Innovative aspects of the project

In this project we will demonstrate the use of an innovative remediation technology (ISCO with perozone) under very specific circumstances (an EX-rated plant in operation).

1. Innovative remediation technology (ISCO with perozone)
In situ chemical oxidation (isco) requires injection of an oxidizing chemical (oxidant) into the subsurface. The oxidant chemically breaks down the organic contaminants to inert compounds such as carbon dioxide, chloride, and water. This technology also provides an innovative tool for treating non-aqueous phase liquids (NAPL), which are difficult to treat using conventional technologies.

The ISCO remediation technique is often discussed at conferences and seminars. It has also been used on the pilot-scale level with various types of oxidants. However, there is little experience in Europe with this technique in full-scale remediation projects. There is some experience with ISCO in the US, but this experience is largely limited to small sites where one type of contaminant is present and using other types of oxidants. The US Environmental Protection Agency (EPA) has developed a website to summarize timely information about completed and ongoing applications of in situ chemical oxidation technologies. At the time of this proposal, 74 projects were posted on the website. An overview of the type of oxidants used in these projects is presented below.

Oxidant	Number of sites
Fentons	19
Hydrogon peroxide	13
Ozone	10
Permanganate	29
Persulfate	3

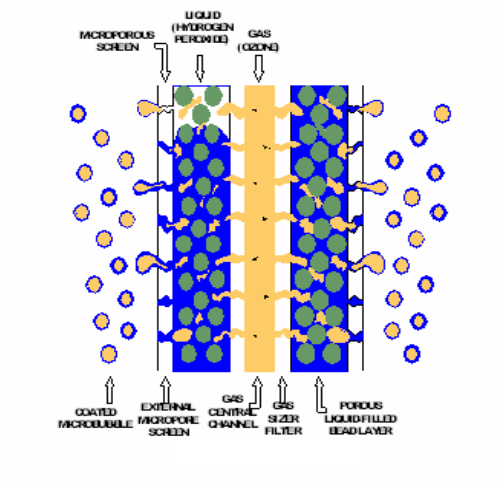
None of the projects on the EPA website used perozone as an oxidant during the remediation process. This emphasizes that very little information and experience is available in the US and Europe on the use of ISCO with perozone.

Perozone is created by coating nano-sized to micro-sized bubbles of air-encapsulated ozone with a liquid oxidant (hydrogen peroxide). The chemical equation for this coating is presented below. In this reaction, free OH radicals are formed, which creates a high oxidation potential. As a result of this high oxidation potential, different types of contaminants can be treated with perozone. In addition, oxygen is released during the reaction, which enhances biological aerobic degradation.

$2O_3 + H_2O_2 \longrightarrow 2OH^{\cdot} + 3O_2$

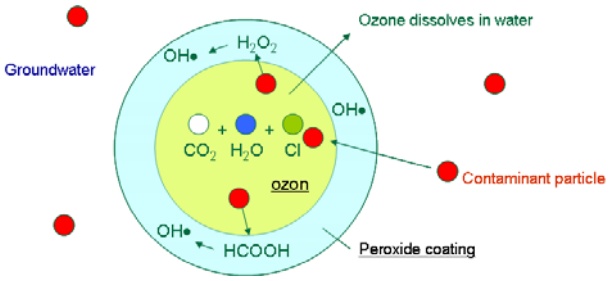
The perozone is injected into the soil using injection filters composed of two compartments: an inner and an outer tube. Liquid hydrogen peroxide is present in the outer tube. Ozone is injected into the inner tube and the pressure causes the ozone to be pushed through the outer tube, coating the ozone bubbles with the hydrogen peroxide. This process is illustrated in the figure below.

Figure: Formation of coated microbubbles



The reaction of ozone with the contamination forms hydroperoxides, which in turn creates additional OH radicals. This double formation of OH radicals ensures a very high oxidation capacity.

The interaction of the coated microbubble with the contaminant is portrayed in the figure below.



2. Very specific circumstances (an EX-rated plant in operation)
ISCO is a remediation technique in which a highly reactive oxidant is injected into the soil. This oxidant reacts with the contamination present, causing a temperature rise in the soil and releasing oxygen, water, and carbon dioxide. It is clear that ISCO should be performed in a highly controlled manner to avoid incidents.

Chemical plants often have multiple-parameter soil and groundwater contaminations, which makes them particularly suitable for using ISCO as a remediation technique. However, the nature of chemical plants combined with the presence of highly reactive oxidants and increases in soil temperature mean that remediation using ISCO may cause serious safety issues. Because of this, there is great skepticism within the industry on the use of ISCO at chemical plants.

In this project, methods and safety measures for using ISCO at explosion-sensitive sites will be developed. The objective of the project is to demonstrate that with the appropriate safety measures, ISCO can be safely used at explosion-sensitive sites. The methods developed in this project can easily be transferred to other contaminated sites.

- In Flanders, the soil and groundwater sampling programme for remediation projects is regulated by procedures developed by the Flemish authority OVAM. OVAM has imposed these procedures to assure a minimum quality for sampling of remediation projects. We will follow these OVAM procedures during the remediation process and the LIFE project. These procedures are recorded in an extensive document of approximately 1000 pages. Because of its size this document will not be appended to this proposal; please consult the website www.emis.vito.be (www.emis.vito.be/compendium-voor-monsterneming-en-analyse-cma-uitvoering-van-het-afvalstoffendecreet-en-het-bodemsan-4) for these procedures.

- We will also contact VITO for advice on the level of sampling required to obtain statistically and scientifically sound results. VITO is a high-level Flemish research institute that often writes articles for international scientific journals. They are therefore well-placed to provide advice on how we should carry out soil and groundwater sampling to meet scientific standards and the requirements of international publications. As this action will be taken once the project begins, we cannot provide the VITO sampling procedures at this time.