THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

Concurrent Technologies Corporation

ETV VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**WASTEWATER TREATMENT**		
APPLICATION:	**OILY AND METAL-BEARING WASTEWATER**		
TECHNOLOGY NAME:	**DTIC Industrial Wastewater Treatment Plant**		
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The United States Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by substantially accelerating the acceptance and use of improved, cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholder groups consisting of buyers, vendor organizations, states, and others with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are credible.

The ETV P2 Metal Finishing Technologies (ETV-MF) Program, one of seven technology areas under the ETV Program, is operated by Concurrent Technologies Corporation, in cooperation with EPA's National Risk Management Research Laboratory. The ETV-MF Program has evaluated the performance of a wastewater treatment system for processing oily, and metal bearing wastewater from metal finishing operations. This verification statement provides a summary of the test results for Davis Technologies International Corp.'s Industrial Wastewater Treatment Plant.

VERIFICATION TEST DESCRIPTION

Davis Technologies International Corp. (DTIC) Industrial Wastewater Treatment Plant (IWTP) was tested, under actual production conditions, processing metalworking and metal finishing wastewater, at Federal-Mogul, Inc., in Blacksburg, Virginia. The verification test evaluated the ability of the IWTP system to remove regulated contaminants from the wastewater.

The test plan was designed with three distinct test periods, with a different raw wastewater processed during each test run. The three wastestreams represent wastewaters from three common Metal Finishing/Metal Products and Machinery category manufacturing configurations:

- During the first test period, oily wastewater from metalworking operations (machining, forming, cleaning) was treated.
- During the second test period, metal-bearing wastewater from metal finishing was treated.
- During the third test period, a mixture of oily wastewater from metalworking and metal-bearing wastewater from metal finishing operations was treated.
- The treated effluent from the IWTP system was pumped to a storage tank and fed into the existing Federal-Mogul wastewater treatment system.

Chemical usage, electricity usage, and sludge generation data were collected to perform the cost analysis.

TECHNOLOGY DESCRIPTION

The following technology description was provided by DTIC and was not verified. The IWTP system that was tested is a mobile unit with a flow capacity of 38 to 246 liters/min (approximately 10 to 65 gallons per minute (gpm)). This system is designed to treat various types of industrial wastewaters. When used to process a combined oily and metal-bearing wastewater, the IWTP system consists of two separate processes, oil recovery and metals precipitation, and each process consists of three stages. In the first stage of oil recovery, the hydrocarbon (oil) is cracked via a pH adjustment with hydrochloric acid (HCl). The second stage is flocculation, where a proprietary polymer is added that captures the hydrocarbons in a floc. In the third stage, dissolved air is injected into the wastewater, forcing the flocculated material to the surface, where it is skimmed off and pumped to a collection tank. The metals treatment process is also conducted in three stages. In the first stage, the pH of the wastewater is adjusted using sodium hydroxide. This causes metals to precipitate in a hydroxide form. In the second stage, ferric chloride (acting as a coagulant) and a proprietary polymer are added, which causes precipitated metals to agglomerate in a dense floc. In the third stage, air is injected into the wastewater, forcing the flocculated material to the surface, where it is skimmed off and pumped to a collection tank.

VERIFICATION OF PERFORMANCE

During the first test run (oily wastewater from metalworking operations), an insufficient volume of oily wastewater was available to operate the system at its designed flow rate and this test run was cancelled.

During the second test run (metal finishing wastewater), the IWTP system was evaluated over a four-day period, during which daily composite and grab samples were collected of raw and treated wastewater. Grab samples of the recovered oil and sludge were collected on the final day of testing. The wastewater samples were analyzed for regulated pollutants in order to evaluate the ability of the IWTP system to remove these chemicals. The sludge samples were analyzed to determine their characteristics and for use in mass balance calculations.

During the third test run (metal finishing wastewater and metalworking wastewater combined), the IWTP system was evaluated over a 32-hour period, during which composite samples were collected of raw and treated wastewater at intervals of eight hours, and grab samples of oil & grease (O&G) and sulfide were collected at intervals of four hours. Grab samples of the sludges were also collected. The wastewater samples were analyzed for regulated pollutants in order to evaluate the ability of the IWTP system to remove these chemicals. The sludge samples were analyzed to determine their characteristics and for use in mass balance calculations.

Pollutant Removal Efficiency. The metals found in the raw wastewater at an average concentration of one mg/L or greater include aluminum, copper, lead, tin, and zinc. During Runs 2 and 3, the removal percentages for these five metals ranged from >75 percent to 98.9 percent. During Run 3, when a combined oily and metal-bearing wastewater was treated, the IWTP removed greater than 97.2 percent of O&G (HEM). Pollutant removal efficiency was calculated only for parameters that were found at concentrations above the detection limit in the influent for each daily set of analytical results. Also, four-day average removal efficiencies were calculated for each parameter for the two test runs. When the concentration in the treated sample was below the detection limit, the detection limit value was used as the value for determining the removal efficiency and a "greater than" sign was used in front of the removal efficiency value. The four-day average removal efficiency could not be calculated if one or more of the daily removal efficiencies could not be calculated.

Parameter	Run 2 (Metal Finishing Wastewater) Averaged Results			Run 3 (Metal Finishing and Oily Wastewater) Averaged Results		
	Raw Wastewater mg/L	Treated Wastewater mg/L	% Removal	Raw Wastewater mg/L	Treated Wastewater mg/L	% Removal
Sulfide	<1.0	<1.0	NC	<4.0	<1.0	NC
O&G (HEM)	<1.2	<1.0	NC	41.72	<1.0	>97.2
O&G (Freon)	<1.2	<1.1	NC	51.28	<1.0	>98.1
pH*	11.4	7.9	NA	6.3	7.4	NA
TDS	3665	3520	4.0	3135	3463	0.0
TSS	310	25	92.1	61	18	70.1
TOC	5.3	5.5	0.0	11.3	10.6	6.2
Aluminum	ND	ND	ND	4.24	<1.0	>75.5
Cadmium	0.014	<0.006	>49.9	<0.005	<0.005	NC
Chromium	0.070	0.021	69.7	0.073	<0.067	>8.2
Copper	49.65	2.87	94.2	29.70	1.04	96.5
Manganese	0.122	0.150	0.0	0.08	0.16	0.0
Molybdenum	<0.1	< 0.1	NC	<0.10	<0.10	NC
Nickel	0.090	<0.054	>36.7	<0.05	<0.04	NC
Lead	9.85	0.18	98.1	4.15	<0.05	>98.7
Tin	20.85	0.31	98.5	5.14	<0.10	>97.2
Zinc	89.73	17.39	80.6	34.87	8.02	77.0

* pH units
NA = Not Applicable
NC = Not Calculated
ND = No Data
TDS = Total Dissolved Solids
TOC = Total Organic Carbon
TSS = Total Suspended Solids

Table i. Averaged Pollutant Concentrations and Removal Percentages

Raw Wastewater Variability. The characteristics of the wastewater changed significantly between test runs and also within each run. A comparison of average pollutant concentrations for Runs 2 and 3 are shown in **Table ii**. Of particular significance are the differences in TDS, TSS, copper, lead, tin, and zinc. Note that the percent difference between the runs in many cases exceeds 200%.

Parameter	Raw Wastewater, Run 2, 4-Day Avg. (mg/L)	Raw Wastewater, Run 3, 4-Day Avg. (mg/L)	% Difference Run 2/Run 3 x 100%
Sulfide	<1.0	<5.2	NC
O&G (HEM)	<1.2	45.8	NC
O&G (Freon)	<1.2	55.8	NC
TDS	3665	3135	117%
TSS	310	61	508%
TOC	5.3	11.3	46.9%
Cadmium	0.014	<0.005	NC
Chromium	0.071	0.07	101%
Copper	49.2	29.5	167%
Manganese	0.122	0.08	153%
Molybdenum	<0.1	<0.1	NC
Nickel	0.090	<0.05	180%
Lead	10.0	4.1	244%
Tin	20.8	5.0	416%
Zinc	90.5	35.1	258%

NC = Not Calculated

Table ii. Comparison of Raw Wastewater From Runs 2 and 3

Ability to Meet Target Effluent Levels. Two levels of effluent quality were selected and agreed upon by all parties as target effluent concentration levels for certain pollutant parameters. The bases of these levels are the Metal Finishing Point Source Effluent Limitations (target level 1) and the proposed Metal Products and Machinery (MP&M) Point Source Effluent Limitations (target level 2). The "ideal" case would be if the treatment system could meet the more stringent target level 2. The analytical results from each day or sampling period were compared to the two target levels to determine if the IWTP achieved these effluent quality target levels. During Run 2, the target level 1 concentrations were met for all parameters except copper (Day 2) and zinc (Days 1, 2, and 4), and the target level 2 concentrations were met for all parameters except copper (Days 1, 2, 3, and 4), manganese (Days 1 and 2), lead (Days 1, 2, 3, and 4), and zinc (Days 1, 2, 3, and 4). During Run 3, the target level 1 concentrations were met for all parameters except zinc (Periods 2, 3, and 4), and the target level 2 concentrations were met for all parameters except copper (Periods 1, 2, 3, and 4), manganese (Periods 3 and 4), lead (Period 2), and zinc (Periods 1, 2, 3, and 4).

Parameter	Target Level 1	Target Level 2	Run 2[1]				Run 3[2]			
			Day 1	Day 2	Day 3	Day 4	Period 1	Period 2	Period 3	Period 4
Sulfide	**NR**	**31**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
O&G (HEM)	**NR**	**15**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.7	<1.0
TOC	**NR**	**87**	6	4.5	5.8	5.8	11.8	12	8.7	9.8
Cadmium	**0.69**	**0.14**	<0.005	0.012	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	**2.77**	**0.25**	0.016	0.014	0.021	0.036	0.027	0.22	0.013	<0.01
Copper	**3.38**	**0.55**	1.6	7.9	0.6	1.7	0.84	1.1	1.3	0.98
Manganese	**NR**	**0.13**	0.19	0.32	0.041	0.049	0.036	0.13	0.2	0.32
Molybdenum	**NR**	**0.79**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	**3.98**	**0.5**	0.12	0.045	<0.04	0.012	<0.04	<0.04	<0.04	<0.04
Lead	**0.69**	**0.04**	0.069	0.13	0.14	0.42	<0.05	0.067	<0.05	<0.05
Tin	**NR**	**1.4**	0.13	0.2	0.3	0.66	<0.1	<0.10	<0.1	<0.1
Zinc	**2.61**	**0.38**	36.5	24.1	2.5	3.5	2.3	9	8.6	13.7

NR = Not Regulated.

Note: [1]Run 2 consisted of four 24-hour sampling periods.

[2]Run 3 consisted of four 8-hour sampling periods.

Table iii. Average Pollutant Concentrations, mg/L

Oil Removal Efficiency. To evaluate the effectiveness of the technology, During Run 3, 61 liters (16 gal) of oil were metered into the raw wastewater to evaluate the effectiveness of the IWTP with regard to oil removal/recovery. The analytical results indicate that the IWTP removed the oil to near or below detection limits (1.0 mg/L) for all sampling periods. Oil is removed by the first process step of the IWTP. Prior to testing it was expected that the oil would be removed in a recoverable form as "free oil." However, during testing, the solid material collected from the first process step more closely resembled an oily sludge than free oil. The usability of this material as recovered oil was not verified during the test.

Energy Use. The power consumption of the IWTP is 23.55 kW under full load at maximum throughput capacity.

Cost of Operation. The following parameters were considered in the cost analysis: chemical reagents, other materials, electricity, sludge management, and oil recovery. The cost of treatment was $0.88/1000 L for Run 2 and $2.21/1000 L for Run 3. The cost is based on total volumes treated during Runs 2 and 3, which were 443,663 L and 188,163 L respectively.

SUMMARY

The raw wastewater treated during this verification contained a number of pollutants whose concentrations varied unexpectedly and suddenly during the test periods. The wastewater variability was a difficult challenge for the technology and may have impacted pollutant removal rates. Many of the pollutant concentrations in the influent to the IWTP varied by more than 200 percent between Runs 2 and 3, with the most significant differences found with TSS, lead, tin, and zinc. The polymer and ferric chloride treatment reagents were added at constant rates previously determined from bench scale testing. The changing characteristics of the raw wastewater may have resulted in non-optimal dosages being applied. The test results show that the Davis Technologies International Corp. Industrial Wastewater Treatment Plant was able to effectively remove oil from metal finishing wastewaters to near or below detection limits and meet the effluent quality target levels for O&G (HEM). However, the IWTP was not able to meet the effluent quality target levels for certain other parameters. The treated effluent parameters that were most frequently found at concentrations higher than the target levels were copper, lead and zinc. These were also the pollutants whose raw wastewater concentration varied significantly. The performance of the IWTP system may also be related to pH during treatment. For sampling periods when the pH of the IWTP effluent averaged above 9.0, the system effectively met the effluent quality target levels for all parameters, except copper and zinc.

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