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SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION

Demonstration Bulletin

*PO*WW*ER™ Wastewater Treatment System Lake Charles Treatment Center*

Chemical Waste Management, Inc.

Technology Description: The PO*WW*ER™ system developed by Chemical Waste Management, Inc. (CWM), reduces the volume of aqueous waste and catalytically oxidizes volatile contaminants. The PO*WW*ER™ system consists primarily of (1) an evaporator that reduces influent wastewater volume, (2) a catalytic oxidizer that oxidizes the volatile contaminants in the vapor stream from the evaporator, (3) a scrubber that removes acid gases produced during oxidation, and (4) a condenser that condenses the vapor stream leaving the scrubber. Figure 1 presents a flow diagram of the PO*WW*ER™ system pilot plant.

Aqueous waste to be treated by the PO*WW*ER™ system pilot plant is stored in a stainless steel feed tank. The feed tank is equipped with an agitator mounted on the top of the tank to mix additives into the feed waste. To control foaming in the evaporator, an antifoam agent can be added to the waste in the feed tank or sprayed directly into the evaporator. Also, the pH of the waste is monitored and adjusted in the feed tank. Once the feed waste is suitable for treatment, it is pumped to the evaporator.

The evaporator consists of three main components: the heat exchanger, vapor body, and entrainment separator. As feed waste is pumped to the evaporator, it combines with heated process brine. The feed waste is then further heated in a vertical shell-and-tube heat exchanger. Heat is provided by steam generated in a boiler. In the heat exchanger, the feed waste is heated to its boiling temperature. However, boiling does not occur in the tubes because of back pressure created by a designed gravity head.

After passing through the heat exchanger, the feed waste enters the vapor body, where boiling occurs. During boiling the feed waste separates into a vapor phase and a brine phase. When the vapor temperature reaches a value corresponding to a specific brine boiling point, some brine is wasted by gravity into a waste brine drum. The vapor exits the vapor body to an entrainment separator. The remaining brine is recirculated.

In the entrainment separator, the vapor passes through a mesh pad that entrains droplets and particles. The mesh pad is periodically rinsed and the rinse water combines with the heated brine and is recirculated in the evaporator.

The next step in the PO*WW*ER™ system is the oxidation of volatile organic and inorganic contaminants in the vapor stream from the evaporator. The vapor is heated to its oxidation temperature by the reactor heater, which is a direct-fired propane burner. The heated vapor then enters the oxidizer and passes through a catalyst bed where oxidation takes place. The oxidizer can operate with a catalyst

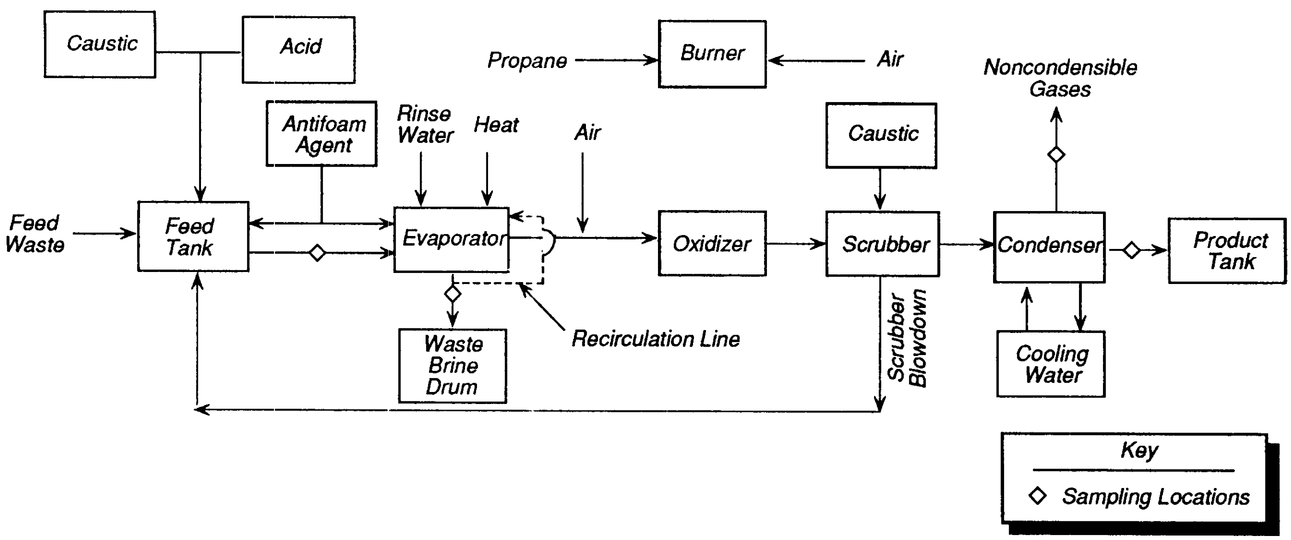

Figure 1. *Schematic diagram showing sampling locations for the PO*WW*ER™ pilot plant.*

in either a fluidized or static bed mode. The static bed mode was used during the Superfund Innovative Technology Evaluation (SITE) demonstration. Possible oxidation products include carbon dioxide (CO_2), carbon monoxide (CO), water, hydrogen chloride (HCl), sulphur dioxide (SO_2), and nitrogen oxides (NO_x).

After oxidation, the vapor stream exits the oxidizer and passes through a scrubber. The scrubber consists of a packed bed in which the vapor passes countercurrently through a caustic solution to neutralize the acid gases. Scrubber blowdown is returned to the feed tank. Scrubber vapor is cooled and condensed in a shell-and-tube condenser. The temperature of the product condensate ranges from approximately 130 to 160 °F. The product condensate is transferred to a stainless steel product tank. The product condensate can either be reused as boiler or cooling tower makeup water, or discharged to surface water, if appropriate. The noncondensible gases are vented to the atmosphere.

Waste Applicability: According to CWMs claims, the PO*WW*ERTM system can effectively treat the following types of wastewater: (1) landfill leachate, (2) contaminated ground water, (3) process wastewater, and (4) low-level radioactive mixed waste. CWM also states that the PO*WW*ER™ system can handle wastewater containing volatile and semivolatile organic compounds (VOC and SVOC), pesticides, herbicides, solvents, heavy metals, cyanide, ammonia, nitrate, chloride, sulfide, plutonium, americium, uranium, technetium, thorium, and radium.

Demonstration Results: The PO*WW*ER™ system SITE demonstration was conducted in September 1992 at CWMs Lake Charles Treatment Center (LCTC) in Lake Charles, LA. During the demonstration, landfill leachate from LCTC was treated by the PO*WW*ER™ pilot plant at a processing rate of 0.21 gal/min. Six test runs were conducted, each lasting approximately 9 hr. The first three replicate runs were conducted with unspiked leachate. The last three replicate runs were conducted with spiked leachate. The leachate was spiked with the following compounds: methylene chloride, tetrachloroethene, and toluene, phenol, mercury, cadmium, copper, nickel, and iron.

During each test, samples were collected from the feed waste, product condensate, and brine. Also, continuous emissions monitoring (CEM) was performed on the noncondensible gas stream. Feed waste, product condensate, and brine samples were analyzed for total suspended solids (TSS), total dissolved solids (TDS), ammonia, cyanide, VOCs, and SVOCs. Samples of feed waste and product condensate were also analyzed for acute toxicity. CEM of the noncondensible gas stream included monitoring for total nonmethane hydrocarbons, CO_2, CO, NO_x, SO_2, and oxygen. Additional analyses were also performed to characterize further the feed waste, product condensate, brine, and noncondensible gas stream.

Key findings of the SITE demonstration including analytical results will be discussed in detail in the Applications Analysis Report (AAR) and the Technology Evaluation Report (TER). The SITE demonstration results will also be summarized in the Demonstration Summary Report and videotape. Key preliminary results of the SITE demonstration are presented below:

- The ability of the PO*WW*ER™ system to concentrate aqueous wastes was evaluated by the volume reduction and concentration ratio achieved. The volume of brine wasted and sampled during each 9-hr test period was about 5% of the feed waste volume processed and sampled during the 9-hr period. The concentration ratio, defined as the ratio of total solids (TS) concentration in the brine over the TS concentration in the feed waste, was about 32.
- The feed waste contained concentrations of VOCs ranging from 270 to 110,000 micrograms per liter (g/L); SVOCs ranging from 320 to 29,000 µg/L; ammonia ranging from 140 to 160 milligrams per liter (mg/L); and cyanide ranging from 24 to 36 mg/L. No VOCs, SVOCs, ammonia, or cyanide were detected in the product condensate.
- The noncondensible gas vent emissions were as follows: (1) the average CO emissions ranged from 1.1×10^{-3} to 3.92×10^{-3} lb/hr, 9.58 to 37.3 parts per million by volume (ppmv), and the 60-min maximum CO emissions ranged from 1.27×10^{-3} to 4.28×10^{-3} lb/hr, 11.1 to 40.8 ppmv; (2) the average SO_2 emissions were less than 5.1×10^{-4} lb/hr, <2 ppmv, and the 60 min maximum SO2 emissions ranged from less than 5.1×10^{-4} to 8.36×10^{-4} lb/hr, <2 to 3.49 ppmv; and (3) the average NOx emissions ranged from 3.47×10^{-2} to 5.03×10^{-2} lb/hr, 233 to 292 ppmv, and the 60-min maximum NO_x emissions ranged from 3.59×10^{-2} to 5.34×10^{-2} lb/hr, 241 to 309 ppmv. The noncondensible vent gas emissions for these parameters met the proposed regulatory requirements for the LCTC site.
- The PO*WW*ER™ system removed sources of feed waste toxicity. The feed waste was acutely toxic with median lethal concentrations (LC50) consistently below 10%. The product condensate was nontoxic with LC50s consistently greater than 100%, but only after the product condensate was cooled and its pH, dissolved oxygen level, and hardness or salinity were increased.

For Further Information:

EPA Project Manager:
Randy Parker
U.S. EPA Risk Reduction Engineering Laboratory
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7271 FAX (513) 569-7620

United States
Environmental Protection Agency
Center for Environmental Research Information
Cincinnati, OH 45268

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