as sole oxidant in source areas where contaminants are readily available (one of the reasons to inject hydrogen peroxide is its desorption characteristics).

The general progress of the remediation works is visualized in figure 1. Areas in which the remediation works have been completed, are indicated in green; those where remediation is in progress are shown in yellow stripes and the areas where the treatment still needs to be started are in red.



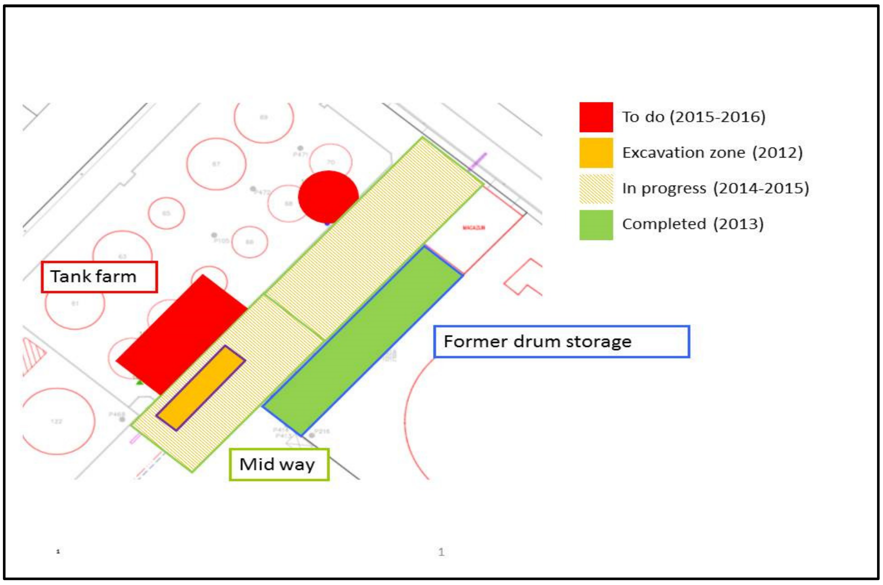


Figure 1. Remediation concept and overview of the remediation progress

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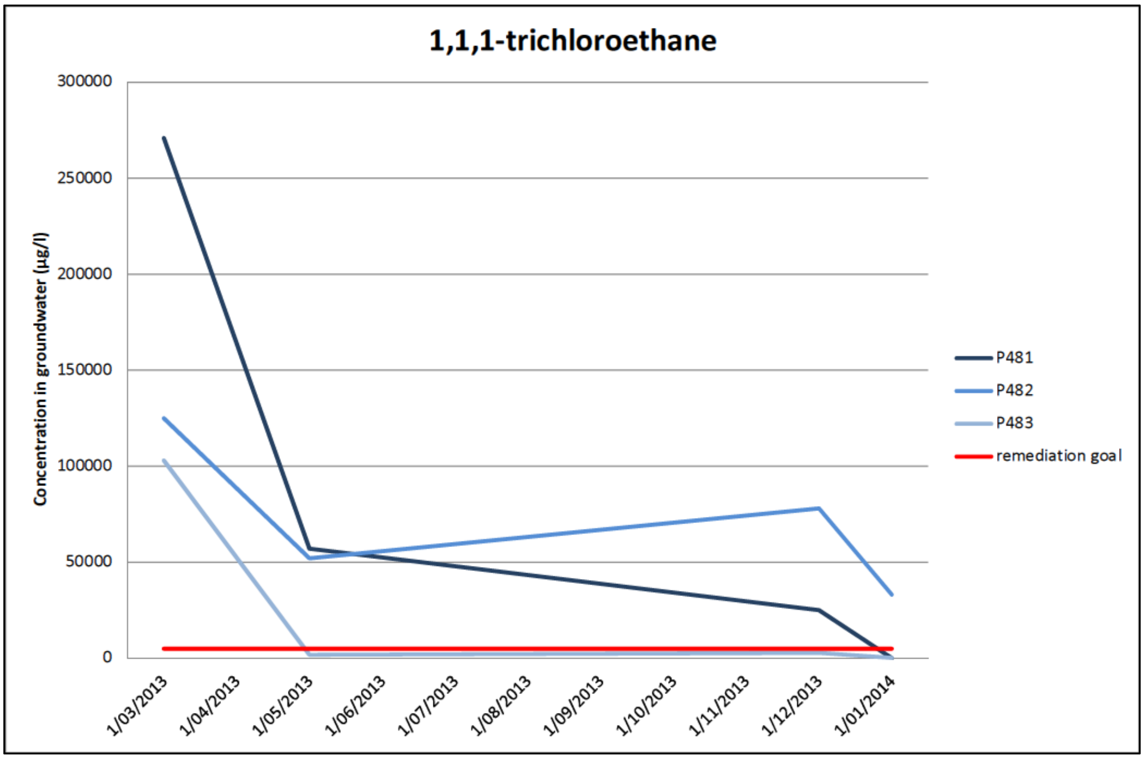
Source area "excavation zone"

The in-situ remediation using ISCO combined with SVE (soil vapour extraction) in the source area near the excavation zone was started in November 2013. Only ozone is being injected instead of perozone, in order to test the effectiveness of ozone as a sole oxidant in source areas with a high contamination load.

Monitoring results

The first groundwater monitoring results (December 2013 and January 2014) already showed decreases of contaminant levels in some of the monitoring wells. The evolution of groundwater concentrations of the most important contaminants 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.



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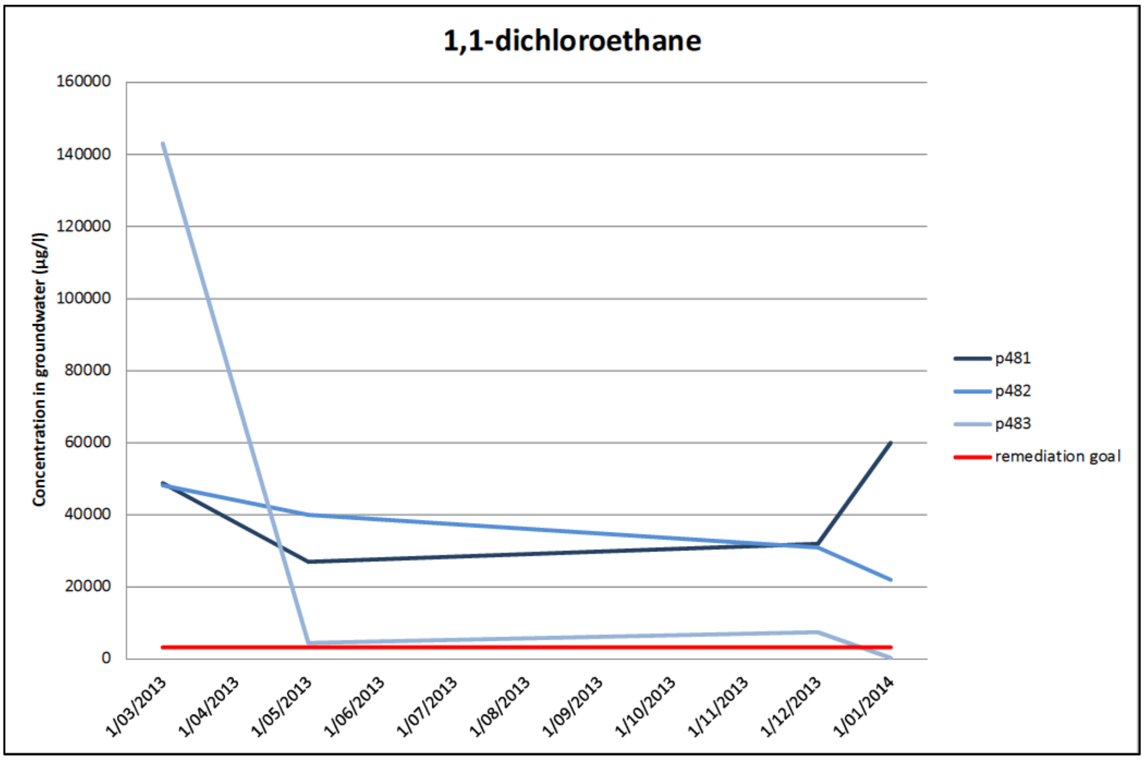

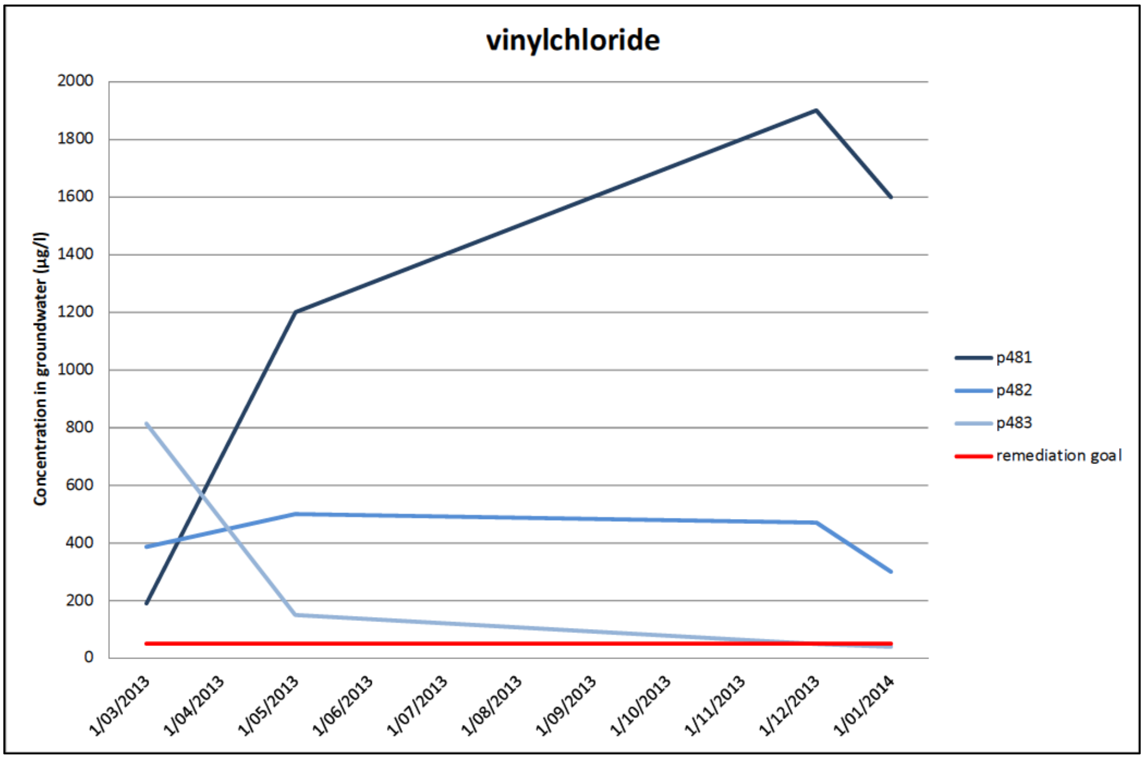

Figure 2. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in situ remediation in the source area around the excavation zone. The blue lines indicate the concentrations in the 3 monitoring wells. The red lines show the remediation goals.

The graphs show a distinct decrease of most of the contaminants. In all 3 monitoring wells a decrease for 111-TCA is observed and in 2 monitoring wells the concentration of 11-DCA also decreases. In P481 the concentration of vinylchloride increased significantly until December 2013, but a decrease was measured in January 2014. In P483 the remediation goals are already reached.

Despite the encouraging monitoring results, a long-term remediation can still be expected before reaching the remediation goals, given the high contaminant mass in this area.

Emissions

In January 2014, emissions of ozone and VOC have been observed during periods of heavy and continuous rainfall. Measurements showed ozone and VOC-concentrations of more than respectively 0,1 ppm (the odour threshold for ozone is about 0,02 ppm) and 300 ppm near fissures in the concrete floor. At breathing height, elevated ozone concentrations were only measured during intermittent and short periods. No VOC's were detected at breathing height.

The occurrence of emissions can be explained by 2 reasons. Since the concrete floor was not completely liquid tight, rainwater infiltrated in the soil and caused a local raise of the groundwater table to about 0,5 m-bgl (which in winter times normally is around 0,8 m-bgl). Due to the high groundwater table the SVE-drains were (partially) flooded and the SVE didn't work properly. The second reason is the disturbed character of the soil at the excavation area. The injected air, enriched with ozone and VOC (due to stripping) rises much faster than in undisturbed soils. Due to the shorter contact time between ozone and VOC's, not all ozone will react and both ozone and VOC's will be emitted.

The solution should tackle both causes: the concrete floor should be completely restored and injection regimes should be adapted to the different areas.

The concrete floor was restored between February and May 2014, as illustrated in the photos. During the renewal works, the injection wells and underground piping of the ISCO were thoroughly inspected. In total 7 injection wells were clogged by sand. These wells have been cleaned and tested again. The connection of one injection point with the ozone piping has been repaired.


Figure 3. Photos of renewed concrete cover in the midway area.

Moreover, 3 additional SVE drains were installed in order to guarantee better functioning of the SVE in the future and enable more accurate regulation of the SVE at the "hot spots". It is expected that no more emissions towards the atmosphere will occur. However this will be closely followed-up.

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Field emission tests

Field emission tests have been executed from February until April 2014 in order to determine an injection regime that prevents or limits ozone and VOC emissions into the unsaturated area of the soil. This is not only important from a H&S point of view (human health risk and risk for explosion/fire), but also from an efficacy point of view: the percentage of ozone used to oxidate the VOC's will be higher and the amount of VOC's, extracted via soil vapour, that needs to be adsorbed on granular active carbon will be lower. The 2 test areas were located in the midway: both the source area near the excavation zone (with a high contamination load and high concentrations) as the plume area near the entrance of the terminal (with lower VOC concentrations).

In each area a trapped test was undertaken, starting with a low injection rate and no ozone load. Step by step the ozone load was increased, first by increasing the ozone concentration in the injected air, then by increasing the air injection rate. Simultaneously, ozone and VOC measurements were carried out in the injection area. Finally, the most favorite injection regime (i.e. the one with the highest ozone load causing no ozone emissions and only limited VOC emissions) was applied in a long term test of 8 hours.

The tests show that each area requires a different injection regime in order to avoid emissions. The optimal regime for the source area near the excavation zone involves an injection rate of 4 m^3/h air and 45 g/h ozone, whereas for the plume area it is 6 m^3/h air and 100g/h ozone (as a comparison, the injection regime in the former drum storage area was 12 m^3/h air and 200 g/h ozone). The tests also show that lower injection times per injection well have a positive effect on the reduction of emissions. Therefore, it was decided to decrease the injection time from 10 minutes to 2 minutes.

Continuation

Taking into account the results of the field tests, the ozone injections combined with SVE have been resumed in June 2014 (alternating injections with a rate of 4 m^3/h and 46 g/h of O_3 in 5 clusters of 3 filters each). The first ozone and VOC measurements in the extracted air, the monitoring wells and the sewer showed no emissions. During the further remediation works, the safety and process parameters will be monitored on a regular basis.

Plume area midway

The in situ remediation using ISCO combined with SVE was initiated in the plume area near the entrance. The perozone injections started in June 2014 (alternating injections with a rate of 6 m^3/h and 100 g/h of O_3 and 7,2 l/h of H_2O_2 (7 %) in 8 clusters of 3 filters each). The first groundwater monitoring is scheduled in August 2014.

More information

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