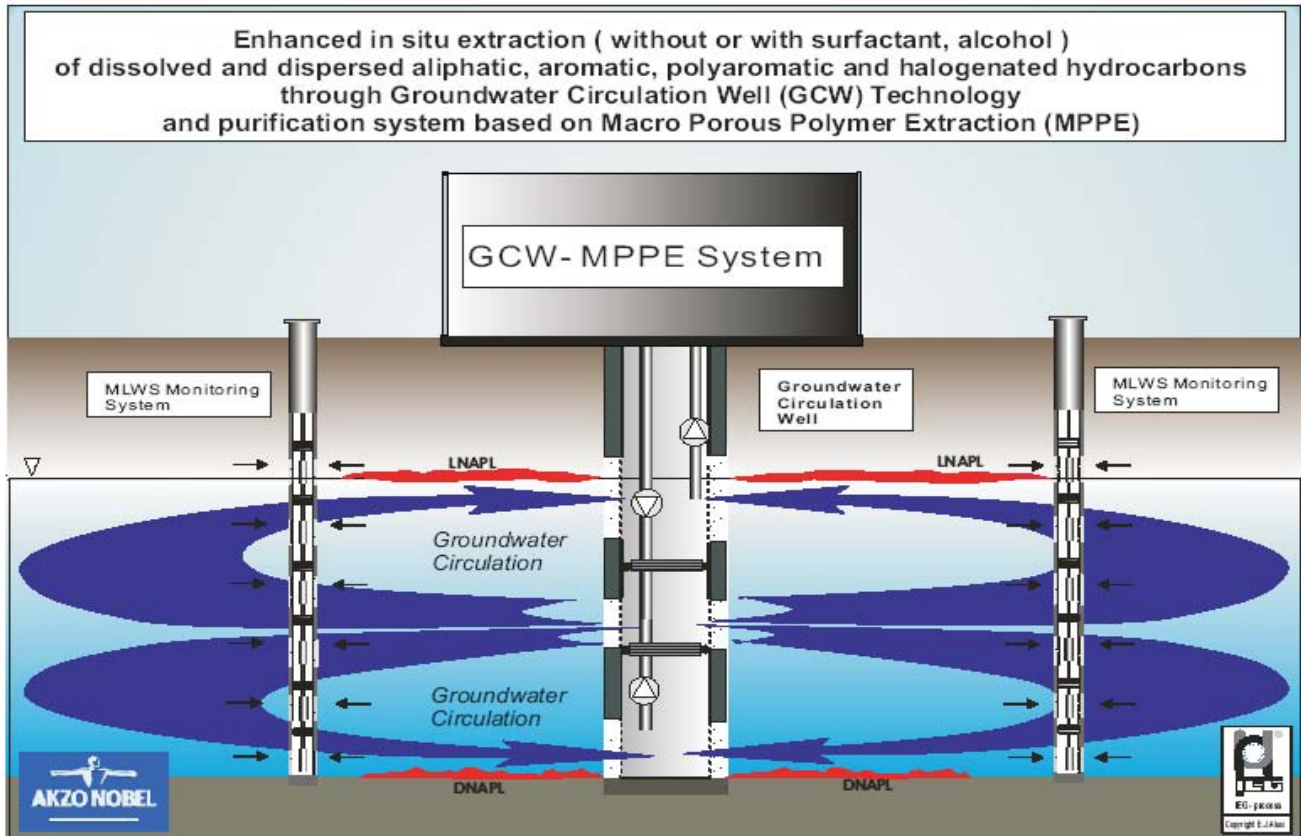


IEG Technical Briefing Note No. 15

Groundwater Circulation Well - IEG (GCW - MPPE)



The GCW-MPPE process is an in situ system for the remediation of groundwater contaminated with dissolved or dispersed aromatic, aliphatic, poly aromatic and halogenated hydrocarbons using a combination of a hydraulic controlled flushing/extraction system with a high efficient physical purification system based on macro porous polymer extraction.

Groundwater circulation well (GCW) systems are designed to create in situ vertical groundwater cells without removing groundwater from the aquifer. Induced differences in potentiometric head establish a 3-dimensional circulation cell in an ellipsoidal area around the central well.

The vertical and horizontal circulation flow patterns force water to move through the entire aquifer portion with the circulation cell thus improving contaminant mobilisation by forcing flow through less permeable formation lenses. The vertical circulation flow system offers the opportunity of an intensive flushing of an aquifer is highly stratified.

In the GCW-MPPE process the contaminated groundwater is pumped from the lower and upper screen section of a specially designed well with a total of three screen sections. Inflatable packers separate the screen sections from each other. Through the reinjection of clean water into the intermediate screen section and the position of the packers, two separate circulation cells will be established. The upper one in a reserve mode, the lower one in a standard mode. The hydraulic pressure forces the water into the aquifer through the intermediate screen section and intensive vertical and horizontal flow are created in the sphere of influence of the circulation cell.

The GCW is capable of removing LNAPL/DNAPL during groundwater circulation and can effectively treat the unsaturated zone, the capillary fringe, and the saturated zone simultaneously.

The flow field around the GCW was systematically investigated for homogeneous and defined heterogeneous aquifer structures by HERRLING and STAMM during the years 1989 to 1996.

The GCW technology provides a robust and hydraulically controllable flow field with large vertical flow components. This allows to control a direct injection of alcohols and surfactants into the groundwater circulation. This allows to recover DNAPL and LNAPL in a short remediation time flushing only about 2 pore volumes.



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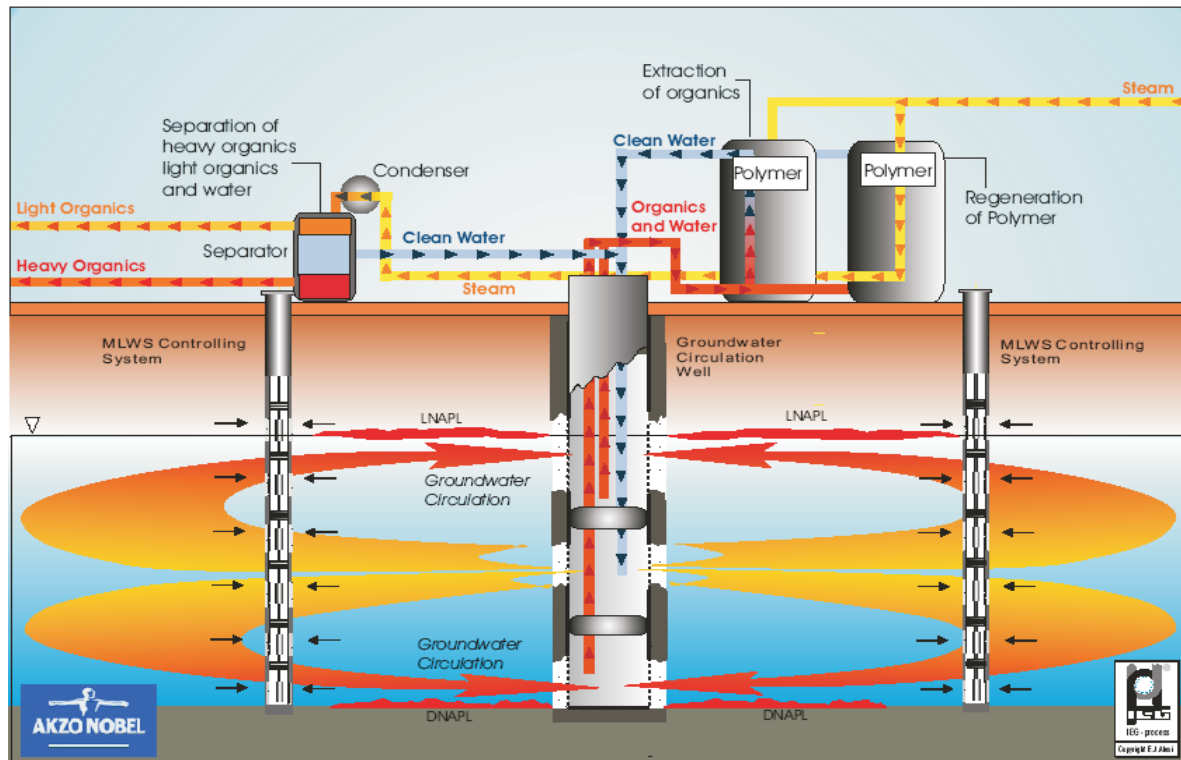
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Groundwater Circulation Well - IEG (GCW - MPPE)

continued



In the MPPE process, hydrocarbon-contaminated water is passed through a column packed with MPPE particles. The particles are porous polymer beads, which contain a specific extraction liquid. The immobilized extraction liquid removes the hydrocarbon from the groundwater. Only the hydrocarbon are removed. Alcohol or the surfactants are not affected and can be re-infiltrated into the GCW for the next flushing cycle.

Periodical regeneration of the MPPE column is accomplished by low-pressure steam injection. The stripped hydrocarbons are condensed and separated from the water by gravity. Almost 100 % pure hydrocarbon phase is recovered. The application of two columns allow continuous operation with simultaneous extraction and regeneration.

Potential Advantages of GCW-MPPE Technology

- Controlled flow hydraulic flow system
- Effective vertical flow system
- Polar components are not affected
- Can be extended to flushing with alcohol and surfactants
- Effective treatment without groundwater discharge
- Simultaneous in situ treatment of LNAPL and DNAPL
- Can be extended to unsaturated zone and capillary fringe
- Minimally invasive and non-disruptive to site conditions
- Very low energy requirements
- Low preparation and monitoring requirements
- Cost-efficient treatment when compared to conventional pump-and-treat systems
- Simultaneous treatment of aliphatic, aromatic, poly aromatic or chlorinated hydrocarbons
- Effective treatment of MTBE, DCA etc.
- Anaerobic operation
- No interference of dissolved iron, heavy metals, salt, polar compounds
- No scaling, no bio-fouling, no iron sludge
- No air emission
- Reuse/recycle of recovered free-phase
- Fully automated
- Remote controlled
- Compact equipment
- The system can treat higher and lower flows
- Effluent requirements can still be maintained by lowering the flow-rate



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