CALGON

CALGON CARBON CORPORATION

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Pipeline treats hydrotest water on site with carbon adsorption

During 1993-94, Buckeye Pipeline Co., L.P., Emmaus, PA., used an activated carbon-adsorption system to make pipeline-hydrotest water acceptable for surface discharge.

The technology, supplied by Calgon Carbon Corp., Pittsburgh, brought water to levels acceptable to U.S. environmental regulations and to those of states served by Buckeye (Fig. 1)

Pipeline's dilemma

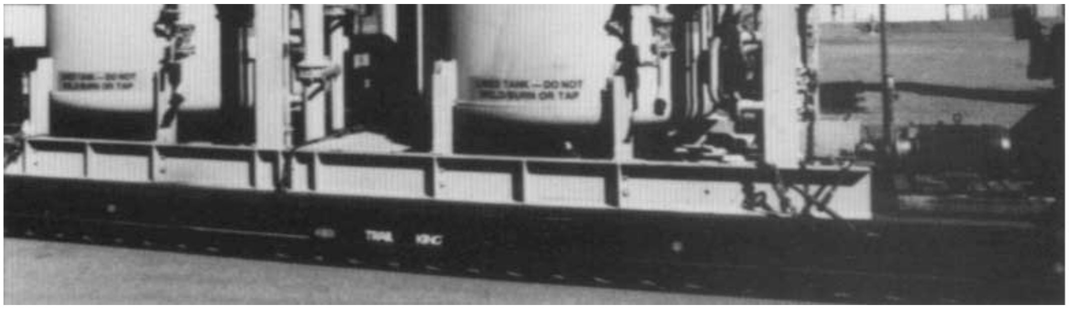
Buckeye's more than 3,400 miles of pipeline serve 80 locations in 10 states, linking major U.S. petroleum refiners with petroleum supply regions.

The company, one of the country's largest independent common carriers, is a major shipper of gasoline, heating oil, kerosine, turbine and diesel fuels and, to a lesser extent, of naphtha, liquefied petroleum gases (LPGs), and refinery feedstocks.

Buckeye supplies airports, commercial marketing terminals, and connecting pipelines. It receives these petroleum products into its pipeline system from refineries, deepwater marine terminals, and connecting pipelines.

Over the 5 years from 1993 to 1997, Buckeye forecast a need to handle an estimated 795,000 bbl (more than 33 million gal) of hydrotest water from its system. The number of trucks needed to transport his amount of water and the cost for disposal ($0.20-0.60/gal) at a treatment, storage, and disposal facility, made disposal economically and logistically prohibitive.

The challenge for Buckeye, therefore, 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.



A mobile, two-stage carbon adsorption system is ready to treat pipeline hydrotest water outside one of Buckeye Pipeline's site along its 10-state system (Fig. 1).

Defining requirements

Buckeye's environmental affairs department evaluated several technologies to find a solution capable of treating hydrotest 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, Buckeye evaluated four possible treatment technologies from several vendors and consultants. The pipeline 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 provides cost-effective multi-phase remediation but proved ultimately unattractive or inconvenient for Buckeye.

  To meet the flow requirements set by Buckeye 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, Buckeye was concerned that a biosystem could not consistently handle a wide range of hydrocarbon concentrations.

- The volatility of the light aromatic hydrocarbons in gasoline made remediation that utilized air sparging/stripping appear to be the most effective means for treating hydrotest water.

  But with the Clean Air Act amendments of 1990, most if not all states will be requiring some off-gas treatment.

  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.

- The major advantage of oxidation 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 waste water. Generally, this process requires the water to be relatively free of suspended particles, oils, and anything else that may hamper ultra-violet-ray 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.

Buckeye was also concerned about the durability of an advanced oxidation system when being transported throughout the pipeline system.

- 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.

Treatment options

Options	$/gal
• Air stripping followed by vapor or liquid phase Carbon polish	0.03 to 0.04
• 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 Buckeye’s environmental affairs department to choose activated carbon for treating hydrotest 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 is unique, says Calgon Carbon, because of its high internal surface area (porosity) and because much of the surface area exists at the angstrom level (10^{-9}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 are generally more adsorbable than inorganic chemicals because they tend to be nonpolar in nature, have low solubility in water (which is polar), and are attracted to the nonpolar surface of the carbon.

Activated carbon is also cost-effective because the same high-temperature process that is used to manufacture carbon can 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 National Pollutant Discharge Elimination System.

The system was also simple to operate, easy to maintain and mobile.

The Model 7.5 system is a complete, skid-mounted, pre-assembled, two-stage, ASME-coded adsorption system. Each vessel contains 10,000 lb of granular activated carbon, and the system can handle a maximum flow rate of 350 gpm in a down-flow mode.

The pre-assembled piping allows the system to be operated with the two adsorbers in series or parallel. Either vessel can be isolated from the treatment process for backwashing or carbon exchange.

The adsorber design, says Calgon Carbon, allows for both quick and efficient transfer of spent carbon from the adsorption vessels and for refill with fresh carbon, each via a water slurry, with minimal downtime and personnel exposure.

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 Buckeye's environmental liability.

Project payback

Two options were considered by Buckeye for the use of Calgon Carbon equipment to treat hydrotest water.

The first involved a turnkey service in which Calgon Carbon Corp. 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 would be for Buckeye to 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 between 1993 and 1997 led Buckeye to purchase the Model 7.5 and handle operations and major maintenance with its own personnel.

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

Buckeye purchased a Model 7.5 adsorption system and used it at seven different locations between June and November 1993 successfully to treat more than 11.5 million gal of pipeline hydrotest water.

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