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LIFE+ project Vopak ExperO3

Newsletter nr. 1 – August 2013

Project description

At the Vopak site a soil and groundwater contamination with chlorinated aliphatic hydrocarbons, BTEX and petroleum hydrocarbons is present. Given their different physical and chemical characteristics, remediation of multiple types of contaminants is very difficult. Using traditional remediation techniques, a succession of several techniques would be required, resulting in a time-consuming and expensive process.

In situ chemical oxidation (ISCO) 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 a gaseous oxidant with a high range of influence. It has the capability of oxidizing all types of organic contaminants.

The presence of strong oxidants however causes major issues with regard to health and safety on explosion sensitive (EX-rated) sites, so that the development of an extensive health and safety plan is needed to define the necessary safety measures during the remediation activities.

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 concept

A remedial action plan (RAP) has been drawn up and submitted to the local authorities (OVAM) in June 2011. The RAP has been approved in October 2011.

The remediation concept comprises a combination of ISCO, multi-phase extraction (MPE) and excavation.

In the areas without indications of pure product ISCO with perozone will be applied as stand-alone technology with MPE as fall back technology.

The area outside the tank farm with indications of pure product (source area) will be treated by excavation followed by ISCO. The excavation is foreseen until 2 m-bgl and the excavated soil will be dug out and transported to an off-site treatment centre.

The source area inside the tank farm will be treated first with MPE to decrease the very high concentrations to levels where ISCO becomes effective.

To eliminate potential emissions of VOC and/or ozone during ISCO, soil vapour extraction (SVE) is foreseen. Outside the tank farm drains at about 0,5 m-bgl will be used. Inside the tank farm the MPE-wells will be used to extract soil vapour during ISCO.

A map showing the remediation concept is shown at the back of this news letter.



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Remediation progress

An extensive H&S-plan has been written prior to the start of the remediation works. The H&S-plan takes into account all H&S-issues that are relevant for an operational industrial EX-rated site. The execution plan of the contractor Verhoeve Milieu en Water implemented all the measures that were needed to tackle the defined H&S-issues.

The most important measures during the civil works (installation of remediation infrastructure and excavation) comprise:

- Continuous measurement of VOC by an expert during the civil works;
- Wearing of respiratory protection when threshold limit values of VOC (primarily benzene and vinylchloride) or PID are exceeded;
- Maintenance of a dynamic and adjustable risk area around the work zone during the excavation works, depending on the measured VOC levels;
- Adaptation of the execution plan or interruption of the work when threshold limit values of VOC (primarily benzene and vinylchloride) or PID are exceeded in operational area's;
- No unauthorised or unnecessary access to the risk area during the excavation works;
- Access to the risk area only allowed when equipped with independent respiratory protection and accompanied by a stand-by safety guard;

The most important measures during the in-situ remediation are:

- Soil vapour extraction (SVE) to avoid emissions of ozone and VOC due to perozone injections;
- Regular measurements of ozone and VOC at the surface near the injection wells, around the remediation installation and in the sewer during perozone injections;
- Regular settlement measurements.

The preparatory works started in October 2012 with the installation of the injection (ISCO) and extraction (MPE) wells, the drain (SVE) and the piping. This work was carried out in phases in order to allow the terminal to remain fully operational.



Photo: Installation of injection and extraction wells



Photo: Installation of piping in grooves



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The heavily contaminated source area outside the tank farm was excavated in December 2012. To enable an excavation until 2 m-bgl, the groundwater table needed to be lowered. For this purpose temporary vertical wells were installed and the extraction and groundwater treatment unit was mobilised. This installation will also be used for the MPE and SVE. About 600 tons of contaminated soil was transported to an off-site treatment center. As the residual contamination around the excavation pit was still considerable, it was decided to install 6 extra MPE-wells around the pit to treat this contamination first with MPE.



Photo: Excavation works and risk zone perimeter

By February 2013 all wells, drains and piping were installed and tested and the concrete floor was temporarily repaired. The concrete will be permanently repaired after settlement of the backfill, which is foreseen in autumn 2013.

Altogether 61 ISCO injection wells, 32 MPE wells and 4 drains were installed. The final set-up of the in-situ remediation is shown on the map at the back of this document.

The perozone production and injection unit was mobilised in February 2013 and consists of 2 containers. In one of them, the “Oxymat”, oxygen is extracted out of ambient air. The other one contains 3 ozone generators, which produce ozone out of oxygen, and a dilution device to make a 7 % solution of hydrogen peroxide out of a 35 % solution.

The extraction and treatment unit comprises:

- An equalisation tank;
- An oil/water separator;
- A sand filter (sediment tank + clean water tank);
- A panel aerator;
- A liquid phase activated carbon adsorption vessel (2 m³);
- 2 vapor phase activated carbon adsorption vessels (2 x 2 m³);
- An effluent aqueous buffer.

Prior to the start of the in situ remediation the reference situation of the groundwater contamination was defined. Oxygen, ORP, pH, temperature, conductivity, groundwater level and VOC of concern were measured or analysed in several monitoring wells. In March 2013 several tests were carried out to check the well functioning of the SVE, MPE en ISCO systems and the PLC. During these tests a correct injection regime and a safe extraction regime were maintained (concentrations should be below 10 % LEL).



Photo: In-situ remediation unit

The in-situ installation is operational since April 2013. Soil vapour is extracted from the 4 drains, MPE is active in the area around the excavation pit and in the tank farm and perozone injections take place in the “drum storage area” (200 g/h of O₃ and 15 l/h of H₂O₂ (7%) is injected in 5 clusters).



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During the in-situ remediation the following parameters are monitored:

- Extracted vapour: PID, LEL, O₂ and periodically individual VOC and volatile petroleum hydrocarbons;
- Ambient air at the surface near the injection wells and in the sewers during perozone injections: PID, LEL, O₂ and O₃;
- In- and effluent water: VOC and volatile petroleum hydrocarbons.

The preliminary monitoring results show no unexpected values. The PID-values in the extracted vapour range from 30-60 (SVE) to 2000-5000 (MPE). Mostly chlorinated ethanes and volatile petroleum hydrocarbons are extracted. At the surface near the injection wells and in the sewers PID and LEL measurements show no high values and no elevated concentrations of O₃ are detected. So far there is no indication of any safety problems related to the ISCO.

In July 2013 the MPE was temporarily shut down owing to an insufficient reduction of the contamination levels in the vapour phase. The SVE and perozone injection remained operational. Before continuing the MPE, additional precautions towards the reduction of vapour emissions will have to be made and are currently being discussed with the authorities.

The first results of the effect of the perozone injections on the groundwater quality will be available in October 2013. If the monitoring results show that the concentrations are below the remediation targets, perozone injections in another area will be started. Otherwise the current injections will be continued.

More information

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

