CASE STUDY

LIFE+, LVM-BIOCELLS

Project background

Anaerobic dechlorination by soil organisms is a promising remediation technique for chlorinated aliphatic hydrocarbon (CAH) contamination if conditions are favourable or can be engineered to become favourable. Potential unfavourable conditions are the absence of suitable microorganisms in the contaminated subsoil or the lack of nutrients to maintain these bacteria. Every CAH parameter requires a different set of bacteria for its degradation into harmless products. Bacteria for the degradation of chloroethenes are commonly available. However, this is not the case for chloroethanes. The University of Ghent in Belgium has carried out research that isolated *Desulfitobacterium dichloroelimans* strain DCA-1. This unique bacterial strain can biodegrade 1,2-dichloroethane to ethene without the formation of toxic intermediates.

To be successful, in situ remediation techniques always require adequate groundwater velocities. If a subject site is characterised by very low velocities, its groundwater velocity has to be increased artificially to carry out bioremediation in situ. The University of Ghent has developed hydrogeobiocells (HGBcells) that increases the groundwater flow velocity by applying a specific pumping and injection programme, after which treatment of the contaminated groundwater is unnecessary.

Site description

A chemical facility produces, stores and distributes monovinylchloride, a raw material for the production of polyvinylchloride, one of the most important plastics of our time. Site activities started in 1972 with a first production line. The commissioning of the second production line in 1976 increased the production capacity.

The production site has an area of 147,000 m² but the operator also owns neighbouring land to the south and east.

Geohydrology

An aquifer reaching a depth of about 100 m with a thick dense clay layer at its base underlies the site. The first 10–15 m of the aquifer is characterised by sandstone lenses.

The subject site is at a groundwater divide that results in very low hydraulic gradients and, consequently, very low natural groundwater flow velocities. At the north of the site, shallow groundwater flows to the northwest whereas the shallow groundwater at the southeast border flows to the south. Locally, deep groundwater flows to the east, but the deep groundwater flows to the west at regional scale.

The groundwater depths range from 6 m below ground level on site to 4 m below ground level to the south.

Contaminants

Several soil and groundwater on-site investigations have revealed contamination by aromatic, aliphatic and chlorinated volatile organic hydrocarbons. An intermediate in the production of polyvinyl chloride, 1,2-dichloroethane, accounts for 80% of this. The sources of the contamination were traced to the tank farm and the former industrial wastewater sewer. At the source zone areas, groundwater concentrations may reach 300 mg/L or more.

The soil contamination in the unsaturated zone is limited to the source areas. Soil contamination in the saturated zone is anticipated to be present at the smear zone. The contaminated groundwater is estimated to have a volume 2,400,000 m³, and has already reached a depth of 60 m.

Remedial action plan (RAP) and EU LIFE+ funding

In anticipation of the site remediation required, laboratory tests have shown substrate injection to be a valid remediation option.

To use biostimulation or bioaugmentation as a remediation technique, groundwater flow velocities have to be increased artificially using groundwater extraction. However, this creates the need for an expensive groundwater treatment installation. Enhanced groundwater modelling techniques were used to develop a tailored treatment that uses HGBcells for the in situ treatment, which remove the need for an expensive groundwater treatment installation. EU LIFE+ funding has been requested and granted for that part of the remediation involving HGBcells. This funding required RSK to prepare an extensive submittal file.

In parallel with the LIFE+ funding file, RSK prepared the RAP, which was approved by the authorities in June 2010. The estimated cost of the remediation is €6.5 million spread over 30 years. The RAP offers a phased approach to the remediation in view of planning required and to spread the investment costs.

The following actions are part of the remediation:

- off-site groundwater remediation by stimulating biological degradation in groundwater cells consisting of extraction and injection filters (HGBcells)
- on-site pump and treat in source zones for lowering groundwater concentrations
- on-site remediation of unsaturated soil by dual-phase vacuum extraction in source zone areas
- on-site groundwater remediation by stimulating biological degradation in groundwater cells consisting of extraction and injection filters (HGBcells). Where necessary because of high contaminant concentrations, bacteria will be added to enhance the biodegradation.

First HGBcell in the field

RSK's goal is to translate theory into reality and apply this innovative technique in the field. To do this, on approval of the RAP in 2010, RSK drafted the technical specifications for the installation of the extraction and injection wells of the first HGBcell off-site. In January 2011, a pumping test was performed and then the HGBcell was installed.

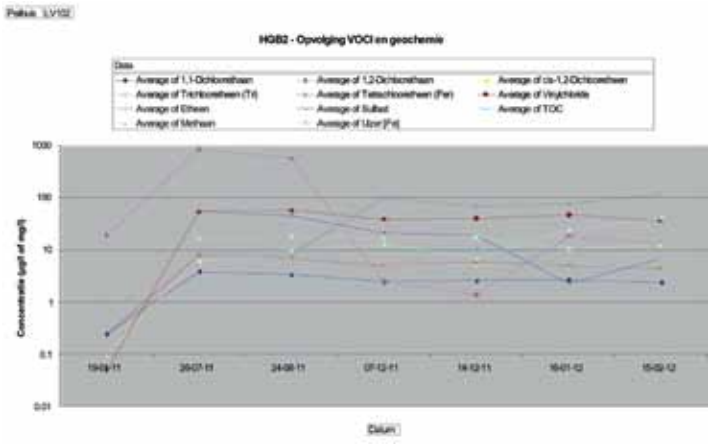
Start-up of the HGBcell showed that the normal development of the extraction and injection filters was inadequate to prevent pressure build-up in the injection well. Subsequent modification of the well made it possible to extract and inject 16 m³/h without pressure build-up in the injection well.

After several tests, the first operational phase of the HGBcell started in October 2011 with sodium lactate dosing. In the following months, RSK was able to show that the HGBcell was becoming active and that 1,2-dichloroethane biodegradation was occurring.

LIFE+ funding

The European Commission has recognised this innovative technology and will fund 50% of the costs of the remedial works for five years through the LIFE+ programme. Funding began in 2010 and will continue until December 2014.

Performing a pumping test at the location of the first HGBcell.



Decreasing 1,2-dichloroethane levels in the monitoring well prove biodegradation in the HGBcell

Installation of the first HGBcell

For further information, please contact:

RSK: Businesspark Rivium, Antwerpsesteenweg 45, 2830 Willebroek, Belgium
Tel: +32 3 451 93 00 · Contact: Lars VanPassel · Email: lvanpassel@rsk.co.uk