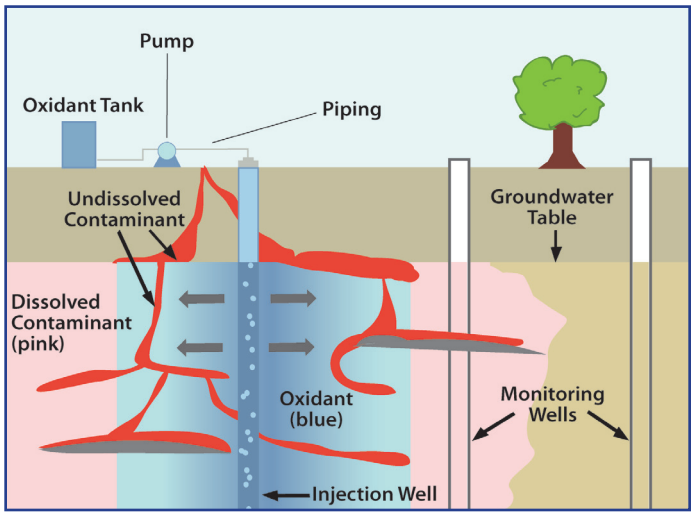
A Citizen's Guide to In Situ Chemical Oxidation

What Is In Situ Chemical Oxidation?

Chemical oxidation uses chemicals called "oxidants" to help change harmful contaminants into less toxic ones. It is commonly described as "in situ" because it is conducted in place, without having to excavate soil or pump out groundwater for aboveground cleanup. In situ chemical oxidation, or "ISCO," can be used to treat many types of contaminants like fuels, solvents, and pesticides. ISCO is usually used to treat soil and groundwater contamination in the source area where contaminants were originally released. The source area may contain contaminants that have not yet dissolved into groundwater. Following ISCO, other cleanup methods, such as pump and treat or monitored natural attenuation, are often used to clean up the smaller amounts of contaminants left behind. (See *A Citizen's Guide to Pump and Treat* [EPA 542-F-12-017] and *A Citizen's Guide to Monitored Natural Attenuation* [EPA 542-F-12-014].)

How Does It Work?

When oxidants are added to contaminated soil and groundwater, a chemical reaction occurs that destroys contaminants and produces harmless byproducts. To treat soil and groundwater in situ, the oxidants are typically injected underground by pumping them into wells. The wells are installed at different depths in the source area to reach as much dissolved and undissolved contamination as possible. Once the oxidant is pumped down the wells, it spreads into the surrounding soil and groundwater where it mixes and reacts with contaminants.



To improve mixing, the groundwater and oxidants may be recirculated between wells. This involves pumping oxidants down one well and then pumping the groundwater mixed with oxidants out another well. After the mixture is pumped out, more oxidant is added, and it is pumped back (recirculated) down the first well. Recirculation helps treat a larger area faster. Another option is to inject and mix oxidants using mechanical augers or excavation equipment. This may be particularly helpful for clay soil.

The four major oxidants used for ISCO are permanganate, persulfate, hydrogen peroxide and ozone. The first three oxidants are typically injected as liquids. Although ozone is a strong oxidant, it is a gas, which can be more difficult to use. As a result, it is used less often.

Catalysts are sometimes used with certain oxidants. A catalyst is a substance that increases the speed of a chemical reaction. For instance, if hydrogen peroxide is added with an iron catalyst, the mixture becomes more reactive and destroys more contaminants than hydrogen peroxide alone.

Following treatment, if contaminant concentrations begin to climb back up or "rebound," a second or third injection may be needed. Concentrations will rebound if the injected oxidants did not reach all of the contamination, or if the oxidant is used up before all the contamination is treated. It may take several weeks to months for the contamination to reach monitoring wells and to determine if rebound is occurring.

ISCO may produce enough heat underground to cause the contaminants in soil and groundwater to evaporate and rise to the ground surface. Controlling the amount of oxidant helps avoid excessive heat, and if significant gases are produced, they can be captured and treated.

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How Long Will It Take?

ISCO works relatively quickly to clean up a source area. Cleanup may take a few months or years, rather than several years or decades. The actual cleanup time depends on several factors that vary site to site. For example, ISCO will take longer where:

- The source area is large.
- Contaminants are trapped in hard-to-reach areas like fractures or clay.
- The soil or rock does not allow the oxidant to spread quickly and evenly.
- Groundwater flow is slow.
- The oxidant does not last long underground.

Is ISCO Safe?

The use of ISCO poses little risk to the surrounding community. Workers wear protective clothing when handling oxidants, and when handled properly, these chemicals are not harmful to the environment or people. Because contaminated soil and groundwater are cleaned up underground, ISCO does not expose workers or others at the site to contamination. Workers test soil and groundwater regularly to make sure ISCO is working.

How Might It Affect Me?

Nearby residents and businesses may see drilling rigs and tanker trucks with oxidants and supplies as they are driven to the site. Residents may also hear the operation of drilling rigs, pumps, and other equipment leading up to and during the injection period. Following an injection, however, the cleanup process occurs underground with little aboveground disruption. Workers may visit the site to collect soil and groundwater samples to monitor cleanup progress.

Why Use ISCO?

ISCO is usually selected to clean up a source area, where it destroys the bulk of contaminants in situ without having to dig up soil or pump out groundwater for aboveground treatment. This can save time and money. ISCO has successfully cleaned up many contaminated sites and has been selected or is being used at around 40 Superfund sites and many other sites across the country.

ISCO system installed behind a small drycleaning facility.

Example

Groundwater near a former wastewater treatment plant at the Naval Air Station Pensacola in Florida was contaminated with solvents and acids from painting and electroplating. A groundwater pump and treat system had operated for more than 10 years to control migration of contaminated groundwater. However, it did not do much to lower the concentrations of contaminants. ISCO using hydrogen peroxide with an iron catalyst was chosen to reduce contaminant concentrations in the source area enough to allow monitored natural attenuation to complete the cleanup.

The natural chemistry of the site's groundwater was found to limit the effectiveness of the first phase of injections. In the second phase, a chemical was added to the reagent mix to stabilize the oxidant mixture. Contaminant levels fell substantially. The successful use of ISCO at this site was estimated to save several million dollars compared with continued pump and treat.

For More Information

For more information about this and other technologies in the Citizen's Guide Series, visit:

www.cluin.org/remediation
www.cluin.org/products/citguide
www.cluin.org/chemox

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