OAK RIDGE Y-12 MERCURY TREATMENT FOR DISCHARGE

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ABSTRACT

Several years ago a substantial amount of mercury was inadvertently released into the surface and subsurface structures at the Y-12 Plant. Following the initial recovery from that event, residual amounts of mercury have migrated and been detected in a variety of locations, including building sumps that discharge into the East Fork of Poplar Creek. Today Y-12 Plant sumps and sediment in Poplar Creek are contaminated with mercury.

The Department of Energy Office of Environmental Restoration and Waste Management has an aggressive program for restoration of the Y-12 Plant and other Oak Ridge sites. This paper describes the demonstration of the E PROCESS for the removal of mercury and other heavy metals from Y-12 Plant groundwater.

INTRODUCTION

The Oak Ridge Y-12 Plants were originally built to separate uranium-235 from other uranium isotopes. Hazardous wastewaters have been generated at Y-12 since 1943. These have included both radioactive and chemical wastes. Over the years, some treated and untreated wastewaters have been discharged to the Upper East Fork of Poplar Creek, which originates at the Y-12 Plant. One of the most significant contaminants in this water has been mercury, the element used during World War II to separate lithium isotopes as a part of the hydrogem bomb production process. Residual levels of mercury found in the building sumps range from 10 to 50 ppb.

The difficulty in dealing with low concentrations of mercury found in the sumps is that the mercury has become incorporated into a biological form that tends to concentrate the mercury to the ppm level while at the same time making the metal impervious to standard removal treatment methods. This phenomenon of mercury in the biological form has been observed with the mercury found throughout the Poplar Creek flow path.

Mercury is an elemental metal that has created problems in aquatic environments throughout history. It does not breakdown in the environment and can become more hazardous as methylmercury. This change to methylmercury occurs when a carbon and three hydrogen atoms attach to the mercury in an aquatic environment. Because methylmercury is an organic compound, it is now more readily adsorbed and absorbed in biological species. The toxic affects of a few parts per million of methylmercury poisoning in adults and children as a result of food chain progression is well documented.

Table I shows how the concentration of mercury in solution in a sample decreases with time. Figures 1 and 2 illustrate the apparent loss of mercury over several days. Laboratory study has concluded that at least a portion of the mercury loss in studied water samples can be attributed to biosorption on the organisms. However, data suggests that the mercury loss mechanism is even more aggressive than "biosorption". As noted from the Sample B data above, the mercury from the 100 ppb spiked sample was lost over an 8 day period. The samples developed a brown microbial growth which settled to the bottom of containers. Digestion of the mass followed by

TABLE I

Decrease in Mercury Content Over Time In Oak Ridge Waters, Building 9201-2, Sump E-22 and E-25.
Samples received at the SRP Lab on Different Dates and Compared to Spiked Samples of the Same Source

Sample A, Hg Concentration			Sample B, Hg Concentration	
Day	(ppb) Original	Original Plus 50 ppb Spike	(ppb) Original	Original Plus 100 ppb Spike
1	14.98	67.6	17.1	112.6
2	12.2	57.2	12.5	96.2
3	7.2	51.2	7.9	66.5
5	3.9	63.3	1.7	16.0
8	-	-	1.4	6.2
9	3.1	57.2	-	-
10	2.9	43.2	-	-
11	3.0	48.0	-	-

Sample A, "Day 1", is the fourth day after receipt of samples
Sample B, "Day 1", is the fifth day after receipt of samples

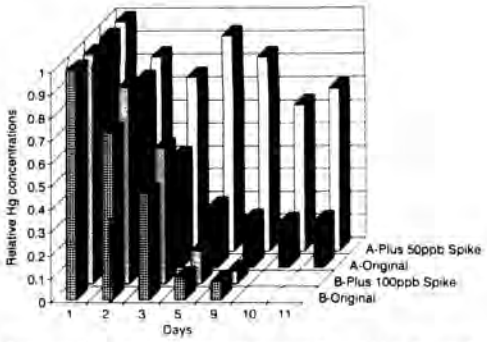

Fig. 1. Relative Hg concentrations of original and spiked samples.

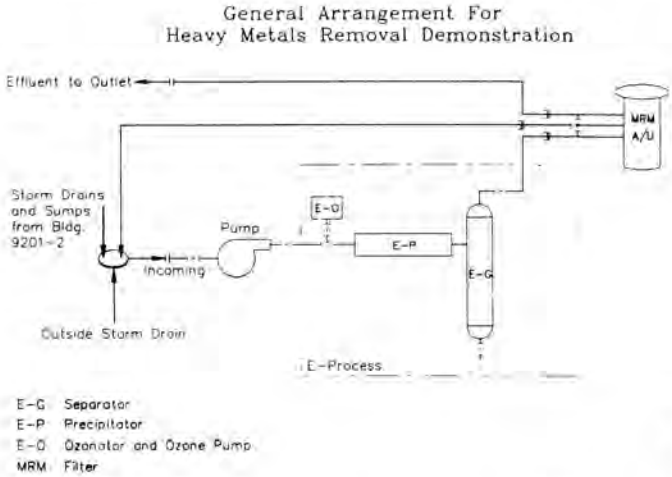

Fig. 2. PFD for mercury treatment at Y-12.

mercury analysis revealed high concentrations of mercury, in the ppm range.

Methylmercury has been observed in the Y-12 area, including Poplar Creek, as a result of the original spill. This mercury form cannot be removed from the waste stream (sump discharge) by conventional methods. For years the sumps and storm drains at Y-12 have been discharging into the East Fork of Poplar Creek and flowing through the City of Oak Ridge. See Fig. 3.

Because of the mercury transport and conversion process described above, for this project, CH2O* chose the E-Process to treat the sump water coming from the Y-12 Plant. The E-Process includes a Metal Removal Medium (MRM) filter for removal of the Hg^{+} and HgO fractions released after it destroys the aerobic and anaerobic bacteria.

TECHNOLOGY

The E-PROCESS has successfully demonstrated its ability to remove heavy metals from the Y-12 Plant surface water. This demonstration was done as a part of the Environmental Protection Agency Superfund Innovative Technology Evaluation (SITE) Program. With the SITE Program the U.S. Environmental Protection Agency (EPA) promotes the demonstration of technologies that offer above average promise for waste management and environmental remediation.

The flow diagram for the E PROCESS is shown in Fig. 4. The process is (depending on application) composed of multiple sections that provide unique, but complementary functions.

- The E-O Section of the process is used to inject Ozone (or other additatives) into the liquid stream. The Ozone is an oxidizing agent that reduces organics and promotes oxidization of metal ions in the E-P Section.
- The E-P Section applies a high energy pulse that uses the process fluid as the electrical conductor. This energy pulse passes a strong magnetic field through the fluid. The E-P and E-O Sections promote precipitation of dissolved contaminates in the liquid.
- The E-A Section is an agglomerator that aids the precipitation and agglomerates particles that are in the liquid.
- The E-G Section is a mechanical separator that separates the precipitates and particles that are in the liquid.
- The MRM Section of the E-PROCESS can have one or more subsections, each with a different formulation of metal ion removal media. These media are polymer based and impregnated on a sponge-like fill material.

In addition to its effectiveness in removing a variety of dissolved and suspended waste stream contaminants, a major benefit of the E PROCESS is the low waste volume generated. The MRM media is on a sponge that can be volume reduced by a factor of 15. The hydro-mechanical separator discharge is a sludge.

PRELIMINARY RESULTS

In 1992 CH20 Inc., in cooperation with the U. S. Department of Energy (DOE), Environmental Protection Agency (EPA), Martin Marietta Energy Systems (MMES) and SAIC; performed a feasibility test to determine the efficacy of treating the water from the sumps in Y-12 Plant Building 9201-2. The purpose was to remove mercury to an acceptable effluent quality level of 2 ppb or less.

Y-12 sump water samples were shipped in chilled containers directly from SAIC-Oak Ridge. The samples were collected on April 21, 1992 in two 5 liter, amber, glass bottles . The samples were packed in ice and sent by overnight express to the CH2O Virginia office for processing. They were received on April 23, 1992. The sample water was processed through the MRM filter of the E-Process on April 23, 1992. The process samples were then shipped to EPA's contract laboratory by overnight express. The samples were labeled and preserved in accordance with SAIC's approved procedures. SAIC provided the sample custody record and the procedure and apparatus for shipping and preserving the samples.

Samples from CH2O were identified as numbers 1001, 2001, 2002 and 2003. Sample 1001 was the untreated control

* CH20 is a Subsidiary of ADTECHS Corporation

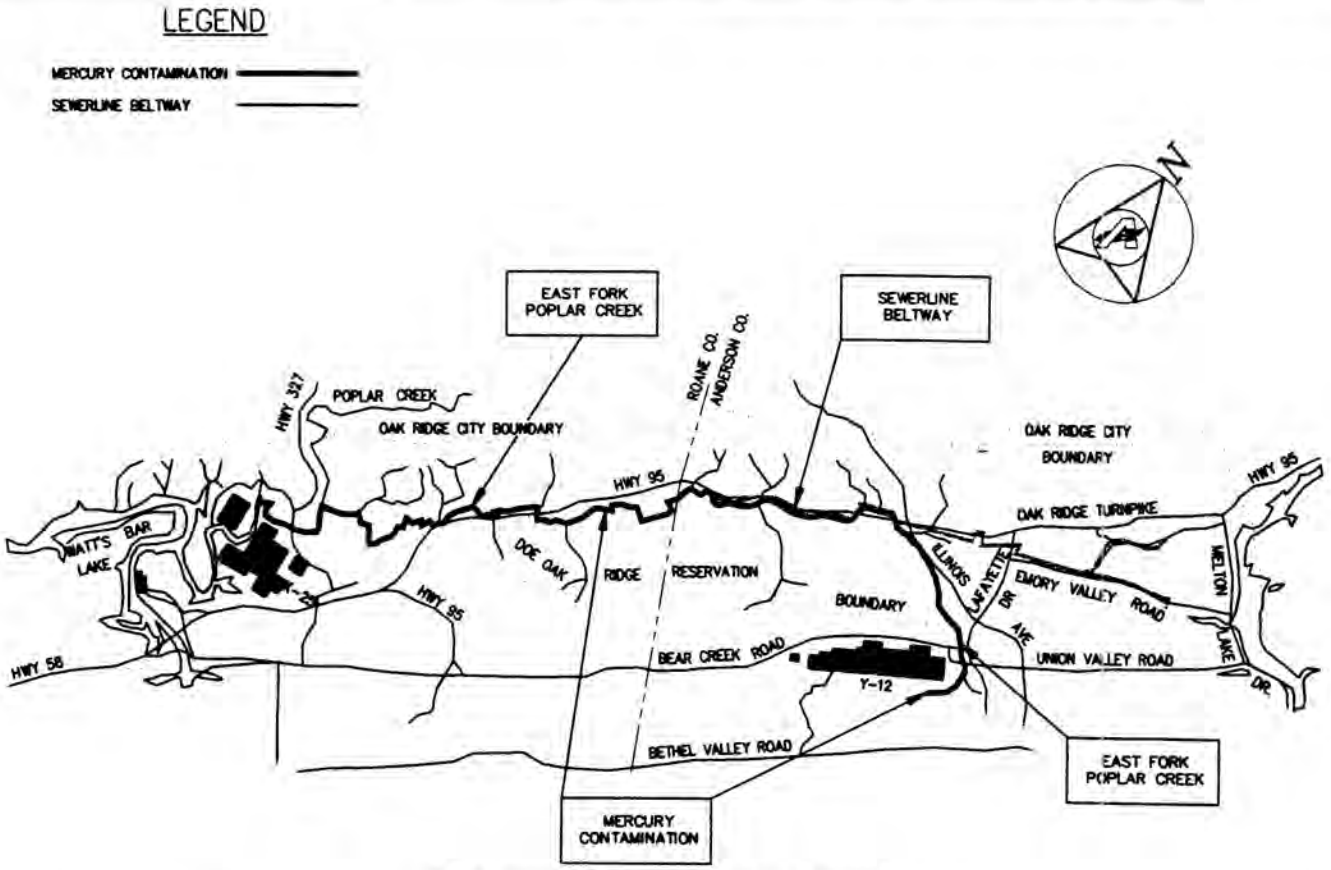

Fig. 3. Contaminated area of poplar creek.

sample and samples 2001, 2002 and 2003 were the treated samples. SAIC sent a control sample directly from Oak Ridge to the EPA contract laboratory using the same packaging and shipping procedures as used for the samples treated by CH2O. This control sample was designated as 2901-1.

Samples were processed through a bench scale E-Process System with an MRM Filter. This process was selected because of its unique ability to remove bacterial elements from waste water while treating for metals. Testing was performed using three different E-Process configurations.

Based on the lab results, treatment Configuration 2, see Fig. 2, is the best arrangement for the removal of the mercury. Since Configuration 2 is the one customarily used for other heavy metal removal applications, it had been predicted to be the best treatment method prior to the test.

TABLE II

Y-12 Sample Analysis Results

Sample I.D.	Concentration ppb	Treatment Process or Sample Description
1001	16.8	Control Sample
2001	2.6	Configuration 1 (proprietary)
2002	0.77	Configuration 2 (proprietary)
2003	0.83	Configuration 3 (proprietary)
2901-1	11.3	Direct Control Sample

Analysis by cold vapor extraction in accordance with EPA approved procedures.

An interesting aspect of the sample analysis report reveals how quickly bacteria can begin to attack and assimilate mercury in solution. Note the difference between sample 2901-1 and sample 1001. Both samples were collected at the same time and handled the same, up to the point of acid fixing. Generalizations can't be made based on such limited data, but this difference in the samples is characteristic of the findings of previous analysts that have investigated the Y-12 sample anomalies.

CONCLUSIONS

CH2O selected the E-Process to treat the water from the sumps and storm drains at the Y-12 plant because of the dynamics of the mercury transport and the biological conversion environment present. The E-Process combines the MRM Filter for the Hg^{+} and HgO fractions as well as a the basic E-Process for treating aerobic and anaerobic bacteria. Generally, it was found that the anaerobic bacteria fraction has a high affinity for metals. In addition, the E-Process generally improves the overall quality of the discharge water from the Y-12 building outfalls into the East Fork of Poplar Creek

This study has provided real promise for the problems such as the one that exist at Y-12 plant. Treatment methods for methylmercury have been sought for years as increasing scientific data confirms the health risks of methylmercury entering the food chain. Further study of the process is required and planned at Y-12 to evaluate long term treatment of the waste stream.