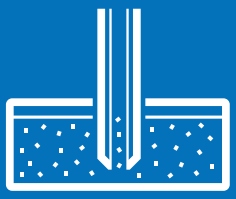
IN SITU CHEMICAL OXIDATION

Technology for Remediation of Contaminated Sites



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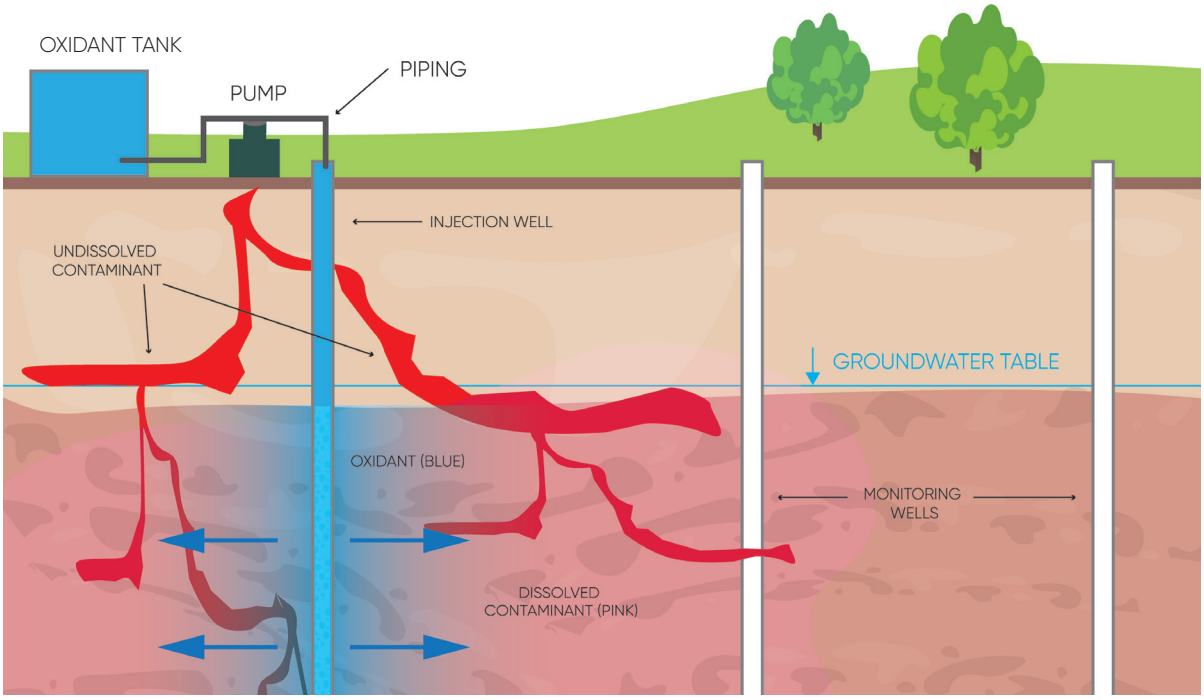
PRINCIPLE

In situ chemical oxidation (ISCO) uses oxidants (chemicals capable of oxidising other chemicals) to oxidise harmful contaminants in place where they are present (*in situ*) without a need of pumping or excavation of the contaminated matrices. In principle, all contaminants that can be oxidised to less toxic or even non-hazardous products can be treated by ISCO. Under ideal conditions, final products of the oxidation of the contaminants are carbon dioxide, water and dissolved ions. ISCO is commonly used to treat organic contaminants like fuels, solvents, and pesticides, present in groundwater in high concentrations. Such conditions are typical in the so-called source areas where contaminants have been released originally. ISCO is commonly combined with other remediation technologies, like pump-and-treat or bioremediation.



DESCRIPTION

Direct contact between the oxidant and the contaminant is crucial in order to achieve the contaminant oxidation. Therefore, the main issue of the ISCO remediation is to ensure proper distribution of the oxidants in the contaminated matrices. In order to treat contaminated soils and groundwater *in situ*, the oxidants need to be injected into the contaminated zones of the aquifer. This can be achieved primarily by direct-push application, via permanent application wells, and, in some cases, also by application to drainage systems or by soil mixing. Once the oxidant is applied into the groundwater, it spreads into the surrounding soil and groundwater where it mixes and reacts with the contaminants.

The injected oxidants react also with other materials present underground. Such reactions represent a loss of the oxidant that cannot react with the contaminants. In some cases, usually in the case of sites with high natural organic matter content, this phenomenon can render ISCO ineffective.
The oxidants most often used for ISCO are persulfate, hydrogen peroxide and compounds capable of releasing it, and permanganate. The first two oxidants are typically activated *in situ* either by catalysts or other activation methods. Such activation leads to formation of radicals which increase the speed of the chemical reaction. Combinations of different oxidants can also be advantageous.

APPLICATIONS

ISCO is usually used to remediate a source area, where it destroys the bulk of contaminants *in situ* without a need for excavation or pumping. It can be utilised for a variety of organic contaminants present both in industrial sites, old dump sites, around pipelines, etc. Chemical oxidation can be utilised also for *ex situ* treatment of soil.

Main advantages of the technology:

- Cost-effective compared to other source zone treatment technologies
- Relatively easy application and maintenance
- Possibility of combination with other treatment methods
- Relatively quick

Potential limitations

- Inappropriate in sites with high natural organic matter content
- Changes in groundwater quality (altered pH, increased salinity)
- Oxidants are hazardous materials
- Low permeability of the saturated zone may negatively affect the method efficiency

REFERENCES

COMMERCIAL REMEDIATION PROJECT - BŘEZINKA

ISCO combining persulfate and calcium peroxide direct push injections was utilized to treat the groundwater beneath an old unmanaged landfill contaminated by a mixture of chlorinated hydrocarbons (mainly 1,2-dichloroethane and chloroform) and BTEX (mainly benzene and toluene). First of all, the old landfill was excavated to the groundwater level. 3D model of the contamination beneath the landfill was developed based on a detailed direct sensing investigation using the Membrane Interphase Probe (MIP Geoprobe). Based on the model, targeted direct push injections of persulfate and calcium peroxide mixture were performed. This mixture provided a strong oxidant for ISCO of the present contaminants, and it also released oxygen for further aerobic bioremediation of the solvents in the contamination plume.

Direct push injection of the persulfate/calcium peroxide mixture

Preparation of the persulfate/calcium peroxide suspension

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