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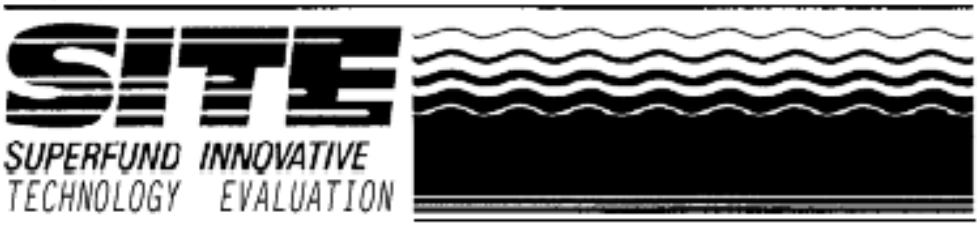

Demonstration Bulletin

Adsorption-Integrated-Reaction (AIR2000) Process

KSE, Inc.

Technology Description: The AIR2000 technology was developed by KSE, Inc. (KSE) of Amherst, Massachusetts. The demonstration unit was designed and manufactured by Trojan Technologies, Inc. of London, Ontario. The AIR2000 unit treats air streams containing volatile organic compounds (VOCs). The technology was evaluated during a U.S. Environmental Protection Agency Superfund Innovative Technology Evaluation (SITE) Program demonstration at the Stamina Mills Superfund site in North Smithfield, Rhode Island from August to October 1999. The SITE program evaluated the technology's ability to treat air containing trichloroethene (TCE) and trace levels of other chlorinated organic compounds. The air stream for this evaluation was the off-gas from the existing soil and groundwater remediation system: soil vapor extraction (SVE) and multiphase extraction with groundwater stripping. The influent concentration to the AIR2000 unit ranged from 10 to 78 parts per million by volume (ppmv).

In the AIR2000 technology, a contaminated air stream flows into a photocatalytic reactor where the VOCs are adsorbed onto the surface of a proprietary catalytic adsorbent that is continuously illuminated with ultraviolet light. The ultraviolet light destroys the adsorbed, concentrated VOCs through enhanced photocatalytic oxidation. KSE claims that the AIR2000 process offers advantages over other photocatalytic technologies because of the high activity, stability, and selectivity of the photocatalyst. Analytical results compiled prior to the SITE demonstration indicate that the photocatalyst is highly resistant to deactivation, even after thousands of hours of operation in the field.

Waste Applicability: The process is claimed to be capable of treating chlorinated and nonchlorinated VOC concentrations ranging from 1 to more than 5,000 ppmv. The technology can treat the off-gas of existing remediation technologies, such as SVE, air stripping, and thermal desorption methods, and thus serve as an integral part of a remediation system.

Demonstration Approach: The technology was evaluated during two sampling events: (1) A detailed sampling event, conducted August 31 and September 1, 1999, involving seven sampling and analysis periods to monitor for VOCs and for primary and secondary reaction products, including chlorine, phosgene, and chlorinated acetic acids; and (2) a follow-up sampling event, conducted October 19, 1999, involving four sampling periods to monitor for VOCs only. System operating conditions were also monitored during both events.

The primary objectives were as follows:

- Demonstrate that the AIR2000 unit meets the design objective of a contaminant removal efficiency (CRE) across the reactor of 95 percent or higher for TCE.
- Demonstrate that the VOC emissions from the water scrubber that follows the AIR2000 process meet the Rhode Island emission standards for TCE and chloroform of 0.02 and 0.002 pounds per hour, respectively. (Originally, TCE was the only organic contaminant of concern for assessing VOC emissions. However, during the SITE demonstration, preliminary sampling and analysis indicated that low levels of chloroform appeared to be forming, and thus, chloroform was included in this objective.)
- Demonstrate that the AIR2000 unit effectively destroys TCE following an extended operational period.

Demonstration Results: The results of the demonstration relating to evaluation of the primary objectives are summarized in Tables 1 and 2. The unit operated at rates from 490 to 600 standard cubic feet per minute (scfm) during the tests. The average VOC mass flow rates into the system during the detailed and follow-up events were 0.72 lb/hr and 0.13 lb/hr, respectively. TCE accounted for about 94% of the VOC mass. The average power consumption during both events was 15 kilowatts. This power consumption is with full lamp usage for a design basis of 1000 ppmv TCE at 700 scfm. When lower concentrated streams and flow rates were encountered, the process could be operated with a lower number of lamps illuminated, significantly lowering power requirements while not lowering removal efficiency. However, this feature was not tested during the SITE evaluation.

The observed CRE for TCE exceeded 99.6% during both sampling events meeting the 95% CRE objective at greater

Table 1. Contaminant Removal Efficiencies (CRE)

Sampling Event	Compound	Average Inlet Concentration (ppmv)	Average CRE (%)
Detailed	TCE	56	99.63
	VOCs[1]	62	98.87
Follow-up	TCE	11	99.64
	VOCs[1]	13	98.77

Note:
(1) The CRE for VOCs is carbon-atom based and includes by-product VOCs

Table 2. VOC Emissions Prior to Carbon Adsorbers

Sampling Event	Compound	Average Outlet Concentration (ppmv)	Average Emission Rate (lb/hr)
Detailed	TCE	0.19	0.0023
	Chloroform	0.46	0.0050
Follow-up	TCE	0.038	0.00039
	Chloroform	0.045	0.00041

Note:
Rhode Island emission standards for TCE and Chloroform are 0.02 lb/hr and 0.002 lb/hr, respectively.

than a 99% confidence level. There was no change in the CRE for TCE and VOCs between events. This suggests that there was no catalyst deactivation during the evaluation time period. The TCE emissions during both events were within the Rhode Island limit of 0.02 lb/hr. Results indicate that the AIR2000 process can produce certain VOCs, such as chloroform, as byproducts. On a carbon-atom basis, less than one percent of the inlet VOCs were converted to these by-products. Chloroform emissions during the follow-up event were well within the Rhode Island standard of 0.002 lb/hr. However, the chloroform emissions for the detailed event would have been sufficient for the Rhode Island chloroform emission standards to be exceeded without the additional removal provided by carbon absorption beds downstream of the AIR2000 unit. The AIR2000 demonstration unit was not designed for chloroform removal, and the appearance of this compound during the field evaluation was unexpected given KSE's experience in related treatability studies. KSE claims these emissions can be mitigated through the use of alternative photocatalysts or reactor configurations designed for treating single-carbon chlorinated compounds.

Key findings from the demonstration, including complete analytical results, operating conditions, and a cost analysis, will be published in a Technology Capsule and an Innovative Technology Evaluation Report.

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