# *In situ remediation of contaminated groundwater at an industrial production site of monovinylchloride (MVC)*

**Multidechlorobac**, a highly active bacterial culture, is applied for the remediation of a site at Tessenderlo (Belgium), contaminated with chlorinated ethenes and ethanes. This safe and validated culture was developed by Avecom and the University of Ghent (Belgium). On the site in Tessenderlo, monovinylchloride (MVC) is produced out of 1,2-dichloroethane (1,2-DCA). The full scale application of Multidechlorobac fits in the Life + project LVM-BIOcells (http://biocells.merchanttech.co.uk).

## *Problem*

On the site of concern, the groundwater is contaminated with chlorinated compounds, with 1,2-dichloroethane as the main pollutant. The contamination is predominantly situated between 10 and 20 m-bgl. Lower concentrations of the chlorinated compounds were detected up to 50 m-bgl. As a result of the very low groundwater flow, the contamination is mainly spread on the site itself. The slow distribution rate of the contamination also allowed the company to investigate in detail the most appropriate remediation technique.

## *Solution*

Many xenobiotic compounds can be degraded by bacteria. In the soil of the site at Tessenderlo, bacteria that can degrade 1,2-DCA as well as chlorinated ethenes under anaerobic conditions were found. For the 1,2-DCA degradation, a unique bacterium *(Desulfitobacterium dichloroeliminans* strain DCA1*)* was isolated, that can remove two chloro-atoms simultaneously without the accumulation of toxic intermediates like MVC. Avecom and the University of Ghent (Laboratory of Microbial Ecology and Technology) succeeded to strengthen these dechlorinating bacteria in an organized culture suited for degrading high concentrations (ppm level) and mixtures of chlorinated compounds.

The chlorinated compounds are dechlorinated completely to ethene, without the accumulation of toxic intermediates. **Multidechlorobac** is a diverse and robust dechlorinating culture. It consists of both dechlorinating bacteria and supportive fermenting micro-organisms.

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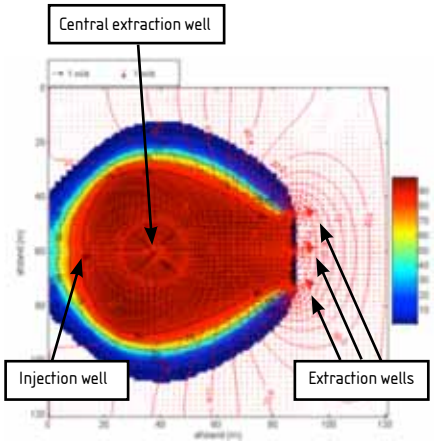
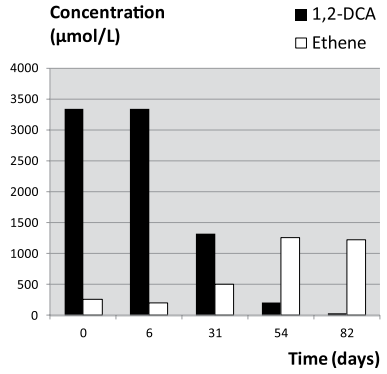
## How to distribute the bacteria?

At the site in Tessenderlo, groundwater flow velocities are very low. Intensive modelling resulted in an optimized configuration of injection and extraction wells, called the hydrogeobiocell (Groundwater modelling, Department of Geology and Soil Science, University of Ghent, Belgium) in order to create a significant groundwater flow. The figure (top right) illustrates the distribution of the bacteria realized by the artificial groundwater flow. The red color indicates high concentrations of bacteria and nutrients, whereas the blue color points at low concentrations. After sufficient recirculation and activation of the bacteria, decontaminated water can be pumped out of the central extraction well.



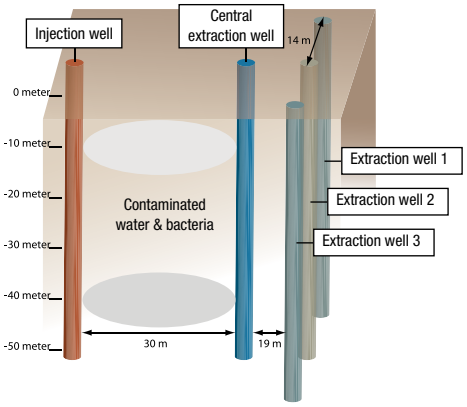

## Field validation

Various pilot tests showed effective degradation of chlorinated compounds by Multidechlorobac under field conditions. Successful degradation of the pollutants was observed in a reasonable timespan (e.g. 3000 µmol 1,2-DCA/L in 50 days).




## The real work

Several hydrogeobiocells are being constructed for the full scale remediation of the site in Tessenderlo. Bacteria and nutrients will be dosed via the injection well and spread by recirculation of the groundwater. As a result, an active bacterial cloud is created in the subsoil. This bioaugmentation technique offers a cost-efficient and sustainable remediation strategy.





Scientific publications on *Desulfitobacterium dichloroeliminans* strain DCA1:

De Wildeman et al., 2003. Stereoselective microbial dehalorespiration with vicinal dichlorinated alkanes. Applied and Environmental Microbiology 69, 5643-5647.

De Wildeman et al., 2004. Complete lab-scale detoxification of groundwater containing 1,2-dichloroethane. Applied Microbiology and Biotechnology 63, 609-612.

Maes et al., 2006. Transport and activity of *Desulfitobacterium dichloroeliminans* strain DCA1 during bioaugmentation of 1,2-DCA-contaminated groundwater. Environmental Science and Technology 40, 5544-5552.

Van Raemdonck et al., 2006. Real time PCR quantification in groundwater of the dehalorespiring *Desulfitobacterium dichloroeliminans* strain DCA1. Journal of Microbiological Methods 67, 294-303.