

ART LOWPERMA IN-WELL TECHNOLOGY

The newly developed and patented LowPerma In-Well Technology is designed to treat soil and groundwater contamination associated with VOCs, semi-VOCs, and other degradable compounds in low permeability (tight) geological formations. The technology is based on well-proven and established concepts including air sparging, flushing, soil vapor extraction, and enhanced bioremediation/oxidation in an innovative well system. The technical value of the LowPerma Remediation Technology includes:

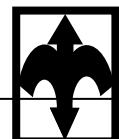
- Multiple, proven technologies working together – sparging/stripping, SVE, oxygenation, enhanced bioremediation and dynamic subsurface flushing.
- An innovative approach to remedy groundwater in low permeability formations.
- Dynamic circulation in the subsurface affects remediation of larger area - both vertically and horizontally.
- Concentrated, multiple sparging in concert with flushing effects enhances remediation of a wider range and a greater amount of recalcitrant compounds.
- No submersible pump in the well - the well is the pump!
- No groundwater extraction above the surface; therefore, no on surface treatment, disposal, NPDES permitting and sampling.
- No high-vacuum or high-pressure pumps and associated operation and maintenance costs.
- Groundwater extraction rate, treatment time, lifting elevation, injection zone, and velocity can be easily tailored and adjusted to site conditions.
- The pumping and injection mechanism is highly efficient and minimal maintenance is required.
- Extraction and injection cycles will result in flushing contaminants from the soil matrix above and below water table levels.
- The sparging component will boost DO in the groundwater to enhance aerobic degradation and oxidization.
- Wells can be used to distribute amendments in order to accelerate the remediation of recalcitrant compounds.
- There are no complicated components.

The combined effects of the LowPerma technology will result in reduced time to closure and reduction in overall project costs.

Technical Description

The innovative, patented, LowPerma technology is based on the following treatment steps:

1. Exerting adequate vacuum to extract groundwater from a desired extraction zone



2. Treating the groundwater via well-proven, in-situ remedial measures
3. Transferring the treated water to a desired injection zone, and
4. Applying adequate pressure to infuse treated groundwater back into the formation at the proper screen elevation

The technology is based on an innovative concept to enhance water flow into and out of the well. The general idea is similar in approach to a typical piston pump with the well being the piston cylinder. The LowPerma technology is designed to be installed in a four-inch well that consists of two separate screens at different elevations. As shown in the attached figure, the lower screen is positioned near the bottom of the contaminated groundwater zone. The upper screen is located near the water table or the desired injection zone.

As detailed in the attached figure, a main component inside the well is a moving shaft connected to a movable disk (disk 1), initially positioned at the top of the bottom screen. A second fixed disk (disk 2) is located near the top of the upper screen. The shaft can slide up and down freely through a hole in the fixed disk. When disk 1 is pulled upward via the moving shaft, the space between the moving disk 1 and the fixed disk 2 is gradually reduced.

When the shaft is pulled up, high vacuum is created below disk 1 forcing water to flow through the lower screen from the formation into the well. Simultaneously, as the space between disks 1 and 2 is reduced, high pressure is created at the water unit between disk 1 and disk 2, resulting in diffusing the water through the upper screen back into the formation. The pressures and holding time can be controlled and altered to maximize efficiency. When the shaft is released down, a check valve is opened to allow water transfer, and the process is repeated.

Water treatment occurs via continuous air sparging through the shaft from diffusing holes near the upper side of disk 1. The air is continuously sparged to strip contaminants from the groundwater and to saturate the water unit with dissolved oxygen (DO). A valve to allow vapor flow to the upper chamber (above disk 2) is installed in disk 2. The valve is designed to permit vapor/gas and block water flow through disk 2. Contaminant laden air will then be extracted via vacuum extraction applied near the top of the well. A pneumatic cylinder will facilitate movement of the shaft apparatus.

The innovative idea incorporated in the LowPerma technology includes enhancement of groundwater flow into a lower screen (extraction screen) under high vacuum pressure, injection of treated groundwater through an upper screen (injection screen) under pressure. Both actions are achieved in the same motion (stroke).



