

## Why Aqueous Cleaners are so effective: Emulsification versus Displacement Cleaning Considerations

There is a relationship between the cleaning bath, its temperature and surface tension. Wetting agents or surfactants lower the surface tension of solutions. This improves wettability to allow penetration into soils and their removal from the substrate. The surfactants added singularly or in combination with others are determined by the ultimate application and cleaning demands for the intended cleaner. Typically, small concentrations dramatically reduce surface tension, beyond which larger doses at best minimally affect surface tension reduction.

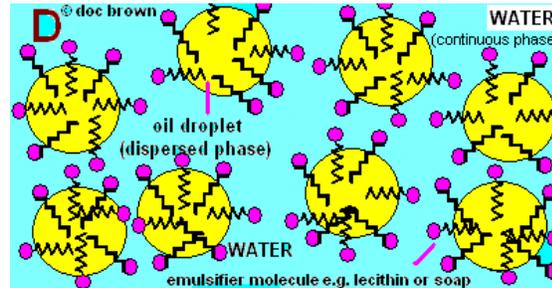
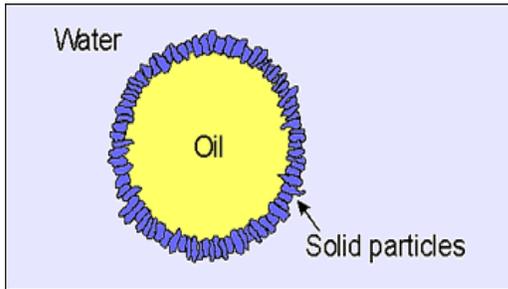
The surface tension in working cleaners is usually 20-35 dyne/cm. (Water, by comparison, is about 70 dyne/cm.) Decades ago, substantial theoretical studies were supported by experimental work showing a relationship between temperature of the solution and surface tension. This relationship is almost linear when considering long temperature ranges. It confirmed that surface tension decreases with rising temperature.

Increasing temperature causes the free surface energy to pull molecules inward from the solution surface to the interior. This is counteracted by the opposing tendency of thermal agitation to push the molecules outward through the surface and into the vapor phase.

Soak cleaners are provided in two general formulations: emulsification and displacement. They both clean with a high degree of effectiveness. How do these two methods in fact differ?

**Emulsification** cleaning defines the mechanism by which oily soils once removed from the part surface are encapsulated and held in suspension in the cleaner bath. Most soak cleaners formulated to clean steel parts emulsify or hold oils in the range of 8-10% by volume until the bath is saturated.





### *Oil Encapsulated in Emulsion Cleaner*

As the basic illustrations show, there is a point at which saturation of the emulsion occurs, which describes the limit of an emulsifying soak cleaner.

At this point the cleaner is dumped and replaced with a fresh make up.

It would certainly be an advantage to extend the service life of the soak cleaner. Let us consider a modification to the emulsifying soak cleaner, in which the oily soils are held in what can be described as a "mini emulsion." Following a short encapsulation period, the oils are purposely released. This is known as displacement soak cleaning.

### Is Displacement Cleaning for You?

First things first. When monitoring the cleaning tank and down-line tanks, what do you see?

- Insufficient emulsification capability of the cleaner, with relatively short service life of the working bath?
- Oils and grease dragging down the line?
- Poor cleaning?
- Oily and discolored plating barrels?
- Excessive downtime and consumption of waste treatment chemicals, all related to frequent cleaner dumps?

The good news: Displacement cleaning has a positive impact on all the above items as long as the candidate displacement type cleaner is appropriate for the intended application. The emergence of oils and grease on the surface does, however, introduce a new problem, namely how to efficiently remove them.

Belts and disks are relatively inexpensive, durable oil-removal devices. That said, consider the following:

The belt's length is not a critical factor. What is of importance is the width. Since a surface layer of oil is being skimmed, the belt width is of practical importance to optimize skimming versus tank size. The following examples indicate rate of oil pick up based on belt selection.

Belt Width (inches)	Tank Size (gal)	Gal/Hour Skimmed
1	18	1
1 or 2	100	3-6
4	540	6-12

The disk diameter is important. Available surface area to pick up oil increases with disk diameter.

Positioning the disk is critical as well. Ideally it should be within the oil layer or just below it.

For approximate oil removal and disk selection;

Disk Diameter (inches)	Disk Dia. Inches Below Surface	Gal/Hour Skimmed
12	4.5	1-2
18	7.5	3-5
24	10	8-10

A shallow immersion into the cleaner surface better conforms to a smaller diameter disk skimmer and belt skimmer. The disks in the above example range in weight from 13-19 lbs. with a speed of 7-8 RPM. Stainless steel disks are often preferable because they provide the best service life and durability, especially when it comes to warping. Other viable mechanical oil-removal devices include coalescers and ultrafiltration.

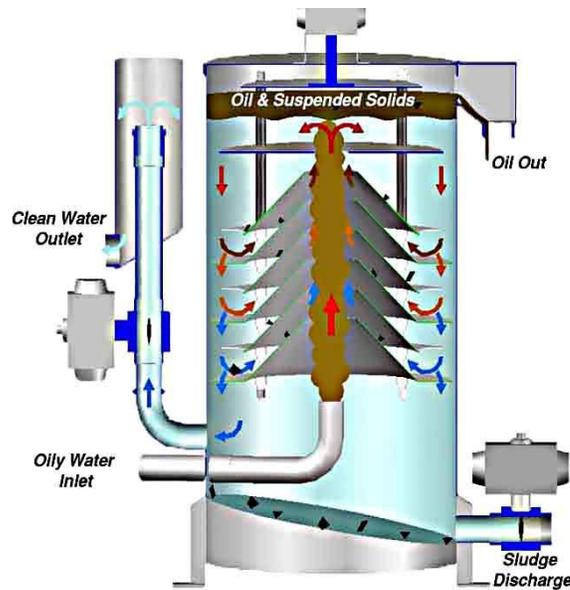
***Belt Skimmer Unit***



***Disk Skimmer Unit***



***Colescer Removes Oils Soils from the Soak Cleaner***



### *Ultra-Filtration Unit Removes Oils from the Soak Cleaner*



A frequent question: why bother with a displacement soak cleaner if there are mechanical equipment options to viably extend the life of the emulsion soak cleaner? It should be noted the coalescer and ultrafiltration unit are both equipment purchases. The coalescer would range in several hundred to a few thousand dollars. A large process operation could produce a reasonable payback. In fact, the coalescer could be moved to different cleaner tanks in the metal finishing operation.

The ultrafiltration unit would cost upwards \$50K with the requirement of a trained staff member to provide proper operation and maintenance. This makes it better to very large metal finishing operations, where several thousands of gallons of cleaners could be treated on an ongoing basis. The cost remedy is to outsource an ultrafiltration unit, either by renting it or having a specialized treatment company provide the services.

As we've mentioned, the displacement cleaner is readily maintained for oil removal by utilizing a skimmer, either belt type or disk. Either unit costs up to \$500 and requires little maintenance. The cleaner is then best maintained for long service life utilizing either the belt or disk skimmer. Hubbard Hall's quality line of displacement cleaners are a unique best fit with skimmers.

**Our people. Your problem solvers.**



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