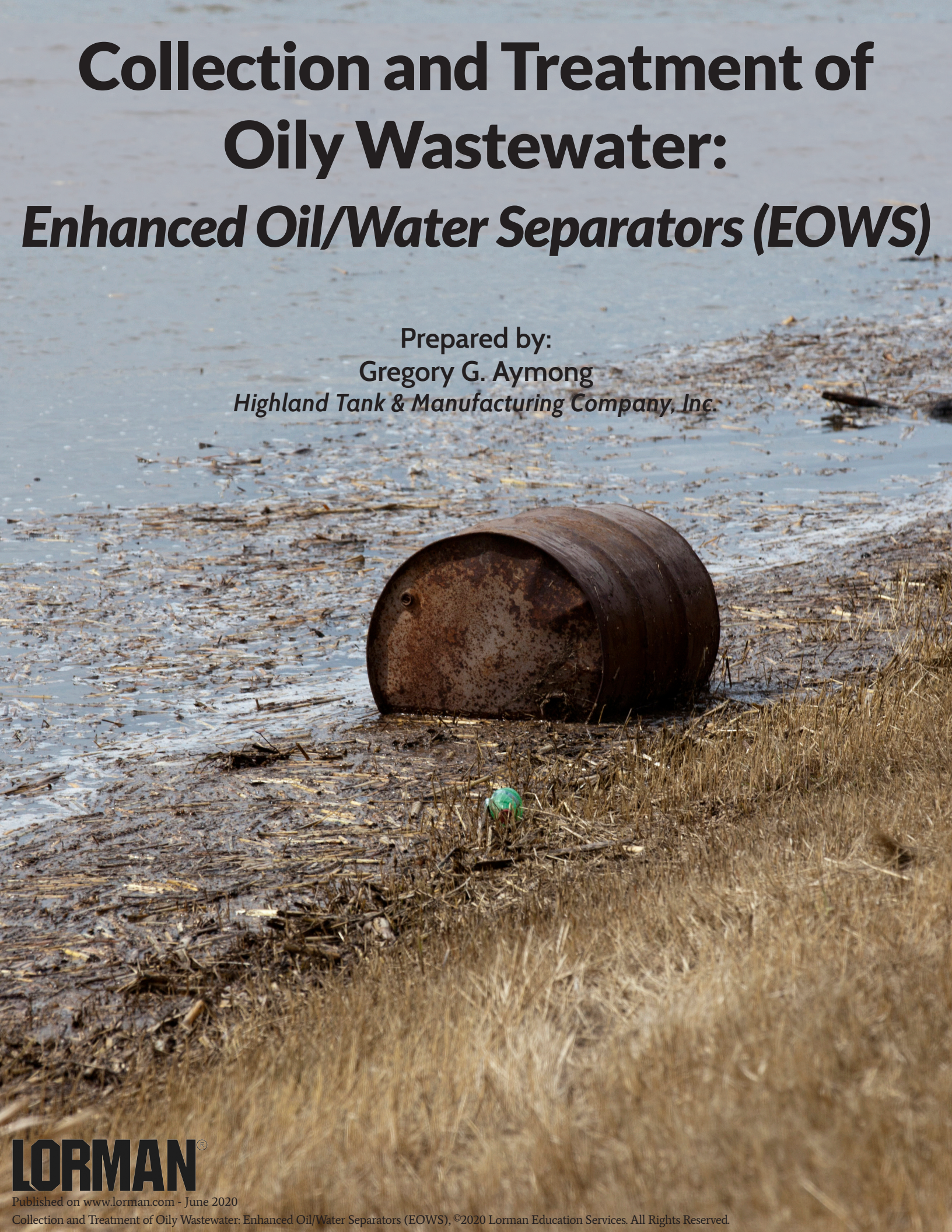
Collection and Treatment of Oily Wastewater:

Enhanced Oil/Water Separators (EOWS)

Prepared by:
Gregory G. Aymong
Highland Tank & Manufacturing Company, Inc.



LORMAN®

Published on www.lorman.com - June 2020

INTRODUCING

Lorman's New Approach to Continuing Education

ALL-ACCESS PASS

The All-Access Pass grants you UNLIMITED access to Lorman's ever-growing library of training resources:

- ☑ **Unlimited Live Webinars** - 110+ live webinars added every month
- ☑ **Unlimited OnDemands** - Over 3,900 courses available
- ☑ **Videos** - More than 1,900 available
- ☑ **Slide Decks** - More than 3,300 available
- ☑ **White Papers** - More than 2,000 available
- ☑ **Reports**
- ☑ **Articles**
- ☑ **... and much more!**

Join the thousands of other pass-holders that have already trusted us for their professional development by choosing the All-Access Pass.

Get Your All-Access Pass Today!

SAVE 20%

Learn more: **www.lorman.com/pass/?s=special20**

Use Discount Code Q7014393 and Priority Code 18536 to receive the 20% AAP discount.

*Discount cannot be combined with any other discounts.

COLLECTION AND TREATMENT OF OILY WASTEWATER ENHANCED OIL/WATER SEPARATORS (EOWS)

Gregory G. Aymong
Highland Tank
grega@highlandtank.com

ABSTRACT

The public's increasing interest is the conservation of the nation's water resources, which has directly affected many industries. Impacted industrial facilities are facing increasingly more stringent regulations covering the treatment and discharge of oily wastewater and now risk costly penalties resulting from public pressure for the government to control harmful oil spills and pollutant discharges.

Treatment and spill control can be accomplished in several ways; with an oil/water separator, and in some cases, with the addition of an Advanced Hydrocarbon Filtration System. The method of treatment depends on the concentration and the type of contaminants in question as well as the location of the discharge.

INTRODUCTION

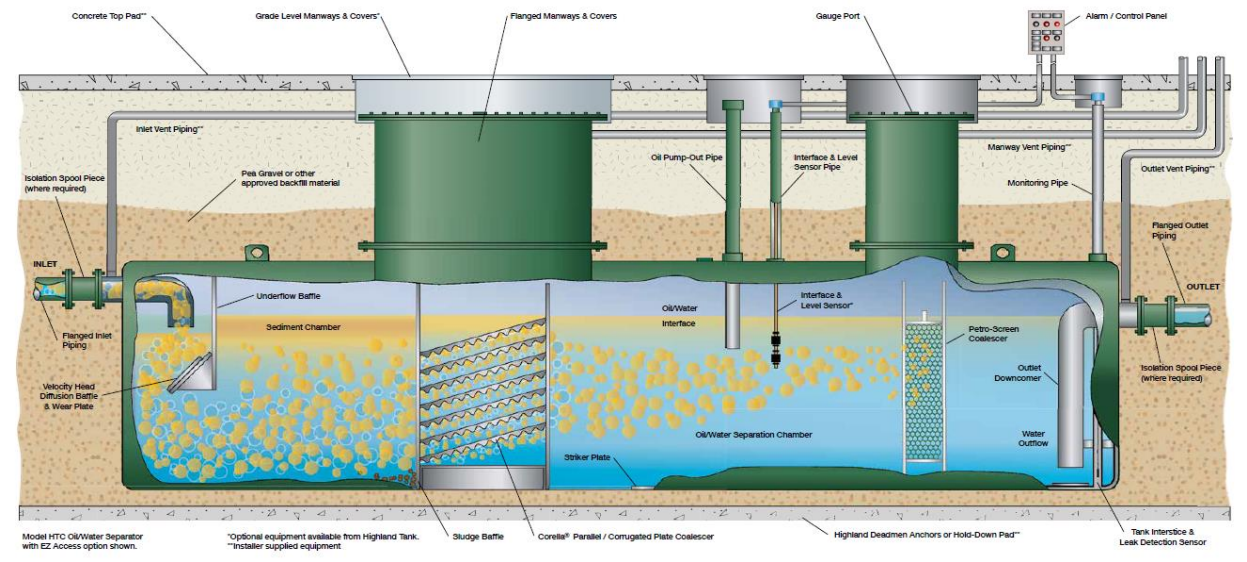
The public's increasing interest is the conservation of the nation's water resources, which has directly affected many industries. Impacted industrial facilities are facing increasingly more stringent regulations covering the treatment and discharge of oily wastewater and now risk costly penalties resulting from public pressure for the government to control harmful oil spills and pollutant discharges.

ENHANCED OIL/WATER SEPARATORS (EOWS)

STEP 1.

One of the major drawbacks of the parallel coalescing plate separator is, like any settling facility, they present an environment in which solids will be settled coincidentally with the separation of the oil. One can see that in the initial settling period, these corrugated plate systems will work very well. Over time, as the separated solids begin to build up on the corrugated plate upper surfaces, the flow paths between the paths will become clogged and constricted. The result is frequent cleaning and maintenance of the oil/water separator.

Technology has advanced toward the development of the Enhanced Oil/Water Separator (EOWS). Figure 4. The features that make these oil/water separators “enhanced”, more effective at removing small oil droplets, and easier to maintain are their specially designed coalescing plate packs and coalescing media.



Enhanced Oil/Water Separator
Figure 4

As previously stated, free oil is removed from the water by gravity separation, a process that takes advantage of the density difference between oil and water. The effectiveness of this process also depends upon the size of the oil droplets and the rate that they raise through the water. Small droplets may not rise fast enough to be captured for removal unless the unit is very large or includes coalescing packs consisting of a series of specially designed parallel corrugated plates.

The coalescing plate pack provides greater surface area to contact and intercept small oil droplets. Oil droplets are removed by accumulating on the underside of the plates. Upon contact, small oil droplets coalesce forming larger droplets, resulting in an increased buoyancy and rise rate to the surface of the unit for removal. This innovative utilization of the dual capabilities of gravity assist separation and coalescence can generate a dramatic result as clean effluent is observed exiting the separator.

Unfortunately, the primary reason for failure of this style of oil/water separator is the clogging of the coalescing plates with settleable solids. The more advanced coalescing plate pack in the EOWS combine the features of both flat and corrugated plate. Figure 5. The difference lies in the manufacture of the coalescer with inclined parallel plates that are flat on the top and corrugated on the bottom. The plates are constructed and arranged to allow settleable solids to accumulate on the flat top and slide downward, while the oil coalesces into sheets on the corrugated undersides and slides upwards. Both oil and solids can be removed without shutting down the separator for periodic cleaning. This configuration also allows increased contact time of the oily water with the plate pack, thus enhancing the coalescing of the oil.

The EOWS functions best with laminar flow rather than turbulent flow, because turbulence constitutes a mixing effect. A velocity head diffusion device placed near the inlet of the

oil/water separator results in a laminar flow at the coalescer plates by reducing flow turbulence and causing the turbulent zone to face away from the coalescing plate pack.

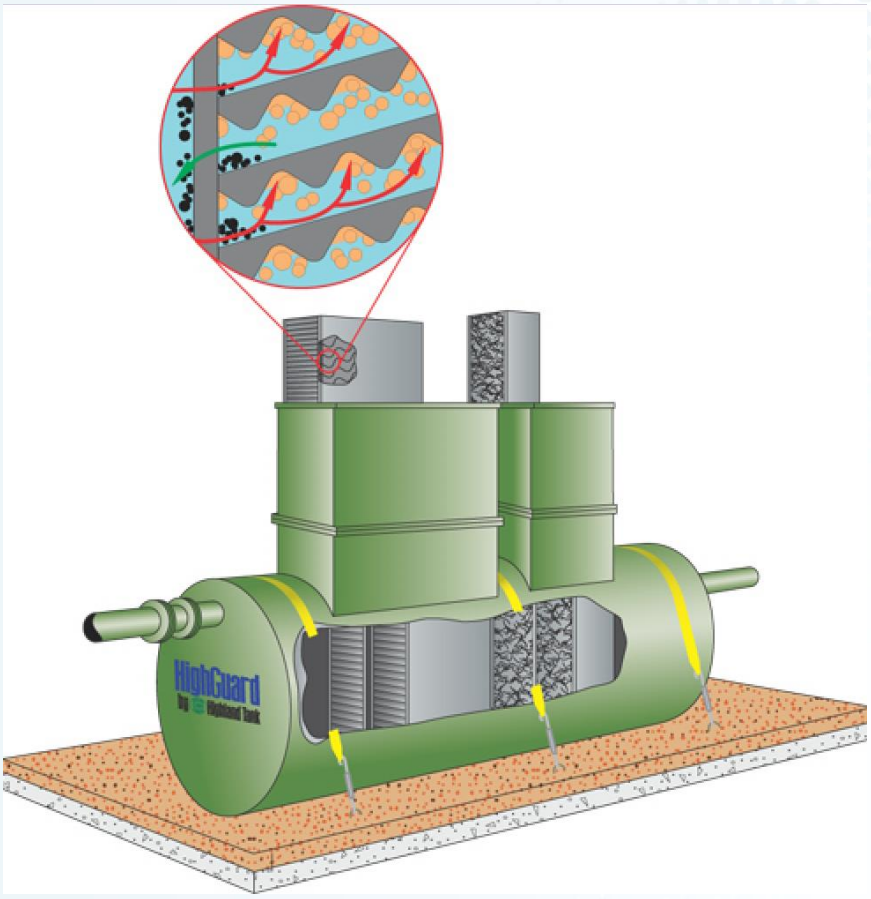
In the preferred form of, the wastewater stream, under the influence of the velocity head diffusion device, is transformed into a laminar flow and enters the inclined coalescing plate pack. The flow is effectively subdivided into separate vertical flow paths, one above the other, having a vertical rise of a few inches, which is much less than the overall height of the separator. Within the pack, each oil globule or solid particle will, in accordance with Stoke's Law, rise or settle at a rate depending on its own diameter.

Oil globules rise the short distance between the adjacent plates to coalesce on the underside of the plates and creep up the surface to the outlet region of the oil/water separator tank. Coalescence occurs when the corrugations passively provide alternating acceleration and deceleration to the fluid flow enhancing collisions between the oil particles and coalescence between them. Furthermore, coalescence occurs when large oil droplets rising at a high rate of speed collide with smaller, slower droplets. The larger droplets which are formed combine again with small droplets to form even larger droplets with an even higher rate of rise. Conversely, solid particles sink and agglomerate on the top of the flat plates and slide down the surface of the flat plates to the inlet section of the coalescer where they are collected at a solids collection point.

To emphasize, the oil globules rise and impact on the underside of each of the corrugated plates, likewise, solid particles settle and impact on the top of each of the flat plates. The oil globules are coalesced into sheets of oil on the underside surfaces of the corrugated plates; the solid particles agglomerate into a definable sludge on the top of the flat plates.

As the separated globules and particles migrate along the angled plates, coalescence takes place due to the collision between droplets exhibiting different migration rates. This coalescence and agglomeration take place in the direction of globule or particle migration. The separated oil creeps up the underside surface of each of the corrugated plates and finally breaks loose at the top in the form of large globules that rapidly rise to the separating section to the surface. The separated sediment slides down the top surface of each of the flat plates and drops off at the bottom to the floor of the separator. Coalescence and agglomeration are important to enhance because the rate of separation (rising or settling) is directly proportional to the square of its diameter. By encouraging smaller droplets to join to form larger and larger particles, the efficiency of separation is increased accordingly.

As the separated oil begins to accumulate at the top of the separator, clarified water is directed away from the coalescing plate pack and enters the separation section. This quiescent zone provides further gravitational separation of oil from water. It is in the separation section that the oil and water form separate layers because of the difference in specific gravity.



EOWS Coalescing Plate Pack
Figure 5

The advantages of the coalescing plate pack in the EOWS are:

- The corrugations on the underside of the plates allow for the plate pack to influence the full strata of the wastewater stream eliminating the possibility of channeling the oil droplets from the entrance, straight through the gaps in the pack, to the exit.
- The plates are stacked one atop another so that the settling solid particles and rising oil globules do not have to travel as far vertically. Minimum spacing is usually 1 inch.
- Both the oil and the solids can be removed without shutting down the separator for periodic cleaning and maintenance. Angling the plates allows for any solids settling coincidentally with the separation of the oil in the wastewater to slide off the plates into a sludge collecting area. Without this feature separated solids would begin to build up on the plate surfaces, and the flow paths between the plates would become clogged and constricted, requiring cleaning and maintenance.
- The coalescing plate pack is engineered with an enlarged effective separation surface area to remove solid and oil droplets of a size that will insure that all particles or droplets larger

than it are also removed. The particle or droplet size selected will be a function of the removal efficiency needed to achieve the effluent standard.

- The coalescing plates can be constructed of stainless steel or CPVC plastic and arranged in the form of a cartridge. The cartridges can be arranged and assembled to fit in the oil/water separator. Each cartridge will have a pre-engineered effective separation surface area. The cartridges can be arranged and assembled to fit in either a prefabricated, field-fabricated, or existing oil/water separator tank.

Enhanced Oil/Water Separator Underground Installation

Enhanced Oil/Water Separator Aboveground Installation

STEP 2.

An impingement coalescer, usually constructed of polypropylene plastic, can be incorporated in the EOWS to intercept globules of oil too minute to be removed by the coalescing plate pack.

Like a plate coalescer, impingement coalescing devices rely on a variety of physical and surface-chemical mechanisms to cause fine oil globules to grow into larger ones, form free oil, and thus, achieve separation. A polypropylene impingement coalescer, for example, has an oleophilic (oil loving) property and is usually specified for optimum oil coalescence. The coalescing media is usually a fibrous, filter-like cartridge configuration that must provide a tortuous path for the fine oil globules in order to achieve reliable coalescence. Small globules of oil, as low as 20 microns in diameter (the upper range of a mechanical dispersion or physical emulsion), are attracted to these fibers where they collect and coalesce. Polypropylene coalescing media installed in an oil/water separator provides an extremely large surface area on which oil globules can coalesce. The larger the oil globule, the faster the rate of rise. The globules wick up the coalescing media and break free to rise to the surface for removal.

The Enhanced Oil/Water Separator with impingement coalescer is highly effective with an effluent discharge of 10 mg/L free oil and grease. Oil is removed from the separator by pumping or skimming the surface with a variety of devices specifically designed for this purpose. Sludge pump out or blow-down from the bottom hoppers can also be accomplished. Oil and solids can be removed without shutting down the separator. Recovered oil and sludge may be transferred to holding tanks for storage prior to proper disposal or recycling.

DEFINITIONS

OIL: Oil means oil of any kind or in any form, including, but not limited to: fats, oils, or greases of animal, fish, or marine mammal origin; vegetable oils, including oils from seeds, nuts, fruits, or kernels; and, other oils and greases, including petroleum, fuel oil, sludge, synthetic oils, mineral oils, oil refuse, or oil mixed with wastes other than dredged spoil. See the "List of Petroleum and Non-Petroleum Oils" on the USCG Web site at: https://homeport.uscg.mil/mycg/portal/ep/contentView.do?contentTypeId=2&channelId=30565&contend=120944&programId=117833&programPage=%2Fep%2Fprogram%2Feditorial.jsp&pageTypeId=13489&BVSessionID=@@@@1350455393.1250257064@@@@&BV_EngineID=cccdadehmkjifjkcfjgcfgfdffhdghm.0

DISSOLVED OIL: The oil fraction that forms a solution with water; or oil that is $\leq$ 0.5 microns.

EMULSIFIED OIL: Small oil droplets (in the range of 1 to 20 microns diameter) that form a stable suspension in the water as a result of the predominance of interparticle forces over buoyant forces.

FREE OIL: Oil droplets that are of sufficient size (greater than 20 microns in diameter) so that they can rise as a result of buoyant forces to form a defined oil layer on top of the water in an oil/water separator.

RISE RATE: The velocity at which oil droplets move upwards toward the surface of the oil/water separator.

OIL INTERCEPTOR: A gravity oil/water separator designed to remove free oil (150 microns or greater) and some suspended solids. Interceptors are relatively simple, requiring nothing more than an underground, horizontal, cylindrical or rectangular vessel with influent and effluent tees and divided into compartments by a series of vertical baffles.

ENHANCED OIL/WATER SEPARATOR: A gravity oil/water separator that uses more technically sophisticated methods to remove oil globules as small as 20 microns. Enhanced coalescer technology combine the features of both a flat plate coalescer and a corrugated plate coalescer into a new "self-cleaning" design that performs better than traditional plate separators. Equipped with secondary, impingement coalescers, they meet the new Underwriter's Laboratories, Inc. UL SU2215 design, construction, and performance standards for engineered oil/water separators rated at 10-ppm oil and grease.

REFERENCES

API, *Monographs on Refinery Environmental control – Management of Water Discharges, Design and Operation of Oil-Water Separators,* Washington, DC: American Petroleum Institute.

Branion, R. "Principles for Separation of Oil Drops from Water in Gravity Type Separators." In *Oil in Freshwater: Chemistry, Biology, Countermeasure Technology*, New York, NY; Pergamon Press.

Dull, L. Survey of Oil/Water Separating System Technologies or Methods and Their Application id Controlling Pollutants of Concern in Wastewater from Transit Buses, Seattle, WA: Metro, 1984

OSHA, *Title 29, Code of Federal Regulations (CFR) Part 1910*, Washington, DC, Occupational Safety and Health Standards.

U.S. EPA, *Title 40, Code of Federal Regulations (CFR), Part 112, National Pollutant Discharge Elimination System*, Washington, DC; United States Environmental Protection Agency.

U.S. EPA, *Title 40, Code of Federal Regulations (CFR), Part 280, Technical Standards and Requirements for Owners and Operators of underground Storage Tanks,* Washington, DC; United States Environmental Protection Agency.

U.S. EPA, *Title 40, Code of Federal Regulations (CFR), Part 112, Oil Pollution Prevention*, Washington, DC; United States Environmental Protection Agency.

UL, *Subject 2215 Outline of Investigation for Oil/Water Separators,* Northbrook, IL: Underwriters Laboratories, 2000.

ABOUT THE AUTHOR

Gregory G. Aymong is Vice President of Sales for Highland Tank, the largest producer of Storage and Wastewater Treatment Tanks and in the United States. He is also the inventor of the patented Highland Tank Oil/Water Separator and Corella® enhanced coalescer technology and has worked for Highland Tank for 34 years. His numerous equipment and process patents and designs are used extensively by petroleum, industrial, municipal, military and commercial facilities worldwide for the prevention of oil, grease, and hazardous materials spills into the environment. Mr. Aymong has worked in the industry in the United States and overseas for 40 years and has authored numerous articles on oil/water separators and storage tanks and vessels. Gregory has lectured on "Water Storage Tanks: From Construction to Rehabilitation" for Lorman Education Services. He has spoken about storage and wastewater treatment tanks at many Petroleum Equipment Institute (PEI), National Petroleum Management Association (NPMA), National Institute for Storage Tank Management (NISTM), American Society of Plumbing Engineers (ASPE), American Society of Sanitary Engineering (ASSE), Constructions Specifications Institute (CSI), Water Environmental Association (WEA), American Society of Civil Engineers (ASCE), and American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) chapter meetings in the United States and Canada.