

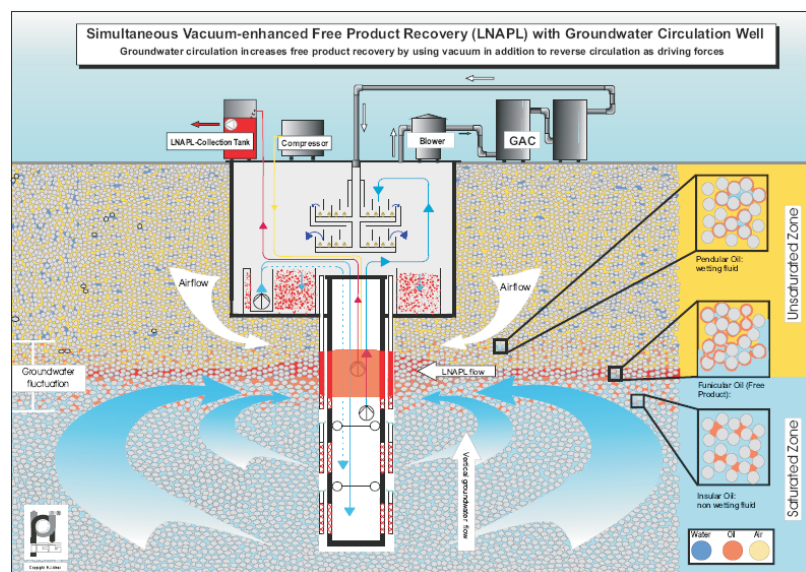
IEG Technical Briefing Note No. 18

LNAPL Recovery with GCW - (IEG GCW LNAPL)

A GCW-system is capable of accumulating and extracting LNAPL during groundwater treatment. The amount groundwater passing through the GCW system can be adjusted according to the type of contamination and the well construction. Recovery of LNAPL floating on top of the groundwater can be achieved by using a GCW-Reverse flow system. Pure LNAPL product can be pumped to an on-site collection tank.

The groundwater circulation and the negative pressure in a reverse flow system provides a "driving force" for free-floating LNAPLs to flow into the well. As a result LNAPL accumulates in the well, ensuring maximum permeability of LNAPL due to continuous saturation in the recovery zone. A pneumatic explosive-proof pump manually adjusted to a certain depth will be installed in the screened interval of the GCW, extending into the LNAPL layer. Free product is extracted through this pump. Creation of a negative pressure gradient (vacuum) within the well enhances removal of floating LNAPL and residual product trapped in small pores above the water table. Two sensors fixed below the pump inlet detecting water and LNAPL and switch on/off the pump for recovery of the trapped and accumulated LNAPL. Conventional methods cannot overcome the capillary forces that retain the remaining LNAPL within soil pores. Vacuum-enhanced LNAPL recovery may be used to help overcome these capillary forces.

Vacuum-assisted reverse groundwater circulation should be regarded as potentially capable of inducing the liquid flow through the upper groundwater part and the groundwater fluctuation zone ('smear' zone). The drawdown is reduced compared to dual pumping systems especially in medium- and fine-textured soils. The pneumatic and hydraulic gradients of a vacuum-assisted reverse groundwater circulation create a cohesive flow for free product. The reduction in pressure within the well induces a flow from higher atmospheric pressure zones towards the well. Vacuum-assisted free product recovery pulls LNAPL mainly in a horizontal direction resulting in increased efficiency compared to other dual pumping Systems that create a cone of depression and use a vertical hydraulic gradient for LNAPL removal. Because groundwater drawdown is not required, the problem of "smearing" of contaminants is eliminated. Smearing increase the vertical extent of contamination by introducing contaminants from the capillary fringe area into the aquifer



Combined GCW/LNAPL recovery is an order of magnitude greater than rates using conventional skimming and dual pump recovery skimming or dual-pump methods. Often it is the only successful method in low permeable aquifers.

The system can operate without any groundwater extraction. The mobile phase in the capillary fringe can be easily extracted. During fluctuation of groundwater the reversed circulation has access to insular distributed LNAPLs within pore spaces of the aquifer. The collected liquid phase is trapped inside the well and pumped continuously to an on-site collection tank. The circulated groundwater is not affected of this process.

Advantages

- Recovery efficiency much higher compared to systems where the flow of LNAPL is induced by gradient
- Radius of influence is supported by groundwater circulation, which enhances the sphere of influence compared to conventional pump system
- Recovery of residual hydrocarbons from the groundwater fluctuation zone ("held in small pores by negative pore pressure") is enhanced by the partial vacuum induced recovery
- No draw-down of the groundwater level
- Capital costs are less compared with conventional systems while at the same time the efficiency is increased, thus reducing remediation time and treatment costs
- System can be easily converted to a Bioventing system
- System can be adapted to groundwater fluctuations. Fluctuations in the elevation of the water table, and associated smearing, are minimized since product moves horizontally toward the well
- No expensive separation of oil and water
- Low maintenance



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