SOCIETY OF AMERICAN MILITARY ENGINEERS • JANUARY-FEBRUARY 2014 • VOL 106 • NUMBER 687

TME
The Military Engineer

Maj. Gen. John Peabody on the Future of Civil Works
Page 44

The Restoration of Fort Ord
Page 63

How the Air Force is Leveraging Assets
Page 61

Remediation Under the Sea
Page 55

Main Theme: Environmental Engineering • Special Report: Innovative Financing & Privatization

Removing Oil from Water

The challenge facing engineers of providing systems to remove oil from wastewater at vehicle maintenance facilities is only intensifying as environmental regulations become more stringent.

By Kirby S. Mohr, P.E., M.SAME, and Riley Moore, EIT

(Top) Retrofit of existing separator at Marine Corps Air Ground Combat Center, Twentynine Palms, Calif. PHOTO COURTESY DAVID VAN DYKE, THE VAN DYKE CORP.

(Right) The frame type separation system installed in a new concrete vault at Byrd Field, Va., is primarily intended to service the water from a fueling area. PHOTO COURTESY JIM MABRY, POND CONSTRUCTORS

It is no secret that oil is present in the water discharged from vehicle maintenance facilities, which are present on all military installations and many other government sites. Most of this oil comes from the vehicles that are washed prior to their being serviced and some comes from washing work areas, including from washing floors.

It is necessary to remove this oil that is present in water before it may be discharged from the facility. In some cases, facilities will have dedicated wastewater treatment equipment, but most wastewater from vehicle maintenance facilities is directed to the local sanitary sewers.

The rules for wastewater discharge are set either directly according to the *Clean Water Act* requirement for "no sheen" or, if there is a treatment entity down-stream, by the water treatment facility requirements. Permissible levels of oil discharged into sanitary sewer can range from 75 to 200-mg/l. For direct discharges to lakes or rivers, most states and localities allow only 15-ppm oil and grease, based on a 24-hour composite sample. Analyses are generally conducted using the EPA-1664 method, which is done by most laboratories and accepted by most authorities.

EVALUATING AVAILABLE SYSTEMS

There are a variety of technologies used to separate oil from water. Most are overly simplistic and often ineffective. However, there are some design alternatives that may be successful for pretreatment of the wastewater prior to discharge. The following methods are those used (with varying success) to attempt to meet effluent requirements with minimum cost and maintenance.

Gravity Separation. Some of the simplest possible separators are the API (American Petroleum Institute) and API type separators. Many systems utilized are "API type separators" and though similar in style, they do not meet the design parameters required in the API method. Advantages of the API and API type separators are simplicity of design, low cost, low maintenance and resistance to plugging with solids. The primary disadvantage is the poor quality of separation that they provide. The API method was originated to produce an effluent quality of 150-mg/l; this would not meet the requirements of most sanitary sewer authorities and certainly not the *Clean Water Act*. API type separators are even less effective.

Enhanced Gravity Separation. Enhanced gravity separators provide better separation quality than is possible with simple gravity separators while maintaining the low capital and maintenance cost benefits. Enhanced gravity separation systems have similarities to API separators, but include coalescing media that enhance the separation of oil and water. These internal features act as a substitute for the additional residence time provided by the API separators.

Multiple Angle Plate Separators. Multiple angle plate separators were developed to take advantage of gravity's effects to the fullest and optimize oil removal. The plates are corrugated in both directions, making an "egg-carton" shape. This is done

Performance Test Results • Byrd Field, Va.			
Sample No.	**Inlet oil content**	**Sample No.**	**Outlet Oil content**
2	10.7	1	Non-detect
6	41.4	4	Non-detect
14	721	12	Non-detect
10	804	8	Non-detect
11	1200	13	Non-detect
18	2430	6	Non-detect
7	4100	9	Non-detect
15	18000	17	330
19	25000	21	Non-detect

Notes:
1. Testing performed on rainwater with corn oil as test contaminant.
2. Corn oil has a specific gravity higher than jet fuel and therefore corn oil is a more stringent test media. More importantly, it is more environmentally safe.
3. Oil content analyses conducted using EPA-1664 method.

Performance testing was conducted on the Byrd Field system (shown on p. 59) as part of the approval process. TEST RESULTS COURTESY JIM MABRY, POND CONSTRUCTORS

so that all of the underside surfaces slope upward, encouraging captured oil to move toward the surface. Spacers are built into the plates for two or more vertical spacings (often 8-mm and 16-mm). Narrower spacing is more efficient while the wider spacing is more solids-tolerant.

Maintenance Separators. Maintenance separators are utilized as above or below ground separators. The choice of separator designs is often dictated by site requirements, but all else being equal, it is usually more cost-effective to utilize below-ground precast concrete separators. Below-ground systems are often fitted with the media installed in frames. The captured oil is self-removing to the surface.

Coalescing Plate Separation Systems. Coalescing plate separation systems offer better performance than the simpler systems, but may have higher costs. Where applications require high efficiency oil removal as well as the ability to tolerate solids, the multiple angle media systems have been proven to perform under difficult conditions and still provide effluent oil concentrations low enough to meet normal regulatory requirements.

SPECIFICATIONS AND DESIGN

Flow Quantity. The first step in determining the required design for a vehicle maintenance facility water treatment system is to determine the maximum instantaneous flow rate.

In some facilities, the quantity of wastewater emanating is well-known because it is the result of a pumped flow system and the capacity of the pump should be known. The quantity also may be established by the flow of other equipment such as pressure washers, which typically have the flow rate posted on the machine. If other data is not available, 5-gal/min (18.9-l/min) is a satisfactory estimate for the flow of a single pressure washer type hose.

Sometimes the maximum flow rate will be the result of the use of one or more garden hoses for floor washing. A reasonable flow rate for designing under these circumstances is approximately 10–gal/min (37.8-l/min) per garden hose.

Operating Temperature. The operating water temperature is an important variable because it governs the viscosity of the water. In many maintenance facilities a reasonable assumption is 55°F. This is a safe assumption for groundwater worldwide; if the water is heated though, it will be higher.

Oil Content. The oil content is seldom known—and varies wildly with the operations of the facility. Mohr Separations Research (MSR) has historically used 1000-mg/l (0.1%) based on its experience.

Oil Specific Gravity. MSR generally uses 0.85 as an estimate for the hydrocarbon specific gravity. This is typical for diesel fuel and is based on some analyses of captured oil from working separators. Lubricating oil is somewhat denser than diesel fuel, but more diesel fuel tends to leak from vehicles than lubricating oils, so the density of diesel fuel is suggested.

Solid Particles. In maintenance facilities, characteristics of the solids will be mixed. MSR generally uses as an estimate for typical solids a specific gravity of 1.4, which is given in *Perry's Chemical Engineer's Handbook* for river mud and an average particle size of 60-µm. If large quantities of solids are expected, it is advisable to provide some settling volume ahead of the separator media.

Information developed based on the above suggestions can be used to prepare specifications and request bids on the equipment. Most coalescing media providers will be able to provide not only media, but also the process dimensions for the concrete vaults or steel separators required. Some media providers have equipment listed in the U.S. General Services Administration catalog, which can simplify ordering. Often, it also is possible to retrofit existing equipment with more sophisticated internals to enhance separation quality, or to increase allowable flow rates, or both.

SUMMARY AND CONCLUSIONS

Environmental regulations are becoming more restrictive and requiring lower concentrations of hydrocarbons in effluent water. Some localities have much more stringent effluent standards than the U.S. Environmental Protection Agency or other national bodies.

Unfortunately, budgets for wastewater treatment at maintenance facilities are always very limited. Empty tank (API or API Type) systems are not adequate to ensure good treatment and it is necessary to utilize a high-efficiency system to remove the oil. Use of multiple angle coalescing plates in concrete vaults or other systems provides a cost effective method of ensuring effluent water quality that meets, or exceeds, the requirements of federal, state and local regulations.

TME

Kirby S. Mohr, P.E., M.SAME, is President, and Riley Moore, EIT, is Project Engineer, Mohr Separations Research Inc. They can be reached at 918-299-9290, or kirby@oilandwaterseparator.com; and 918-299-9290, or riley@oilandwaterseparator.com, respectively.