IN SITU CHEMICAL OXIDATION (ISCO) BY USING SODIUM PERSULFATE

PRINCIPLE

The remedial method of in situ chemical oxidation (ISCO) is generally based on a principle of redox reaction, where the oxidizing agent is reduced and the contaminant is oxidized.

Oxidation process leads to the destruction of the contaminant, or its conversion into harmless or less toxic compounds. Among the oxidizing agents, which are commonly used in remediation, hydrogen peroxide, Fenton's reagent, potassium or sodium permanganate, and ozone can be included. Recently we can include in this group of chemicals also sodium persulfate, which is increasingly applied as a chemical oxidation reagent.

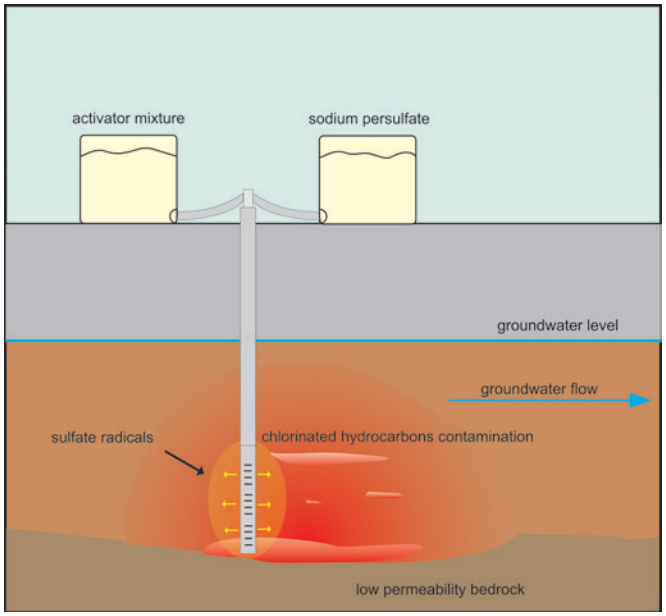
TECHNOLOGY APPLICABILITY

Sodium persulfate ($Na_2S_2O_8$) is a relatively new type of oxidizing agent, characterized by good efficiency, even at sites contaminated by persistent organic pollutants. The failure of conventional oxidizing agents or their use inappropriately for technical reasons on these sites is typical.

The active component is persulfate anion ($S_2O_8^{2-}$) and the oxidation potential can be further increased due to appropriate activation for generation of radicals ($\bullet SO_4^{2-}$). The activation can be performed in four ways: by addition of chelated Fe, the addition of H_2O_2, heating to 40 °C, or by adjusting the pH to the alkaline conditions.

DESCRIPTION

Technological system consists of the activator and oxidizing agent storage tanks (sodium persulfate, Fe^{2+} solution), pumps, injection wells, monitoring wells and instruments for measuring and controlling the process.



Activated persulfate application scheme

Main advantages of the technology

- Better stability and better migration parameters compared to hydroxyl radicals.
- Strong oxidation reagent without a number of application and operating limitations of conventional oxidizing agents (colouring groundwater with potassium permanganate, higher demands for safety during application of hydrogen peroxide or Fenton's reagent etc.)
- Does not react with organic soil components (lower consumption compared to permanganate)

Potential limitations

- The decrease of pH values in the case of insufficient buffering capacity of the geological environment
- Inappropriate in the environment containing large amount of bounded toxic metals (possibility of their unwanted mobilization) - however, this restriction applies all oxidation methods
- The correct choice of the activation method is important (if inappropriate method is chosen, a partial inhibition of the oxidation agents may occur)
- Poor efficiency at the sites with low permeability of geological environment

Services and products

- Investigation of contaminated sites with respect to subsequent ISCO application
- Laboratory and half-scale tests for verifying the ISCO method applicability, including the suggested oxidizing agent and its estimated consumption
- ISCO remediation project design and approval, including application procedures of sodium persulfate, and its activation method
- Installation and operation of the remediation system and equipment for the application of the ISCO using sodium persulfate
- Supply and application (injection) of an oxidizing agent
- Monitoring and supervision of ISCO remediation projects

Data for ISCO system design

- Type, extent and level of contamination
- Required target limits of remediation
- Geological and hydrogeological conditions at the site
- Facilities and installations at the site (buildings, utilities etc.)
- Production, operational and other restrictions resulting from the nature of the site

Application mixture preparation

Pilot test of persulfate application within the area of OZT – Toužim

REFERENCE PROJECT

The demonstration project of sodium persulfate application to remediate the site contaminated by chlorinated hydrocarbons was implemented within the area of OZT – Toužim, the Czech Republic. Within the area of this plant, in the past trichloroethene and tetrachloroethane were used for degreasing. This leads to contamination of the unsaturated zone and groundwater by these substances.

The concentration in groundwater was up to hundreds of mg per litre. The main hydrogeological collector was bound on quaternary sediments, formed mainly by illuvial or deluvial sandy clay loams. These sediments gradually passed into weathered eluvium; the coefficient of filtration was of the order of 10^{-6} m/s.

Application of sodium persulfate was conducted in two phases. Within the project we have verified different ways of activating sodium persulfate, which is necessary when sites contaminated with recalcitrant contaminants are treated. The monitoring showed that even half a year from the persulfate application, the same low levels of the chlorinated hydrocarbon concentration remained at the same low level, which meant a 90% reduction compared to the initial state.

DEKONTA, a.s.
Dretovice 109, 273 42 Stehelceves
Czech Republic

Phone: + 420 312 292 960 / + 420 235 522 252
Fax: + 420 235 522 254
info@dekonta.cz / www.dekonta.com

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