IEG Technical Briefing Note No. 7

Soil Circular Flushing Well - IEG SZB

In the unsaturated zone, bioremediation is critically affected by the soil moisture content. For most natural biological degradation processes, the optimal water content is in range between 50% - 80%. With the **Soil Circular Flushing Well** a vertical multi-phase flow increases the saturation of water in the unsaturated zone. The remaining volatile hydrocarbons are either removed by in-situ stripping in the well, adsorbed on an optional activated carbon bed on top of the outer casing, or biodegraded in the well and unsaturated zone. Water flushing the contaminated soil is enriched with contaminants and enters the well through the lower screen. The first pump determines the water quantity which circulates through the unsaturated zone. The discharge rate of an optional second pump located just below the stripping reactor is higher than that of the first pump. It regulates the inner circulation within the well casing (e.g. working five times more than the first) and ensures that a sufficient stripping rate can be achieved. Simultaneously, due to negative pressure stripping, water leaving the **SZB** Well is enriched with dissolved oxygen and small air bubbles (<100 microns) which enhances population growth of the microorganisms.

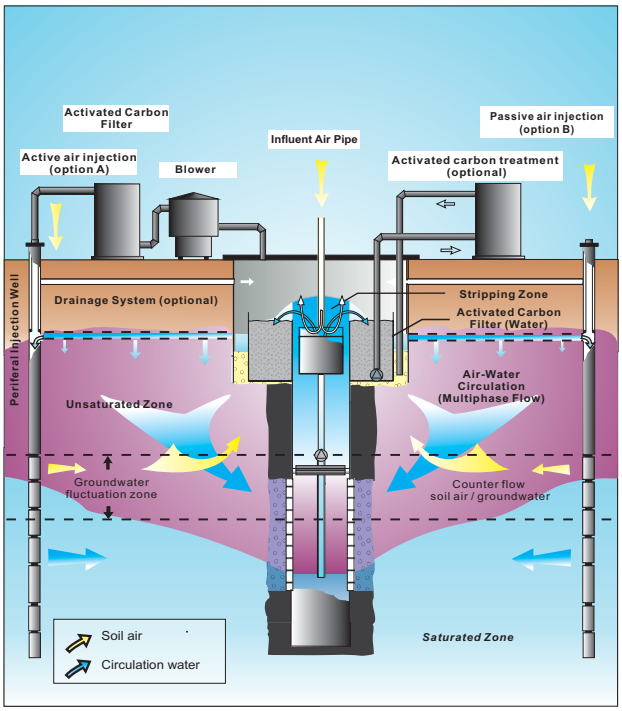
Groundwater level rises inside the well due to the application of a low negative pressure generated by a blower, typically 40-80 millibars. Ambient air is pulled through the multi-stage stripper (labyrinth stripper) via a pipe connected to the stripping reactor located in the well.The rising air bubbles enhance the suction effect at the well bottom and this effect is further enhanced by the use of an air-lift-pump. Biodegradation can be further accelerated by adding nutrients or surfactants. The amount of oxygen dissolved in water decreases with distance to the SZB Well and is at its relative minimum when it re-enters the well. Peripheral air injection wells provide oxygen-rich air to the outer part of the circulation cell. After radially flowing out of the upper screen of the inner well, water accumulates up to a determined level within the outer casing surrounding the inner well. A levelling sensor within the outer casing regulates the operation of the first pump. The outer casing is partially filled with a gravel layer resting on the natural soil. This can easily be replaced in case of chemical precipitation or clogging due to biodegradation.

In the outer casing the negative pressure is approximately in equilibrium with the hydrostatic water column. Nevertheless water leaves the well due to the continuous supply in a downward direction. Soil vapor is drawn in through the outer casing towards the well in a reverse direction to the water. The volume of soil air removed decreases to about 30% of that removed in the soil vapor extraction period.

Because there is a simultaneous multiphase flow of air and water, both phases impede each other such that a slow but continuous flow develops. The saturation of water in the soil controls the discharge rate. At an intended saturation of water of approximately 40 - 60%, the permeability of the flushing water is more reduced than that of air.

An optional horizontal drainage system can be arranged below surface between the SZB Well and the air injection wells. The upper unscreened pipe is in contact with the negative pressure in the well. By adding an inner tube with a packer to the air injection wells, the negative pressure applied in the upper pipe is transmitted to the lower screened pipe. The lower pipe is connected with the water resting in the outer casing of the well. Water draining through the lower pipe is then flushed at a more constant flow velocity in the vicinity of the well and provides a more uniform remediation progress within that drainage area.

The lateral extension of the SZB circulation cell is mainly limited by the extension of such an optional drainage system or otherwise by the sphere of negative pressure influence e.g. the distance of the injection wells from the SZB Well. Additionally, it is controlled by the heterogeneity of the soil and the capillary forces therein.



IEG Soil Circular Flushing System
for biological-physical remediation of the unsaturated zone
(IEG SZB Process)

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