

Separator Control for Fun & Profit

The first criterion for accurate interface control is good separation.

This may entail more or better emulsion-breaking chemicals; longer residence time (less thruput); higher temperature; or additional mechanical or electrical aid to coalescence. The idea that certain instruments can produce less oil in the water sump, less water in the oil, and raise thruput is total baloney! The best instruments offer better control, flexibility, and consistency, in addition to warning of upsets. **Instruments cannot improve separation!** At the same time there is no need for perfect separation. There is usually at least 6 feet of height between the oil and water outlet locations and that provides considerable room for some unbroken emulsion. Unbounded emulsions in separators are the #1 control problem, potentially leading to wet oil, dirty water, or both.

The most basic concept in understanding separator control is the “electrical interface”.

This occurs at the horizontal plane in the vessel, where there is a large, sharp transition from insulating liquid to conducting liquid. The transition occurs within the visually-defined, emulsion or “rag” layer. The rag layer may appear to be homogeneous, but it is actually two separate phases. The upper phase consists of water droplets surrounded by oil (oil-continuous), while the lower phase has oil droplets surrounded by water (water-continuous). The electrical interface forms the basis for any electrical type of sensing, and is the only sharply defined, unequivocal demarcation within the separator liquid.

Contrary to many published accounts, **this** is the level that an RF instrument tracks. Hundreds of separators are running successfully today, based **only** on control of this key item! That is because the separator is not building a huge rag layer, thanks to good separation practice, and reasonably consistent oil. It is possible that the water percentage is the same, above and below the electrical interface. The only difference is: which component is on the outside. Water percentage alone does not determine that!

Above the electrical interface, the water percentage decreases slowly until there is a fairly sharp drop, at the top of the visually-defined rag layer. Since the oil-external emulsion is insulating already, this drop in water content has an infinitesimal effect on conductivity. There **is** a substantial change in dielectric constant, since the typical oil has a dielectric of 2.7 and water is over 40! Because dielectric is a reasonably stable characteristic (independent of salinity), this change is a reliable characteristic for detecting the top of the visual rag layer, using an RF instrument.

This discussion assumes that the separator is releasing oil by overflow, and controlling interface level by the opening of the water-dump valve.

Accurately tracking the electrical interface is the first step in stable, efficient separator control. It is sufficient to avoiding grid overload in thermo-electric separators.

The bottom of the visually-defined rag layer is a much different challenge electrically. Obviously, the conductivity will increase as less and less oil is mixed with the water. It is important to realize that these conductivity changes are a very small percentage of the conductivity with no oil present. If the water conductivity were constant, it would be possible to pick a slightly lower value, and define that as the bottom of the rag layer. The problem is that conductivity in produced water is **far** from constant, with 50% changes easily realizable. The major factor in that variability is salt content, but temperature and suspended solids also contribute. This means (except under very special conditions): **No electrical technology can provide accurate, repeatable indication regarding the bottom edge of the visually-defined emulsion layer.** In many cases, an installation that is thought to be controlling the lower edge of the rag, is actually controlling the electrical interface. Clean water output in this case is the product of the height from water-dump to the electrical interface, combined with good separation.

Beware of the seductive simplicity of sight gages!

Oil coatings that obscure the action are only the beginning. The liquids in the sight gage will seldom reflect the actual condition in the tank, either in degree of separation or temperature. This produces a “manometer effect” that converts this seeming level indication to a density-based illusion.

Stilling wells and external “cages” are often provided for electrical sensing instruments. Interface agreement with the one in the tank is purely coincidental. In a majority of cases they will degrade performance by:

- a) bringing ground very close to the sensor, thereby reducing the discrimination between insulating and conducting phases.
- b) mechanically isolating the sensor from actual tank conditions by “manometer effect” in the case of a cage, or sand plugging a stilling well (a common story in desalters).

THE SOLUTION (OVER)

Separator Control for Fun & Profit

BEST CASE

When the separation is good, with consistent emulsion width, a vertical Drexelbrook interface probe provides a 4-20 mA signal that is the basis upon which to control the water-dump valve. The location of the “electrical interface” can be adjusted to any point on the probe, to improve oil dryness or water cleanliness. Any significant increase of thruput will widen the emulsion and require corrective action in the process. All electrical instruments should be located as close as possible to the outlets and as far as possible from the inlet.

Use a composition transmitter, such as the Drexelbrook Cut Monitor or an antenna loading transmitter on the dry oil line, to modify the interface level control point. This will optimize the cleanliness of the produced water while maintaining the required maximum water percentage in the oil. An alternate scheme could use the output oil dryness information to control the rate of emulsion-breaker injection.

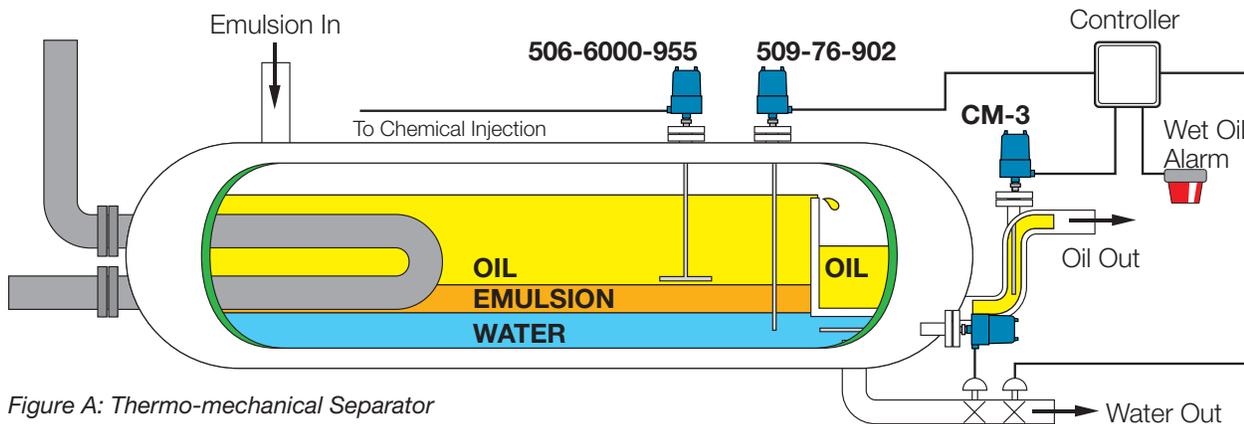


Figure A: Thermo-mechanical Separator

GENERAL CASE

The same Drexelbrook interface transmitter is the basic element, but the addition of an interface switch can warn of emulsion growth, beyond the desired limit. It should be positioned at a level that will be the limit for the upper edge of the emulsion. This switch can be either the Drexelbrook RF type or the “antenna loading” technology. Either type can be on/off or analog output. Generally the analog instrument is preferable, because it is possible to observe changes, and take corrective action (such as increasing the feed rate of emulsion breaking chemical) before the separator is out of control. It has been suggested that a conductivity sensitive, “antenna loading” sensor be used to limit growth of the emulsion lower edge as well (we make no pretense that RF could handle this function). As discussed previously, a 10% drop in water conductivity will cause the “antenna loading” instrument to sound the “wide emulsion” alarm. Since the growth in oil-continuous emulsion is a good proxy for total rag layer, the bottom edge is not required for reliable control.

The use of a composition transmitter on the clean oil line is also of value in this case, as in the previous.

SPECIAL CASE

When it can be determined that produced water will have constant conductivity (such as a single well, producing constant temperature fluid), “antenna loading” sensors can be used to good effect in limiting contamination of both output streams, provided that corrective action is available.

The required logic is:

- Excess oil at the lower edge sensor.....decrease water dump valve opening
- Excess water at upper edge sensor.....increase water dump valve opening
- Excess of both on respective sensor.....increase emulsion-breaker injection

U.S.A. Sales: 800-553-9092 • 24-Hour Service: 800-527-6297 • International Support: 215-674-1234 • Fax: 215-674-2731

AMETEK®
DREXELBROOK

205 Keith Valley Road
Horsham PA 19044 U.S.A.

E-mail - drexelbrook.info@ametek.com
Web - www.drexelbrook.com

AMETEK Nihon Drexelbrook
2 Chome • 12-7 Minami Gyotoku
Ichikawa City • Chiba 27201 Japan
Phone: 81-473-56-6513
Fax: 81-473-56-6535
E-mail: nd@nihon-drexelbrook.co.jp

AMETEK Singapore Pte. Ltd.
10 Ang Mo Kio Street 65
#05-12 Techpoint • 569059 Singapore
Phone: 65-6484-2388
Fax: 65-6481-6588
E-mail: aspl@ametek.com.sg

AMETEK Precision Instruments Europe
Rudolf-Diesel-Strasse 16
D-40670 Meerbusch Germany
Phone: 49-2159-9136-0
Fax: 49-2159-9136-39
Web: www.ametek.de