

Enhanced reductive dichlorination (ERD) of chlorinated aliphatic hydrocarbons (CAHs)



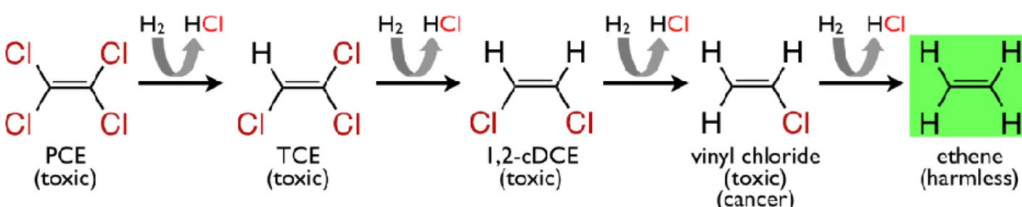
Context

Under the underground parking lot of a residential building in the city centre of Brussels (Belgium), a soil and groundwater pollution with chlorinated aliphatic hydrocarbons (CAHs) was present in relatively high concentrations. Previously, the building was used as laboratory and the pollution was caused by the improper use and disposal of solvents, used as extraction liquid. The original compound was mainly tetrachloroethylene (PCE), which showed some incomplete natural biodegradation to trichloroethylene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). The latter two causing a potential exposure risk via the indoor air of the underground parking lot. The main challenges on this project were the accessibility of the treatment zone under an underground parking lot, which was only accessible by a car elevator, and the low permeability geology on the site which consisted of an alteration of silty and clayey layers with presence of peat lenses. Injectis intervened to advise on the degradation reaction and the products to be injected to find the best possible treatment with the best cost/benefit/duration ratio. As reductive dechlorination, although incomplete, was taking place under natural conditions, enhanced reductive dechlorination of PCE, TCE, cis-1,2-DCE and VC to ethene was selected as the most suitable degradation mechanism.



Reaction and reagents

Due to the presence of high amounts of natural organic matter (peat), the aquifer and the saturated soil were already in anaerobic conditions. As a result, natural degradation was observed, but cis-1,2-DCE and VC accumulated. The lack of a suitable and readily available/degradable carbon source seemed to be the limiting factor in this particular case. To stimulate this naturally occurring process, a combination of a rapid starter carbon source (Brenntapplus VPI) and a slow release carbon sources (3DMe) was chosen. The easily available carbon source results in a fast grow of the microbial biomass and achieves strong reducing conditions (methanogenic conditions) on the short term (approx. 12 months). The slow release carbon source injected as an oil-in-water emulsion, gradually releases fatty acids over a period of 4 – 5 years and stimulates the further reductive dechlorination.



Geology

The Zenne Valley in Brussels is a geological tapestry woven with layers of silt, clay, and peat, interspersed with deposits of sand and sandstone. These formations narrate the region's ancient history, tracing back millions of years. The name "Brussels" likely originates from the Old Dutch "bruocsella" meaning "settlement in the marsh" a nod to the area's marshy past. Beneath the bustling city lie remnants of ancient seas and wetlands, shaped by geological forces over millennia.

The heterogeneous and mainly low permeability subsoil at this site, in combination with the shallow aquifer, forms a real challenge for the injection and distribution of the reagents. To prevent daylighting of the reagents, a low injection pressure should be used. The finer soil textures make them sensitive to compaction and might easily result in significantly reduced permeability at the injection point when using a displacement drilling method. Therefore, the SPIN® Injection Technology was selected to inject at low pressure in the shallow, low permeability aquifer.



Accessibility

Another challenge on this site was the limited accessibility, namely the presence of the pollution underneath an underground parking lot. The source and plume zone were only accessible via a car elevator with a maximum height of 2,0 m. For these conditions, Injectis has developed the Micro-SPIN® injection rig. This rig has an overall driving height of 1,95 m and a width of 78 cm, which makes the rig fit through a normal door opening, or in this case the car elevator.

Location:	Brussels, Belgium
Geology:	heterogeneous (silt, clay, peat)
Pollutant(s):	PCE (31.000 µg/l), TCE (1.800 µg/l), cis-1,2-DCE (41.000 µg/l), VC (75 µg/l)
Reaction:	Reductive dechlorination
Reagent(s):	Mixture of carbon sources (Brenntapplus VPI, 3DMe)
Application type:	Grid application
Surface/length:	200 m ²
Number of points:	20
Depth interval:	1,0 – 7,0 m-basement
Dosage:	50 l/m

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