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Pollutant Bioventing System - Butane Bioventing

Abstract

The butane injection system may operate concurrently with an extraction system, such as an SVE system, which is used to maintain a vacuum within vadose zone soils (butane Bioventing). Effluent from the SVE system is piped back into the biobutane treatment zone, thus allowing vapor control while reducing operation costs by eliminating the need for carbon replacement or regeneration and by recycling the butane gas. The SVE system may further oxygenate the soil, resulting in enhanced microbial degradation of pollutants such as petroleum compounds. Butane injection may also be applied to traditional bioventing systems that are simply recirculating air into a treatment zone.

Background

Gasoline and other volatile organic compounds such as chlorinated aliphatic hydrocarbons released into the subsurface become distributed into four phases: adsorbed phase (on soil surface); vapor/volatilization phase (in soil gas); dissolved phase (in groundwater); and free phase (pure petroleum or chemical product floating on the groundwater table, also known as light non-aqueous phase liquid or LNAPL, or sinking below the water table as dense non-aqueous phase liquid (DNAPL). Soil vapor extraction (SVE) is a physical means of removing or reducing concentrations of volatile organic compounds (VOC) that partition into the vapor phase. This technology targets the adsorbed, vapor and NAPL phases of the VOC present in the unsaturated (vadose) portion of the subsurface. Dissolved-phase VOC found beneath the groundwater table is not directly addressed by using an SVE system. Remediation by SVE involves applying a vacuum to soils in the unsaturated zone above the water table in order to induce airflow. Contaminated mass removal is achieved by drawing contaminant-free air into the soil void spaces. The contaminant-free air creates a concentration gradient and the compounds diffuse into the air stream. This VOC-laden air is continuously extracted and replaced with contaminant-free air. An additional benefit of SVE is the continuous flow of oxygen into the area where hydrocarbons are adsorbed to the soil. This continuous oxygen supply enhances the biodegradation of the hydrocarbons within the soil matrix. SVE technology was developed to remove volatiles from the subsurface.

A typical SVE system consists of one or more vapor extraction wells strategically located. The SVE wells can be placed vertically or horizontally, depending on depth to groundwater and other site-specific characteristics. The piping system is commonly placed underground, primarily to provide extra protection from accidental damage. The piping system usually ends at a common header pipe, which is connected to a blower or a pump depending on the flow and vacuum desired. An air/water separator and or filter is required prior to the vacuum pump in order to protect equipment from moisture and particulates drawn into the system. Discharge from the blower or vacuum pump is typically connected to an off-gas treatment system.

SVE alone is not effective for removing heavier material such as diesel fuel, jet fuel or fuel oils, because of the nonvolatile high-molecular weight fractions they contain. Since these heavier compounds are susceptible to biodegradation, bioventing was developed, utilizing SVE hardware and vertical piping, as a means of introducing or injecting and reinjecting air (oxygen) into the treatment zone. Bioventing is appropriate when the water table is deep and the contaminant has not reached the groundwater.

In-situ air sparging, also known as in-situ air stripping and in-situ volatilization, is a technology utilized to remove VOCs from the subsurface saturated zone. In-situ air sparging, when utilized with an SVE system, may greatly extend the utility of SVE to the saturated zone. Air sparging is a process in which contaminant-free air is injected under pressure (sparged) below the water table of an impacted aquifer system. In air sparging applications, the air injection pressure is the sum of the hydrostatic pressure (also known as breakout pressure), which is a function of submersion depth of the air sparging point, and the air entry pressure of the geologic formation, a function of capillary resistance to pore water displacement.

Volatile compounds exposed to the injected air are transferred to the vapor phase, similar to air stripping. Once captured by an SVE system, the VOC-laden air is transferred to a subsequent emissions treatment system. Air sparging systems must operate in tandem with SVE systems intended to capture this VOC-laden air stream. Implementing an air sparging system without an SVE system can potentially create a net positive pressure in the subsurface, inducing groundwater migration into areas previously less affected by dissolved-phase VOC. The air sparging system also adds oxygen to the groundwater, thus accelerating the natural biological decay process.

The three primary mechanisms responsible for VOC removal during operation of air sparging systems are believed to be: in-situ stripping of dissolved-phase VOC; volatilization of dissolved-phase and adsorbed-phase VOC beneath the water table and in the capillary fringe; and aerobic biodegradation of both dissolved-phase and adsorbed-phase VOC as a consequence of additional oxygen supplied by the injected air. When an air sparging system is optimized for stimulating biodegradation, it is sometimes referred to as biosparging. Biosparging systems are initially operated for volatilization and stripping. The system is then fine-tuned for enhancement of biodegradation.

Butane Bioventing

Butane Bioventing, especially when combined with Butane Biosparging, can greatly accelerate remediation efforts at Sites that have been impacted by petroleum or chlorinated solvent releases. In terms of total cost for a site cleanup, when you consider the initial cost for the first year for the butane injector, the use of the Butane Bioventing approach, the elimination of carbon, and accelerated cleanup time, the butane approach is usually lower in cost than conventional technologies including SVE/AS with carbon replacement/regeneration.