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SITE
SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION

Demonstration Bulletin

Ultraviolet Radiation and Oxidation

Ultrox International

TECHNOLOGY DESCRIPTION: The ultraviolet (UV) radiation/oxidation treatment technology developed by Ultrox International uses a combination of UV radiation, ozone, and hydrogen peroxide to oxidize organic compounds in water. Various operating parameters can be adjusted in the Ultrox® system to enhance the oxidation of organic contaminants. These parameters include hydraulic retention time, oxidant dose, UV radiation intensity, and influent pH level.

A schematic of the Ultrox system is shown in Figure 1. The treatment system is delivered on four skid-mounted modules, and includes the following major components:

- UV radiation/oxidation reactor module
- Ozone generator module
- Hydrogen peroxide feed system
- Catalytic ozone decomposer (Decompozon) unit for treating reactor off-gas

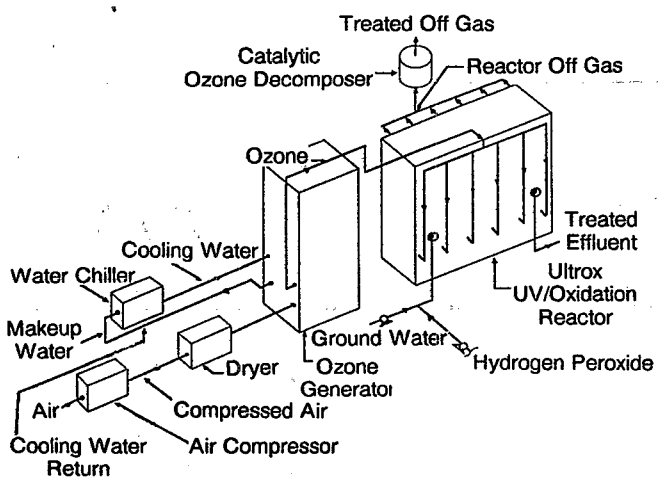

Figure 1. Isometric view of Ultrox System.

The commercial-size reactor used for the SITE Demonstration is 3 feet long by 1.5 feet wide by 5.5 feet high. The reactor is divided by five vertical baffles into six chambers. Each chamber contains four UV lamps as well as a diffuser which uniformly bubbles and distributes ozone gas into the groundwater being treated.

WASTE APPLICABILITY: This treatment technology is intended to destroy dissolved organic contaminants, including chlorinated hydrocarbons and aromatic compounds, that are present in wastewater or groundwater with low levels of suspended solids, oils, and grease.

DEMONSTRATION RESULTS: The SITE Demonstration was conducted at a former drum recycling facility in San Jose, California, over a 2-week period in February and March 1989. Approximately 13,000 gallons of groundwater contaminated with volatile organic compounds (VOC) from the site were treated in the Ultrox system during 13 test runs. During the first 11 runs, the 5 operating parameters were adjusted to evaluate the system. The last 2 runs were conducted under the same conditions as Run 9 to verify the reproducibility of the system's performance.

To evaluate the performance of each run, the concentrations of indicator VOCs in the effluent were analyzed overnight. Three of the 44 VOCs identified in the groundwater at the site were selected as indicator VOCs. These indicator VOCs were trichloroethylene (TCE); 1,1 dichloroethane (1,1-DCA); and 1,1,1-trichloroethane (1,1,1-TCA). TCE was selected because it is a major volatile contaminant at the site, and the latter two VOCs were selected because they are relatively difficult to oxidize.

Key findings from the Ultrox demonstration are summarized as follows:

- The groundwater treated by the Ultrox system met the applicable National Pollutant Discharge Elimination System (NPDES) standards at the 95 percent confidence level. Success was obtained by using a hydraulic retention time of 40 minutes; ozone dose of 110 mg/L; hydrogen peroxide dose of 13 mg/L; all 24 UV lamps operating; and influent pH at 7.2 (unadjusted).
- There were no volatile organics detected in the exhaust from the Decompozon unit.
- The Decompozon unit destroyed ozone in the reactor off-gas to levels less than 0.1 ppm (OSHA Standards). The ozone destruction efficiencies were observed to be greater than 99.99 percent.
- The Ultrox system achieved removal efficiencies as high as 90 percent for the total VOCs present in the groundwater at the site. The removal efficiencies for TCE were greater than 99 percent. However, the maximum removal efficiencies for 1,1-DCA and 1,1,1-TCA were about 65 and 85 percent, respectively (Table 1).

Table 1. Performance Data During Reproducible Runs

	Mean Influent (µg/L)	Mean Effluent (µg/L)	Percent Removal
Run Number: 9			
TCE	65	1.2	98
1,1-DCA	11	5.3	54
1,1,1-TCA	4.3	0.75	83
Total VOCs	170	16	91
Run Number: 12			
TCE	52	0.55	99
1,1-DCA	11	3.8	65
1,1,1-TCA	3.3	0.43	87
Total VOCs	150	12	92
Run Number: 13			
TCE	49	0.63	99
1,1-DCA	10	4.2	60
1,1,1-TCA	3.2	0.49	85
Total VOCs	120	20	83

- Within the treatment system, the removals of 1,1-DCA and 1,1,1-TCA appear to be due to both chemical oxidation and stripping. Specifically, stripping accounted for 12 to 75 percent of the total removals for 1,1,1-TCA, vinyl chloride, and other VOCs.
- No semivolatiles, PCBs, or pesticides were found in the groundwater at the site. Among the VOCs, the contaminant present at the highest concentration range (48 to 85 µg/L) was TCE. The groundwater also had contaminants such as 1,1-DCA and 1,1,1-TCA in the concentration ranges of 10 to 13 µg/L and 3 to 5 µg/L, respectively.
- The organics analyzed by Gas Chromatography (GC) methods represent less than 2 percent of the total organic carbon (TOC) present in the water. Very low TOC removal occurred, which implies that partial oxidation of organics (and not complete conversion to carbon dioxide and water) took place in the system.

A Technology Evaluation Report and an Application Analysis Report describing the complete demonstration will be available in the Spring of 1990.

FOR FURTHER INFORMATION:

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