Comparing Coalescers

The Multi-Pack™ Vs. The Rest of the Pack

The pages that follow describe some of the various coalescer designs on the market today. While each is manufactured to help oil droplets collide and coalesce to the top of a vessel, they all have an inherent problem with premature fouling. All coalescers are efficient when the process flow begins, but the true test of efficiency is how long a coalescer can consistently perform without falling victim to the fouling issues that stem from the build up of sludge.

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OIL+SOLIDS+TIME=SLUDGE™

If you can not keep your oil water separator efficient for sustained periods of time, is it really "efficient"?

THE FORGOTTEN FORMULA... Detention Time, Velocity, Oil Droplet Capture, Equivalent Diameter, Reynolds Number, and Loading Rates are all important pertinent mathematical calculations that need to be considered when evaluating an oil water separator for your application. However, considering a simple "non-technical" equation will help you stay in compliance for longer periods of time and save you thousands of dollars over the lifecycle of your oily wastewater system.

Of course there are several industry equations that we utilize in order to properly evaluate the size and style of oil water separator that is required for various applications. Mercer considers these equations when sizing and designing equipment for each and every one of our clients' applications. However, there is one "equation" we always quietly consider in any conversation that we have about separator design. It is much less technical than Reynolds numbers, equivalent diameter, oil droplet capture capabilities and minimum rise rates. Far away from the neatly organized engineering and process design desk (where theoretical calculations about performance and functionality are being tested via sharp pencils and calculators), a Mercer International inspired formula is making the complex simple, in a "real world" practical manner. The formula is

Oil+Water+Solids = SLUDGE™

Oil plus water, in the presence of solids, over time always equals sludge. It would be so much easier if we could simply calculate a flow rate, run some viscosity and specific gravity numbers on the types of oils present in a certain wastewater, and easily come up with a suitable product. But the fact remains that real-life applications are not simply clean oil and water to be simply handled by the various design formulas and forgotten.

As important as our industry formulas are to proper sizing and design, equally important is the consideration of the solids present and the affect it will have on the functionality of the separator. Calculations made that produce ideal surface area and rise rate numbers are only the first part of the evaluation process. The amount and type of solids present is as important a consideration; and even more important is the way a potential oil/water separator design is able to handle this solids loading. Even a fairly light solids loading can present significant maintenance issues, reduced efficiencies, and lead to drastically more expensive lifecycle costs if they are not processed out of the coalescer efficiently.

Fantasy World

Oil is the only thing present in water.

In The Real World *Efficiency numbers that evaluate oil droplet size capture do so by assuming the only thing present is oil and water.*

Not realistic!

Mercer International markets its Compliance Master™ as a "*High Performance*" oil/water separator because of the coalescer's unique ability to process the solids down and out of the pack as opposed to simply catching them in the pack. The **removal** of the solids is the most important way to ensure the resulting effluent is not just compliant...but compliant for a prolonged period of time.

Parallel Corrugated Coalescers (CPI's)

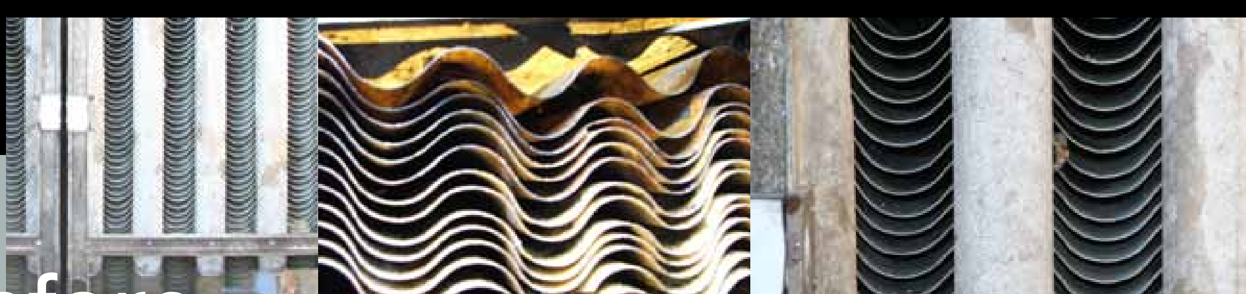
One of the earlier coalescer designs introduced a parallel-corrugated plate configuration. These "sinusoidal" patterned plates were stacked one on top of each other at various angles of inclination and the corrugations created concentrated areas for oils (along the crest line) and solids to settle (along the trough bottoms). Oil would rise and collect and concentrate along the top of each crest and work their way out of the pack. Likewise, the solids would theoretically settle into concentrated areas (along the bottom of the trough) and then work their way downward, along the trough line, and make their way out of the pack.

Over time, designers had to incorporate tighter plate gaps to increase surface areas in order to achieve higher oil removal requirements. Changes in the orientation of the coalescer to the flow were improved to accommodate solids (from up-flow designs to down-flow and ultimately cross-flow designs). These wavy plate designs eventually became a standard, especially in the oil field applications in the "Oil Patch" states.

However, the introduction of corrugations paved the way for a "new wave" of designs utilizing plastic coalescer materials. Designers figured out the by adding tighter and tighter corrugations, they could use less and less material, and even fiberglass or plastic.

The tighter the corrugations (wave amplitude height and width) the more the coalescer was prone to fouling and the more often it needed cleaning.

Parallel corrugated in theory...



Before

The Emergence of Corrugations In theory these sinusoidal patterned plate configurations create separate oil rising channels and solids settling troths.

Parallel Corrugated Coalescers (CPI's)

The reality is that the solids build up and collect in the bottom of the troughs within the coalescer. By design, the corrugations force the solids to concentrate into the trough area, thereby underutilizing the available plate surface area to evenly handle the solids loading. Therefore, about 2/3 of the plate is unusable for solids removal. As the solids move down the trough line, these concentrated solids begin to prematurely fowl the plate gaps in that area. Once the troughs get plugged, velocity within the rest of the coalescer pack increases. The increase in velocity thereby decreases the detention time that is required to effectively remove oil, causing coalescer inefficiency. Once this happens, the design efficiency established for a particular application is no longer being met due to the "trough effect" which reduces useable plate surface area. Eventually the solids and sludge build up throughout the entire coalescer resulting in the internals sagging and breaking due to poor coalescer materials of construction. Eventually coalescer replacement is required. Because they foul more easily than the time-honored flat-plate design, they need to be cleaned out more frequently.

...in reality.

...there is no way for the solids to be efficiently "processed" out of the pack.

After

Clogging of Channels The troths that are supposed to allow for the dropping out of solids actually serve as a resting place for solids and oils to back up and turn into sludge. As these solids build up, there is no longer a separate channel for oils to rise and make their way out because the plates become packed and clogged.

Plastic Coalescing Media

Once coalescers became commonplace, the industry quickly adopted using irregularly shaped plastic media, due to low price. This media was originally used for surface contact in very-low solids cooling tower applications.

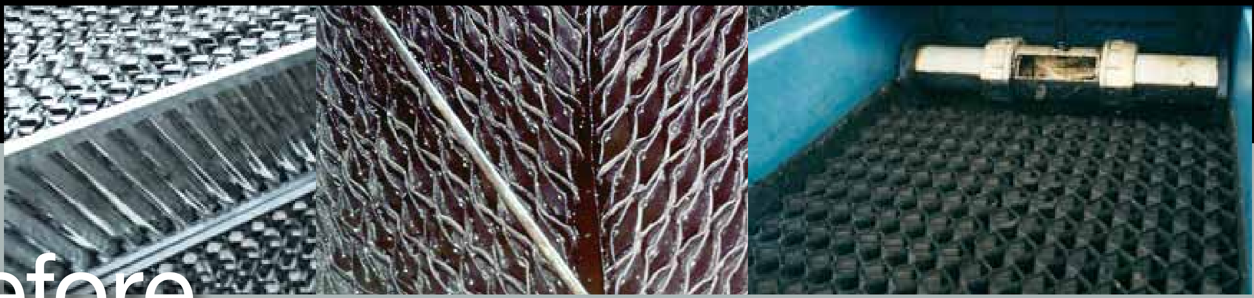
These honeycomb or stacked "egg carton" media are alternately stacked, ribbed sheets of PVC plastic held together by glue.

The corrugations and rigid make up of these bundles help give them the structural integrity they need to keep their shape.

These cube-like sections of media are placed one next to another, and are often times stacked. Theoretically, these packs provide high efficiency oil removal due to their high surface area design.

Like any other enhanced-gravity coalescer, the bundles are to be removed from time to time and cleaned for reuse.

Plastic coalescing media in theory...



Before

It's in the Numbers The manner in which surface area (and subsequently removal rates) are calculated is by examining formulas in a vacuum. With stated efficiencies on paper these "Honeycomb" packs can look very attractive due to their stated high removal capabilities, as well as their lower price point.

Plastic Coalescing Media

Once inexpensive corrugated plastic media became adopted by industry as the "standard", it became a race by manufactures to produce separators with low price as their selling feature. Now the separator industry was selling their equipment on "price" instead of "features & benefits". Once price became the main selling function, many long-standing internal components and sound design standards began to be cheapened or eliminated. By "designing down" the coalescer, the inlet and outlet baffles, solids handling capacities, etc., manufactures began sacrificing functionality and efficiency. This drastically reduced the end user's ability to stay in compliance.

Manufactures tightly pack these plastic bundles in separator units, selling promises of higher surface area and (theoretically) better oil removal capabilities.

The "nooks and crannies" within these coalescers are the problem with this design. The various nooks, crannies, ridges and flat spots cause solids to lodge in and on the plates, building up and fouling the packs prematurely. Further, there is no clear path for solids particles to make their way out of the coalescer. The settling solids have nowhere to go and "dead end" within the coalescer causing even more rapid fouling.

...in reality.

You get what you pay for —and often times much less.

To further complicate the problem with this design, these style coalescers are nearly impossible to clean. Because of their design, high-pressure washers can only penetrate from 6"-12" into the packs before the velocity is dissipated.

The cleaning becomes very labor intensive. Many times the packs cannot be cleaned all the way through. Therefore the end user is forced to throw away these packs after a few cleanings and replace them with new ones. In certain more high-solids applications or applications with "sticky" oils and solids, this could entail a full coalescer replacement every time maintenance is performed.

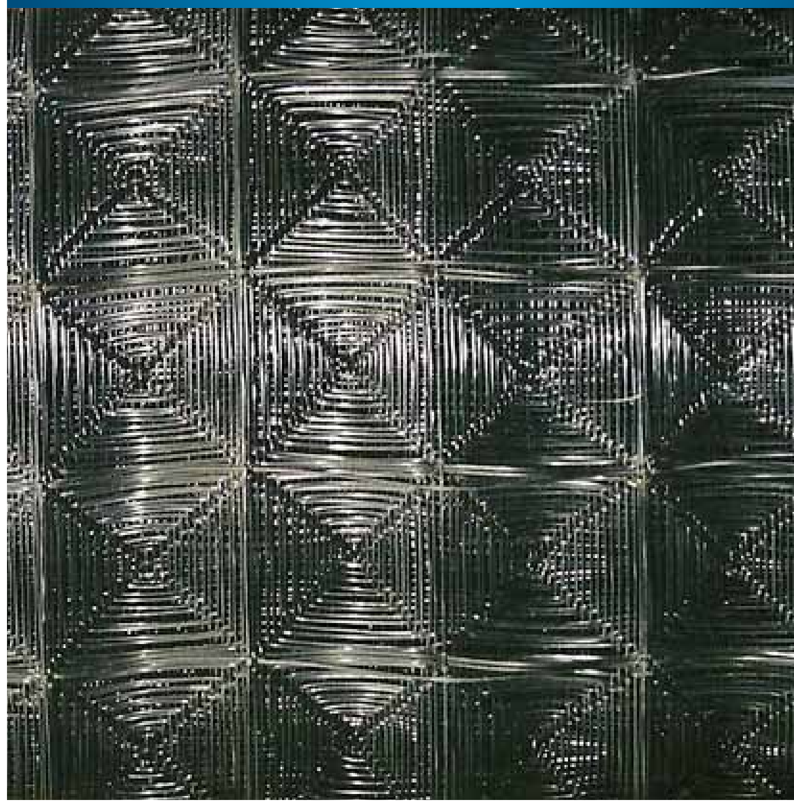
After

Sometimes Numbers Can Be Deceiving You get what you pay for, and most times less than that. This race to the cheapest sets of OWS internals set a frustrating status quo for industry. Frequent maintenance cycles, the inability to clean centers of packs, constant replacement due to clogging and breakage, and compromised efficiencies made end users consider OWS processes burdensome and costly.

Secondary Mesh Packs

This treatment option is most often seen in the below ground cylindrical "simple tank" world. These packs are largely used in the Storm Water, Petroleum Marketing, and Transportation industries. Below ground tank systems do have corrugated plastic plate coalescers, then they are followed up by mesh adsorption packs consisting of PolyPro monofilament fibers. In theory, the Coalescer is the primary separation device and these mesh packs are supposed to allow the water to flow through while any of the small oil droplets coalesce into larger droplets and rise to the top. In most cases the plate coalescers are designed at too shallow an angle to get efficient oil separation, so the manufacturers add adsorption packs to "Improve" removal efficiency and meet effluent standards.

Secondary Mesh Packs **in theory...**



Before

Secondary Treatment These packs of tightly bound plastic or steel fibers are used as a secondary coalescer designed to be a last catch basin for any small oil droplets not removed during the primary treatment.

Secondary Mesh Packs

Relying on polishing mesh packs to "make up for" the shortcomings of an irregularly shaped plastic coalescer is not sound treatment. The design philosophy goes much like this: "Since we cannot meet 60 micron removal requirements with our separator at design at maximum flows, we will simply insert this high surface area mesh in the back and cover ourselves."

Here is an important question to consider: If this were an effective design method to treat oily wastewater with, why wouldn't every separator manufacturer simply fill the entire tank with this mesh and leave out the primary coalescer?

This is the worst fouling treatment in the marketplace. Originally created for treatment in mist eliminators, and a decent alternative for flock matter, this is by no means an effective alternative. Once these clog very quickly, the flow actually builds pressure back and makes these cartridges sag and rip very easily. They are not industrial duty and therefore present constant replacement cost s over the life of the unit.

...in reality.

A Crutch to lean on because of a poorly designed primary coalescer.

After

A Crutch for an Underperforming Coalescer When insufficient coalescer design was recognized, especially in the below ground cylindrical market, manufacturers had to come up with a way to promise stated removal values. These "polishing" packs readily plug at their entrance points, and actually serve as a flow obstruction within the treatment.

Vertical Tube Coalescers

This Vertical Tube Coalescer ("VTC") technology is somewhat of a hybrid between a traditional coalescer and a secondary mesh pack. This design does not utilize "Stoke's Law", and the rise rate of oil as its primary means to remove oil from the horizontal flow of wastewater. Rather, as the oil droplets drift by the polypropylene diamond-mesh tubes they are attracted to the tubes by adsorption (very much the same principal as the secondary mesh pack).

In theory the VTC coalescer should collect droplets of oil and agglomerate them (by coalescence) into larger droplets. The larger droplets are then to break free from the polypropylene matrix and move their way to the surface along the diamond-shaped coalescer. Solids are to simply fall down and out the vertical tubes.

These tubes are heat welded together and equipped with a handle to insert and remove the media from a tank. The idea is to tightly pack the entire volume of the tank with these bundles, and remove them for cleaning when necessary.

Vertical Tube Coalescer in theory...

Before

Plastic Tubes Heat Welded As the wastewater is pushed through the tank, the oil is attracted to the plastic tubes. From there the small oil droplets coalesce with other small droplets and turn into larger droplets that rise to the top. Solids are said to settle to the bottom. These packs of tubes are removable for periodic cleaning.

Vertical Tube Coalescers

In reality, the VTC coalescer's diamond-mesh pattern that creates a fixed coalescer matrix is too "tight". The openings for wastewater to flow are between 1/8" to 1/4" – which is way too small for typical industrial wastewater applications.

The coalescer gets easily blinded by leaves, plastic(s), and solids that are 1/8" and larger.

The fixed, tight matrix **does** attract oil well. However, at the same time the finer solids drift through the pack, they come into contact with the oil and simply cling to the oil particles—creating an oily sludge deep within the coalescer pack.

In practice, solids do not drift down and out of the pack's tubes. They simply get caught in the coalescer as solids get caught in any filter. Once plugged up, the packs are almost impossible to clean completely. These packs need replacement more often than most other types of coalescers, and become an ongoing and expensive replacement part.

...in reality.

The Quickest to Foul, VTC coalescers are hard to clean and are constantly being replaced.

This is a disposable model, as there is no way to clean fully into the center of each bundle. Higher flow rates can have upwards of 20 of these tube packs that need to be pulled out and cleaned/replaced on a monthly basis.

After

Very Prone to Clogging The Vertical Tube Coalescers are the quickest to foul. Because they are nearly impossible to clean, there will be decades of maintenance costs going to replacement media. What may start out being the least expensive option initially, will end up costing two to three times as much over the lifecycle of the unit.