CalgonCarbon

Pipeline treats hydro-test water on site with carbon adsorption

carbon adsorption

Several years ago, a pipeline company in the northeast U.S. used an activated carbon-adsorption system to make pipeline hydro-test water acceptable for surface discharge.

A Project Dilemma

The pipeline company has more than 3,400 miles of pipeline to serve 80 locations in 10 states, linking major U.S. petroleum refiners with petroleum supply regions. This company is a major shipper of gasoline, heating oil, kerosene, turbine and diesel fuels and, to a lesser extent, of naphtha, liquefied petroleum gases (LPGs), and refinery feedstocks.

Supplying airports, commercial marketing terminals, and connecting pipelines, the company receives petroleum products into its pipeline system from refineries, deepwater marine terminals, and connecting pipelines.

A five-year forecast outlined a need to handle an estimated 795,000 bbl (more than 33 million gal) of hydro-test water from its system. The number of trucks needed to transport this amount of water and the high cost for disposal at a treatment, storage, and disposal facility, made disposal economically and logistically prohibitive.

The challenge was to find a suitable treatment system capable of treating large amounts of water on site in a short period. Additionally, the system had to be mobile and sturdy enough to be moved anywhere within the 3,400 mile system.

Defining Requirements

The environmental affairs department evaluated several technologies to find a solution capable of treating hydro-test water with benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations ranging between 10 and 150 ppm. The system had to be capable of achieving greater than 99% removal of BTEX compounds to achieve the low parts-per-billion levels required for surface-water discharge, while maintaining a consistently high flow rate (150-175 gpm).

To ensure operation and approval throughout a 10-state service area, the selected treatment system had to use best demonstrated available technology (BDAT). In addition, the system needed to be easy to maintain, durable, intrinsically safe, readily available on short notice, compact, and mobile.

With cost effectiveness and portability as the major goals, the pipeline company evaluated four possible treatment technologies from several vendors and consultants. The company compared the costs (Table 1), advantages and disadvantages of **biological treatment, air stripping** followed by vapor and liquid-phase carbon polish, **advanced oxidation,** and **activated carbon adsorption.**

Biological Treatment

Biological treatment can providecost-effective multi-phase remediation, but ultimately proved to be an unattractive or inconvenient option. To meet the flow requirements set by the customer while still providing sufficient retention time, the biological treatment system would have been required to be mounted on two separate trailers. Additionally, constant monitoring for bioactivity would have been needed. And, finally, the company was concerned that a bio-system could not consistently handle a wide range of hydrocarbon concentrations.

Air Stripping

The volatility of the light aromatic hydrocarbons in gasoline made remediation that utilized air stripping appear to be the most effective means for treating hydro-test water. The cost of having to treat off-gas with vapor-phase carbon or thermal combustion would generally place the stripping/off-gas treatment combination at two to three times the cost of straight liquid phase carbon treatment.

Advanced Oxidation Systems

The major advantage of an advanced oxidation system is that it reduces or eliminates a hazard rather than transferring it to a different medium. The disadvantage is the technology's dependence on light penetrating the wastewater. Generally, this process requires the water to be relatively free of suspended particles, oils, and anything else that may hamper ultraviolet light penetration.

An advanced oxidation system would require a feeder mechanism for introducing an oxidant (ozone and/or hydrogen peroxide), a reactor tank fitted with ultraviolet lights, and follow-up devices for preventing ozone from entering the atmosphere. The durability of an advanced oxidation system when being transported throughout the pipeline was also a concern.

Activated Carbon Adsorption

Liquid-phase purification with carbon adsorption has long been cost-effectively applied to process streams, drinking water, and municipal and industrial wastewater. Activated carbon is a relatively inert, highly porous material, which adsorbs organic compounds via physical attractive forces.

Liquid Phase Adsorption Equipment (CalgonCarbon Model 8 shown).

Making Water and Air Safer and Cleaner

carbon adsorption

Treatment Options

Options	$/gal
Air stripping followed by vapor or liquid phase	0.03 to 0.04
Carbon polish	
Biological treatment	0.025 to 0.035
Carbon adsorption	0.01 to 0.02
Chemical oxidation	
Ozonation	
Transporting waste-water for disposal	0.20 to 0.60

Method, Vendor Choice

Information supplied by vendors and consultants in water treatment led to the environmental affairs department to choose activated carbon for treating hydro-test water and Calgon Carbon as the supplier.

Activated-carbon treatment is based on adsorption in which molecules of a liquid or gas adhere to the surface of an adsorbent. Activated carbon offers a high internal surface area (porosity), and much of the surface area exists at the angstrom level (10 m in pore size) in which adsorption forces are additive and strong.

Adsorption works because the attraction of the carbon structure for molecules is stronger than the forces that keep the molecules in solution. Organic molecules such as benzene, xylene, and toluene, adsorb more readily than inorganic chemicals because they tend to be non-polar in nature, have low solubility in water (which is polar), and are attracted to the non-polar surface of the carbon.

Activated carbon is also cost-effective because the same high-temperature process that is used to manufacture the product can also be used to reactivate the carbon for reuse. In reactivation, adsorbed organic chemicals are thermally destroyed, and the carbon can then be recycled for reuse.

Calgon Carbon's Model 7.5 adsorption system was chosen because of its ability to operate in series at 150 to 175 gpm while achieving greater than 99% removal of BTEX compounds to meet the stringent surface-water discharge effluent limits stipulated under federal and various states' programs for the National Pollutant Discharge Elimination System.

The system was also simple to operate, easy to maintain, and mobile. The Model 7.5 is an adsorption system designed for the removal of dissolved organic contaminants from liquids using granular activated carbon (GAC). The pre-piped, skid mounted configuration is designed for on-site treatment where the need is periodic or where a permanent system would be uneconomical.

The Model 7.5 system is delivered as two pre-piped adsorbers on a skid. Installation, piping connections and startup are supervised by Calgon Carbon personnel. When the carbon becomes exhausted, the Model 7.5 is designed for fresh carbon replacement utilizing Calgon Carbon's closed loop carbon exchange service. Using a special designed trailer, spent carbon is removed from the adsorbers and returned to Calgon Carbon for reactivation. The trailer can also provide fresh carbon to recharge the adsorbers, minimizing downtime.

The spent carbon is then shipped to a fully permitted Calgon Carbon reactivation facility as a RCRA, D018-benzene hazardous waste. There it can be thermally reactivated and recycled for reuse.

The reactivation process ensures complete destruction of the adsorbed organics and reduces environmental liability.

Project Payback

The pipeline company considered two options for the use of Calgon Carbon equipment to treat hydro-test water. The first involved a turnkey service in which Calgon Carbon would own the equipment and provide carbon, equipment, major maintenance, operations support, carbon exchange, and reactivation for a cents-per-gallon fee which was several times more economical than off-site disposal.

The second option, the customer would purchase the model 7.5 outright. The amount of water (795,000 bbl) that would have to be treated at various sites on its system in the treatment time period led the customer to purchase the Model 7.5 and handle operations and major maintenance with its own personnel.

Calgon Carbon provided the company with carbon exchange services and technical support as needed. The high volume of water treated led to payback on the equipment purchase of less than 6 months, as compared to the cost of using an outside contractor for treatment, storage, and disposal.

The Model 7.5 adsorption system was used at seven different locations over a six-month time period to successfully treat more than 11.5 million gal of pipeline hydro-test water.

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