Friendly Skies (and waters)

A new treatment successfully removes contaminants from oily wastewater generated by aircraft maintenance operations

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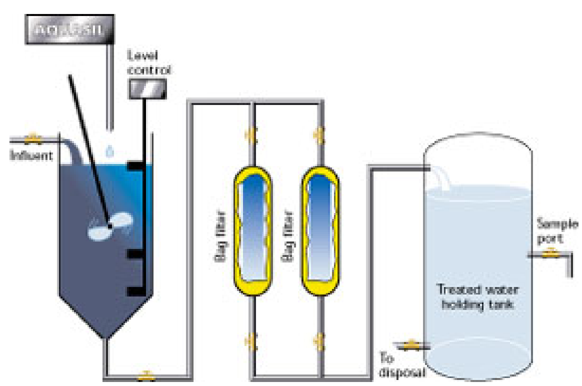
Aircraft maintenance and service operations generate large volumes of oily waste that require pretreatment prior to being released to municipal sewers or surface waters. The oily waste contains lubricants, cutting fluids and heavy hydrocarbons such as tars, grease and diesel oils and hydrocarbons such as kerosene and jet fuel at concentrations that may vary from a few hundred parts per million to as much as 1 to 10 percent by volume. In addition, the oily waste may contain chemically and mechanically emulsified oils, acid/alkaline cleaners, solvents, suspended solids and heavy metals.

Oily wastes encompass both oil in water (O/W) and water in oil (W/O) emulsions. Such emulsions are usually stable and must be subjected to an emulsion breaking process in the course of their treatment. Emulsion breaking often requires the use of physical means such as centrifugation and vacuum filtration or the addition of acids and demulsifiers such as inorganic and organic coagulants.

Conventionally, oily wastewater is treated with sulfuric acid or sulfuric acid and organic demulsifier. The process may also be enhanced by heat. Floating oil and jet fuel, if present, can be separated in an oil/water separator and recovered. Wastewater from the oil/water separator may flow to dissolved-air-floatation (DAF) units or pass through a granular activated carbon (GAC) or an organoclay adsorption cartridge for polishing off residual oil. Flow from DAF, GAC or organoclay cartridges goes to the chemical precipitation equipment for removal of heavy metals.

CASE STUDY

A U.S. aircraft maintenance and service center has separate service stations for aircraft engines, brakes and landing gear, metal plating, instruments, frame repair, machining and other support equipment. Wastewater from the stations is collected in sumps and directed to the main treatment plant where it is treated and released. The facility also generates a waste stream (about 400 to 500 gallons per month) that contains high concentrations of oil, heavy petroleum hydrocarbons, grease, heavy metals and suspended solids. The nature of this waste stream requires that it be segregated and treated separately in a dedicated treatment setup.



In the past, the oily waste was hauled away as a hazardous waste (sludge). Recently, the waste was treated in a setup based on GAC adsorption. The setup consisted of two GAC cartridges, one in use and the second in stand-by. As the waste contained high levels of grease, emulsified oil and heavy petroleum oil coupled with a problematic bacterial growth, the system was prone to fouling and required continuous monitoring while in operation. Furthermore, expired GAC cartridges required removal and replacement by the vendor.

Table 1. Performance of Aquasil

Parameter	Discharge limits (mg/L)	Raw water (mg/L)	Treated water (mg/L)
Total arsenic	0.002	0.005	<0.001
Total barium	1.00	5.100	0.034
Total cadmium	0.050	120.0	<0.001
Total chromium	0.200	14.00	0.017
Total copper	1.130	2.900	0.050
Total iron	0.300	79.00	0.030
Total lead	0.200	0.990	0.003
Total mercury	0.002	0.001	<0.0005
Total nickel	1.290	85.00	0.060
Total selenium	0.002	2.000	<0.002
Total silver	0.100	1.200	<0.025
Total zinc	0.400	2.500	0.070
Total suspended solids	275	580	7.5
Total oil & grease	25.00	23,000	13.6
pH	6.0-9.5	7.85	8.4

The system was deemed inefficient due to the required intensive monitoring and since it did not meet the requirements for removal of heavy metals, the system was finally decommissioned. Through a new environmental program, the facility was required to implement an innovative technology into its operation. The new technology would be assessed for environmental benefits, labor and cost savings and the ability to interface with the various routine operations.

Several technologies were considered for this program.

A performance study was conducted during the spring of 1999 using an AQUASIL® product on a sample of the oily wastewater. Results are shown in **Table 1**.

The AQUASIL® treatment was chosen as the most cost-effective technology. As a result, AQUACHEM was contracted to design and install a fully automated batch treatment system to treat the oily waste stream.

The AQUASIL® pretreatment system employs a proprietary advanced nonhazardous blend of natural and synthetic materials that are made to fit the chemistry of the particular waste stream. Each product is stand-alone and completely hydrophilic and has a high capacity to take up contaminants through fast kinetics and synergy. The product takes up and removes the various contaminants from the waste stream simultaneously. The product is added or metered into an agitated waste stream in a treatment tank, and within minutes a dense floc forms, which quickly settles and is easily dewatered. Generated waste is non-hazardous, as it passes the Toxicity Characteristic Leaching Procedure (TCLP).

The automated batch system consists of a 500-gallon conical bottom reaction tank equipped with a level control, a dry powder feeder and an air-operated diaphragm pump, two bag-filter assemblies — one in use and the other on stand-by. A 500-gallon treated water holding tank and a control panel with an audible horn and flashing red beacon alarms that indicate the ready-to-treat, bag-filter-full and cycle-complete phases are also included in the system.

Wastewater is collected in drums and brought to the treatment system. If light fuel is present in substantial amounts — most of it is removed prior to treatment — it is easily siphoned out and the waste is pumped into the treatment tank. The treatment cycle starts when water level in the treatment tank reaches a predetermined level where contacts in the control panel trigger a switch that starts the mixer. When the high level is reached, the ready-to-treat alarm is energized, the feed pump stops and the dry powder feeder starts dispensing a timed dose of AQUASIL®. The powder feeder stops automatically at the end of the timed period. The mixer continues operating for a timed period. A timed settling period starts, at the end of which an alarm starts flashing, signaling the cycle-complete phase. The entire cycle takes about one to three hours to complete, depending on the quality of wastewater.

The content of the treatment tank is pumped through a bag filter, which separates the floc from the clean water. The alarms on the control panel will indicate when the operating filter bag is full. The operator manually switches to a standby filter bag. Clean treated effluent is collected in the clean water tank, which is equipped with sampling and viewing ports. The effluent is released once its quality has been approved.

Effluent quality

Samples of treated water are withdrawn from the clean-water holding tank and sent to a certified laboratory for analysis. Analytical data for treated effluent are shown in **Table 2**; data for raw water are shown for comparison.

Table 2. Water quality

Parameter	Discharge limits (mg/L)	Raw water (mg/L)	Treated water (mg/L)
Total arsenic	0.002	0.049	ND
Total cadmium	0.050	14.3	ND
Total chromium	0.200	0.560	ND
Total copper	1.130	0.33	ND
Total iron	0.300	27.2	ND
Total lead	0.200	0.051	ND
Total mercury	0.002	ND	ND
Total nickel	1.290	6.40	ND
Total selenium	0.002	0.026	ND
Total silver	0.100	0.810	ND
Total zinc	0.400	2.80	ND
Total suspended solids	275	702	5.00
Total oil & grease	25.00	12,330	2.30
pH	6.0 - 9.5	8.63	9.28

System components

The AQUASIL® treatment delivered high quality effluent with consistent performance over a period of more than eight months. The treatment achieved almost 100 percent removal of heavy metals and oil and grease and more than 99 percent of total suspended solids. It was able to take up 140 percent its weight in oil and yet remained active towards heavy metals and suspended solids. The system requires no maintenance and only minimal operator attention.

Waste characterization

Solidification and stabilization in a non-leaching matrix is the best available technology for disposal of hazardous contaminants in a landfill to ensure these contaminants do not pose a hazard to the environment. In current practices, generated waste undergoes a further treatment with amendments that renders it suitable for long-term disposal. This manipulation is carried out at waste treatment plants and increases the overall cost of water treatment.

Under the authority of the Resource Conservation and Recovery Act (RCRA), hazardous substances are defined in terms of a set of four characteristics:

- Ignitability of flammable and combustible substances;
- Corrosivity of substances that corrode steel due to extreme acidity or basicity;
- Reactivity of substances that undergo violent chemical change; and
- Toxicity, defined in terms of the TCLP.

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Solids generated in the AQUASIL® treatment displayed none of the above characteristics. Although the wastewater had more than 10,000 parts per million of petroleum material, the generated waste did not produce a flash point. TCLP results showed that all metals were below detection. The waste was then classified as non-hazardous. Data for waste characterization are shown in **Table 3**.

Table 3. Waste characterization

Parameter	Regulatory level (mg/L)	Concentrations after treatment (mg/L)
Arsenic	5	ND
Barium	100	ND
Cadmium	1.0	ND
Chromium	5.0	ND
Lead	5.0	ND
Mercury	0.2	ND
Selenium	1.0	ND
Silver	5.0	ND
Flash point (ºF)	NA	>200

Cost of treatment

Capital costs to construct and install the system were about $33,000. Annual operational and maintenance costs are estimated at about $3,000 based on worst-case scenarios. Total cost, based on a 20-year amortization, is estimated at $0.625/gal ($0.165/L); about 69.5 percent and 87 percent savings compared to GAC adsorption and haul away costs, respectively.

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