Ground Water, Surface Water, and Leachate

Granulated Activated Carbon (GAC)/Liquid Phase Carbon Adsorption

Introduction:

Ground water is pumped through a succession of columns containing activated carbon to which dissolved organic contaminants adsorb. Regular replacement or regeneration of saturated carbon is necessary.

Description:

When the concentration of the contaminants in the effluent surpasses a specific level, the carbon can be regenerated *in situ*, removed and regenerated at an appropriate off-site facility, or removed and disposed of. Carbon used for metal contaminated ground water almost certainly cannot be regenerated and must be removed and correctly disposed. Adsorption by activated carbon has a long history in treating municipal, industrial, and hazardous waste.

The two most universal reactors for carbon adsorption systems are the fixed bed and the pulsed or moving bed. The fixed-bed configuration is extensively used for adsorption from liquids. Pre-treatment for removal of suspended solids from streams to be treated is a vital design factor. Suspended solids in a liquid stream could build up in the column, causing an increase in pressure drop. When the pressure drop is too high, the accumulated solids have to be removed by backwashing. The solids removal process requires adsorber downtime and might result in carbon loss and disruption of the mass transfer zone.

Adaptations of GAC, namely silicone-impregnated carbon, may well increase removal efficiency and enhance the length of operation. It may also be safer to regenerate. The time duration of GAC is short-term, however, if concentrations are low enough, it may take much longer. The length of operation and maintenance is dependent on contaminant type, concentration, volume, regulatory cleanup requirements and metal concentrations.

Applicability:

Applicable contaminants for carbon adsorption treatment are hydrocarbons, SVOCs and explosives. Restricted effectiveness may be possible for halogenated VOCs and pesticides. Liquid phase carbon adsorption is efficient for removing contaminants at low concentrations (less than 10 mg/L) from water at almost any flow rate, and for eliminating higher concentrations of contaminants from water at low flow rates (on average 2 to 4 litres per minute). Carbon adsorption is especially effective for polishing water discharges from other remedial technologies to achieve regulatory compliance. Carbon adsorption systems can be deployed rapidly. Logistic and economic drawbacks occur from the requirement to transport and decontaminate any used carbon.

Limitations:

- Presence of multiple contaminants can impact process performance. Bench tests may be conducted to estimate carbon usage for mixtures.
- Streams with high-suspended solids (> 50 mg/L), oil and grease (> 10 mg/L) may cause fouling of the carbon and may require frequent treatment. In such cases, pre-treatment is generally required.
- Costs are high if used as the primary treatment on waste streams with high contaminant concentration levels.
- Type, pore size, and quality of the carbon, as well as the operating temperature, will impact process performance. Vendor expertise for carbon selection should be consulted.
- Carbon used for metal contaminated ground water is not regenerated.
- Highly Water-soluble compounds and small molecules are not adsorbed well.
- Used carbon eventually needs to be properly disposed.

Data Needs:

The key design for liquid phase carbon applications are empty bed contact time (EBCT), usage rate, and system construction. Particle size and hydraulic loading are frequently selected to minimise pressure drop and reduce or eliminate the need for backwashing. System configuration and EBCT have an influence on the rate of carbon usage.

Performance Data:

Adsorption by means of activated carbon has a long history of treating municipal, industrial, and hazardous waste streams. The concepts, theory, and engineering aspects of the technology are well developed and the technology is proven. Carbon adsorption is a somewhat non-specific adsorbent and is valuable for removing a lot of organic, explosive, and some inorganic contaminants from liquid and gaseous waste streams.

Cost:

Costs linked with GAC dependent on waste stream flow rates, type of contaminant, concentration of contaminant, mass loading and effluent concentration. Costs are lower with lower concentration levels of a contaminant of a given type and also lower at higher flow rates. At flow rates of approximately 0.4 million litres per day, costs can increase to £ 1.25 per 1,000 litres treated.