BMA-System Desalter Interface Control Application Sheet

BENEFITS in DESALTER Interface Control

The **BMA-System - Desalter Interface Control** is the most advanced system available for both control and optimization of the desalting process.

This combination of patented sensors provides the operator with a wide range of functions that are far beyond the capability of traditional level controllers.

These capabilities include:

- Continuous Brine Valve Control
- Directional Control of Emulsion Growth
- Inhibition or Elimination of Routine Free Oil Undercarry
- Advance Warning of Emulsion Growth Below the Grids
- Advance Warning of Oil/Solids Contamination of Water Phase
- Advance Warning of Water "Slugging" in the Feed from the Tank Farm
- Potential to Automate Upset Responses
- Optimization of Chemical Dosage and Other Operating Parameters

The BMA-System accurately senses volume percentages (not level) in phase separations such as water and oil. The instruments monitor percentages of water at points in the system, and can measure either water in oil or oil in water mixtures.
This sensitivity gives the operator "vision" inside the system and consequently, more reliable control (the operator see through vessel walls!). The unit operations can effectively monitor and reduce their oily-water releases. Reducing the workload on existing wastewater treatment systems lessens oil-grease levels in effluent water.

SAVE COST & RETURN OF INVESTMENT with BMA-System

The **benefits** of BMA-System in Desalter Interface Control can be summarized as follows:

01. Real Time and Fast Monitoring of the emulsion phase inside of a dynamic process as desalting process

02. Undercarry of hydrocarbons (and benzene) in wastewater streams

03. Control of Emulsion growth (Water/Oil Concentration) toward the electrical grids allowing for optimization/reduction or, in some cases, elimination of chemical feed

03. Automatic Control of brine water to safe filtering process from hydrocarbons

04. Automatic Mud-Wash / Wash Water Quality / Wet Feed

05. Routine oil undercarry is either significantly reduced or completely eliminated, providing both environmental and economic benefits

06. Upsets are detected long before their effects can be felt in the unit, and the alarm outputs offer the option of automating upset response such as increasing or initiating chemical feed(s)

07. Insertion mechanical process connection with patented Seal Housing System getting an easy installation and maintenance

All above benefits means that, with BMA-System in Desalter Interface Control, <u>the user save money getting the best performance in the efficency of the desalting process</u>

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OVERVIEW OF THE DESALTING PROCESS

The crude oil desalting process is a very simple process in theory, but the execution it can be both complicated and misunderstood. However, a good understanding of this process provides the best perspective on the function of the BMA-System.

Crude oil desalting is accomplished in two fundamental steps:

1. Wash water injection and mixing.
2. Water/Oil Separation (Crude Dehydration)

The actual removal of salt takes place well ahead of the vessel that bears the name "Desalter" (although there is some potential for secondary mixing/desalting in some vessel designs).

The primary function of the desalting system is the removal of inorganic chlorides and other water-soluble compounds from crude oil.

Combining wash water with the crude and adding mixing energy forms an emulsion by bringing water droplets into intimate contact with the oil. Inorganic salts that are present in the crude (from production or transportation) are preferentially dissolved into the water phase ("washed out" of the crude).

During the operation of the desalting process a constant balance must be maintained between mixing intensity, wash water quality, chemical demulsifier feed and control of other parameters that can provide optimal salt removal without forming an emulsion so tenacious that it compromises the system's dehydration capabilities.
Adding to this balancing act the new legislative demands placed on effluent water quality present the operator with a difficult challenge.

The resultant emulsion then flows into an electrostatic dehydration vessel, where it is evenly distributed and allowed sufficient residence time to separate.

Inside the vessel are the electrical grids (in most systems these grids resemble sections of fence lying in horizontal layers, in few designs use an assembly of narrowly spaced "plates" layered vertically).
These grids are connected to large transformers, creating a high-voltage electrical field between them. In this electrical field, water droplets are polarized, resulting in an attractive force between them that causes them to join or *coalesce.* The larger droplets of water fall through the oil phase rapidly. Then, this electrical field from the grids is combined with the heat added to the feed in the preheat exchangers, and the result is an acceleration of the oil/water separation process.

This allows a very high crude rate to pass through a relatively small vessel while still attaining very good dehydration. When all goes according to plan, the result is a very low water content crude feed to distillation and an oil-free brine to the wastewater treatment system.

The question therefore becomes how to maximize the electrical work of the grid.

The best detailed explanation of the generation and function of the desalter's electrical field will come from the manufacturer of the system. However, it is important to note that optimization of the electrical field is very much a function of interface control and how that control is accomplished.

The optimization of the electrical filed is the ultimate goal of the BMA-System.

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DESALTING PROCESS and WASTEWATER

Separation processes as the most significant contributors to generated wastewater. These can include both batch processes (tank dewatering, batch separators, etc.) **and continuous processes** (desalters/dehydrators, in-line separators, etc.). Separators with older technology / manually controlled can contribute significant pollutants to wastewater.

Improved approach: controlling the source.

Instead of treating the wastewater after it has been contaminated, it is more efficient to identify the stream and use more sophisticated control to prevent contamination at the source. In a typical crude oil refinery, contamination contributors to wastewater(expressed as a percentage of total oil requiring recovery) can be quantified:

- Desalters 40%
- Storage tanks 20%
- Slop oil recovery 15%
- Other processes 25%.

If improved control methods can be applied to these processes (minimizing hydrocarbons released into the wastewater), then significant operating credits could be realized.

Thus, by cutting hydrocarbon undercarry from the primary contributors, one can achieve fewer losses and much less pollution.

Optimizing the process: an efficient process is the most profitable.

Improved control of crude oil desalting process with BMA-Systema can facilitate impressive returns such as:

- longer run times
- lower equipment fouling and corrosion
- reduced maintenance requirements between and during shutdowns

The desalting system is a particularly good example to demonstrate source reduction opportunities. The desalter not only has a critical impact on operating costs, but also on the wastewater treatment.

The effects on waste treatment facilities from poor desalter performance become increasingly important as emissions limits are more stringently enforced by government legislation.
Many refiners try optimizing the desalter via chemical addition. These chemicals not only have a direct price, but their potential effects on downstream pro-cess equipment and some catalysts must be considered. But even under the best circumstances, chemical alternatives should be used only after more efficient control alternatives have been explored.

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ADVANTAGES of OIL/WATER SEPARATION using BMA-SYSTEM interface control

The most common misconception in controlling the desalting process is the assumption that the interface between the oil and water phases is clear cut. In the greater majority of systems, nothing could be further from the real situation inside the desalter since inside of the vessel the process is in a **Dynamic Operation**.

Desalters and Dehydrators are applications in the oil industry where it is necessary to separate water and oil in a Dynamic Process / Continuous Process.
The density differences between water and oil causes water to drop to the bottom of a separation tank, and oil to rise to the top. When a desired amount or level of water has separated, it is removed through a water draw‑ off valve.
Costly emulsion‑ breaking chemicals, electrostatic precipitation and/or fire tubes are required to assist the separation process.

In the vessel, the structural parameters such as vessel size, grid elevations and feed discharge points are all fixed. The most critical remaining variables then become interface condition and position.

In fact, optimal interface control has been proven to have significant impact on both the oil and water quality resulting from the dehydration process. Yet, in spite of the obvious need for such control, the traditional methods of control have operated on a fundamentally flawed assumption: Level.
The very term "level control" indicates the presumption that the interface between oil and water in the desalter exists at a single point (such as that observed between gasoline and water).
Any review of the internal conditions in the desalter vessel via the try-lines or swing-arm will dispel this notion. There is no level, rather the interface consists of a transition zone from oil to water in a continuous change of volume percent. Understanding the true nature of the interface leads to the conclusion that efficient control comes from controlling these water/ oil percentages and not an imaginary level.

Emulsions

Emulsions are one of the most serious problems in oil/ water separation. In a Dynamic Process these problems means additional cost in maintenance and production since the process efficiency is lower.

Emulsion build‑ up is caused by mixing valves, crude properties (surface tension, viscosity, density), contaminants, vessel temperature, and retention time. The emulsion pad is dynamic - growing and shrinking continuously.

To avoid dumping oil with the free water, it is necessary to control emulsions such that they can only build above a control point. In other instances it might be desirable to force the emulsions to build below the control point.

Traditional Control Methods and their problems

Fig. '1' shows these instruments working under ideal conditions (Ideal World). In a vessel/tank oil and water are separated with a distinct interface. (This situation rarely occurs in the real world, where we would expect to see an emulsion layer.)

Traditional methods of controlling the separation process involve the use of a Sight Glass, Float, and/or a capacitance Probe.

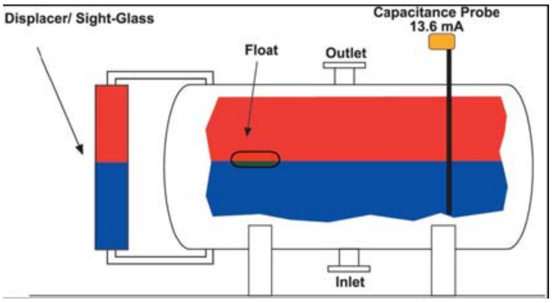
Float Errors

Fig. '3' shows what happens when the mixture extends upwards to the roof of the tank. If the mixture is in the water continuous phase, it will be dense enough to buoy up the float. If the float controls dumping, then ydrocarbons(HC) will unintentionally be dumped along with the free water.

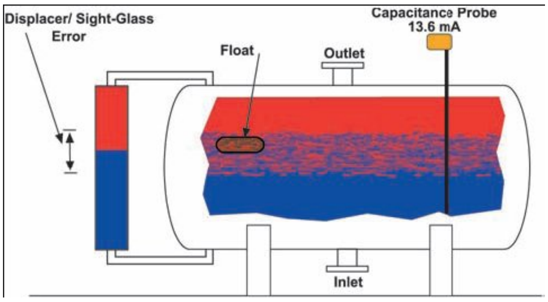
Capacitance Probe Errors

A profiling capacitance probe estimates the over‑ all % water in the tank. It cannot give information to the operator on the size or behavior of the emulsion pad. The tank in fig. '2' has an oil continuous emulsion pad, but the capacitance probe shows no change in the water interface from '1'.
Fig. '3' demonstrates another problem with capacitance probes. They cannot measure oil in a water continuous
mixture, and a high water cut near the top of the tank causes capacitance probes to read full scale.

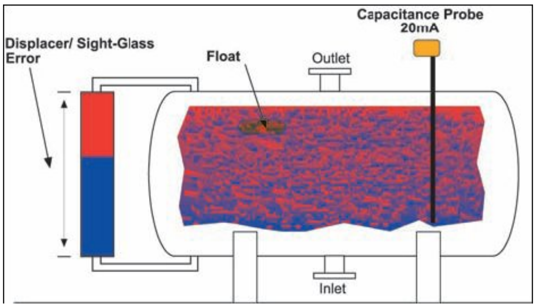
1. Ideal Conditions



2. Small Emulsion Pad

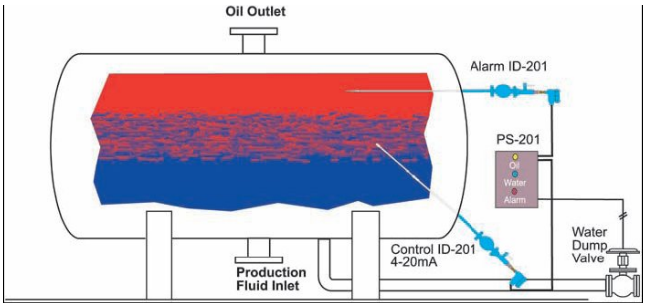


3. Large Emulsion Pad



The Solution: concentration control BMA-SYSTEM

4. Concentration Detection (BMA-System)

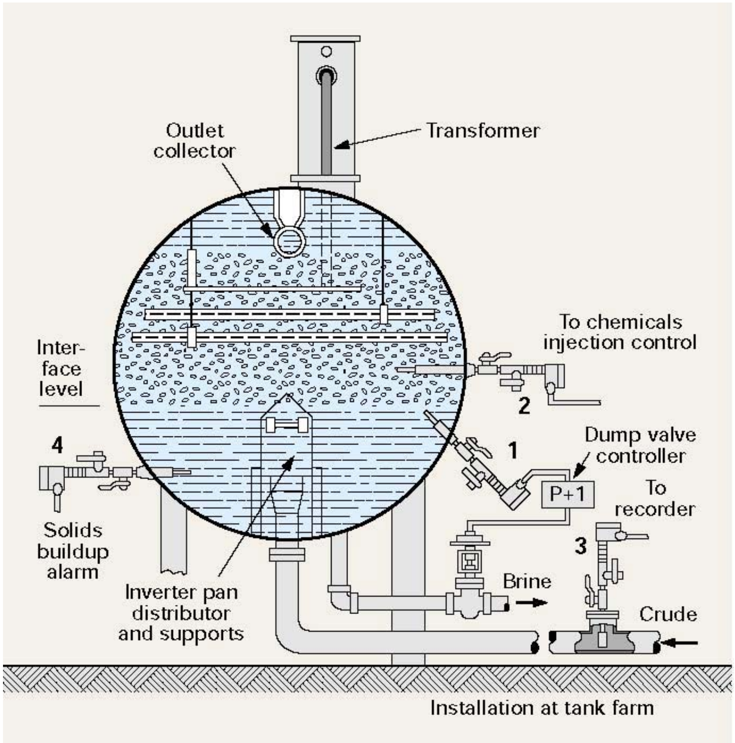


The BMA-System gives a current output proportional to water content over the full scale of 0‐ 100%. This enables operators to answer the two hardest questions in the industry: "How big is the emulsion pad?" and "In which direction is it growing?"

It also enables operators to control their levels accurately, in the desired direction, and make informed decisions as to the types and quantities of emulsion‐ breaking techniques they should use.

Fig. '4' shows a typical BMA probe installed at an angle of 45°. When used to control the dump valve, for example, it opens the valve when it detects, 80% water, and shuts the valve when it detects 70% water.
This ensures that the emulsion develops above the control point and allows only clean water to be dumped. The second probe ("ALARM") can have a lower set point and will activate an alarm, or an emulsion‐ breaking device such as a chemical pump, if the emulsion rises too high.
(Reversing the positions of the two probes and setting the control to 10‐ 20% water would allow the operator to force the emulsion to build below the control point, leaving only dry product in the separators.)

BMA-SYSTEM in DESALTERING PROCESS



The BMA-System technology confronts one of many problems associated with pollution source-point control: detection.
Because operators cannot see through vessel walls, they must rely on other methods that show fluid levels.

The emulsion's nature further complicates level detection and adds to the dilemma.

As see before, for most emulsions, the interface is not a clean-cut line. Rather it is a hydro-carbon/water transition zone where component concentration varies especially with vertical position. Consequently, traditional level control techniques have not acknowledged this phenomenon. Thus they often gave false information that ultimately released hydrocarbons into wastewater.

The BMA-System, energy absorption technology, measures hydrocarbon concentration in water, rather than the interface. This highly reliable method greatly reduces hydrocarbon undercarry.
Other interface control methods procedures for separation process control such as sight glasses and capacitance probes have been ineffective in detecting the hydrocarbon/water interface.

When evaluating control instrumentation to minimize effluent under-carry, and detect/control emulsions and dispersions, certain guidelines must be considered:

- Direct contact with the process
- Measurement of 0% to 100% hydrocarbon/water concentration (not level) in both oil-continuous (water in hydrocarbon) and water-continuous (hydrocarbon in water) phases.
- Local or point measurement, instead of averaging over a large area. This method avoids errors due to hydrocarbon/water distribution or rag layer.
- Minimal effect on measurement from fluid proper-ties (specific gravity, pressure, temperature, viscosity and coating build ups).

The conformity of all above points is the ultimate goal of the BMA-System.

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THE BMA-SYSTEM INTERFACE DETECTOR (ID) and OIL/WATER MONITOR (OW)

In a desalter, the oil/water interface is nothing more than the transition from “dry” (low water content) crude oil to water. This transition may occur over a relatively narrow band of several inches, or it may be several feet thick. The relative size of the emulsion layer is a function of the ease with which the two phases are passing each other. In any case, there will be two “zones” or types of mixtures that normally will be encountered:

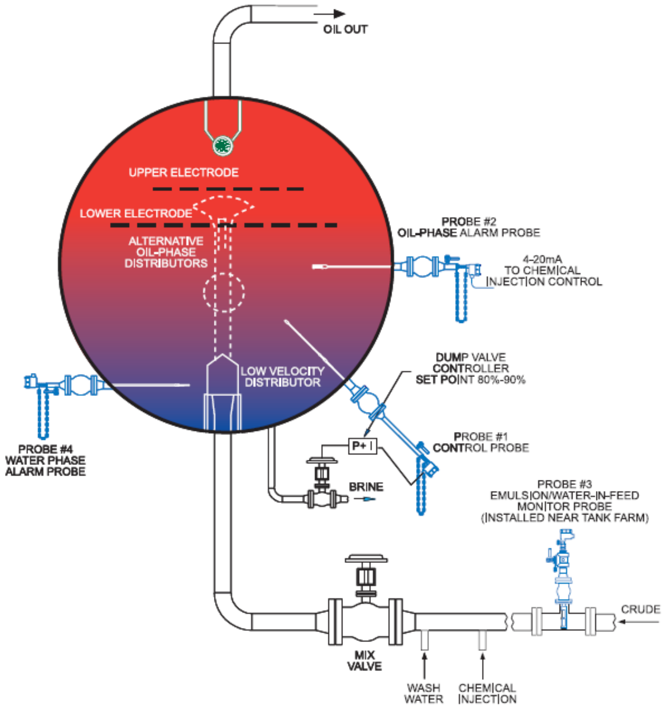
1. The Oil-Continuous or Water-In-Oil Zone (O/C)
2. The Water Continuous or Oil-In-Water Zone (W/C)

The O/C region is what we have historically referred to as an emulsion. It consists of individual droplets of water surrounded by and suspended in oil. The W/C region has quite different properties, and is commonly referred to as a reverse emulsion or a suspension. It consists of droplets of oil and/or oil-coated particles suspended in and surrounded by water (the exact opposite of the O/C layer).

A number of conditions can lead to an upset in the desalter including:

- High solids concentration and/or solids stabilized emulsions
- Off specification pH
- Conditioning chemical optimization
- Excessive mix valve energy
- High water concentration or slugs of water in the crude oil feed
- Low operating temperature
- Feed rate in excess of design capacity

During periods of upset (regardless of cause), the transition or emulsion layer between dry oil and water without free phase oil will grow as the two phases cease to separate smoothly. The results of this growth, if left uncontrolled, will be cross contamination of the effluent phases, seen as oil undercarry or water carryover. The type of emulsion that forms will be important to any effort to stop or retard the growth, and it is critical to the separation process that the growth is detected and controlled before an upset if the system is to perform properly.



The real time monitoring of the emulsion’s growth is the ultimate goal of the BMA-System.

The BMA-System Interface Detector (ID Series) and the Oil/Water Monitor (OW Series) are actually remarkably simple instruments. The probes function by the principle of energy absorption. All materials absorb energy at different rates. AGAR technology uses this fundamental physical property to differentiate between two materials based on the rate at which the energy is absorbed. One common example of two such materials is oil and water. Water absorbs energy at a much higher rate than hydrocarbons.

When calibrated properly for oil and water, an BMA ID and OW will use to determine how much of the material present at the probe is water, and how much is oil. The signal from the pobe to the remote Evaluation Unit is then converted to a 4-20 mA current that is proportional to the amount of water (water concentration by volume) in the area around the antenna from 0% (all oil) to 100% (all water).

The result of this measurement is a system of two or more probes (minimum requirement is two ID probes) that can be used to provide excellent interface control in desalters. This control is not achieved by attempting to measure and report an imaginary “level” between two phases, rather it is accomplished through monitoring and controlling the actual percent water content at different elevations in the system.

In short, **the BMA-System Interface Control system actually controls by measuring the percent water at different elevations in the separation process.** Any changes in the position and size of the interface are immediately measured and reported, and this information is used to continuously control the position of that interface. This point control concept is effective regardless of the degree of emulsification between the phases, and can be used to help correct upsets by reporting the rate and extent of emulsion growth.

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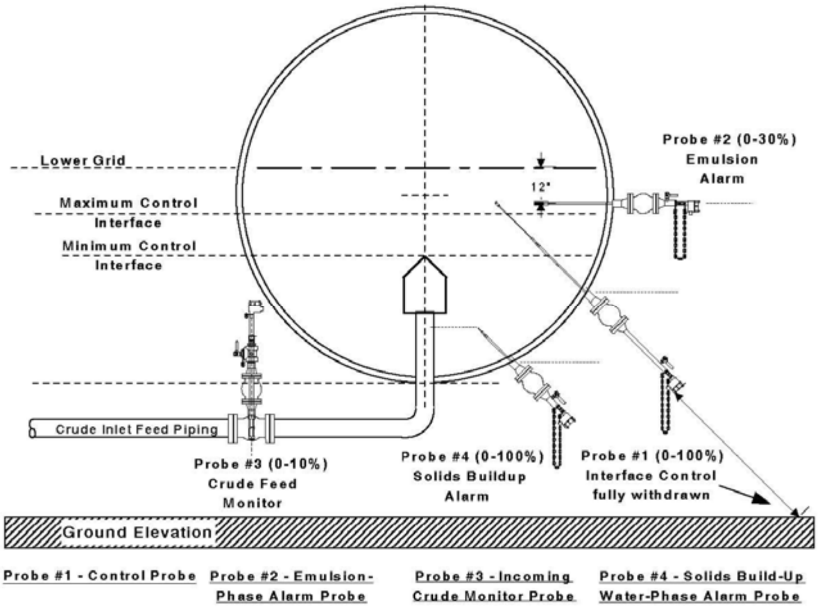
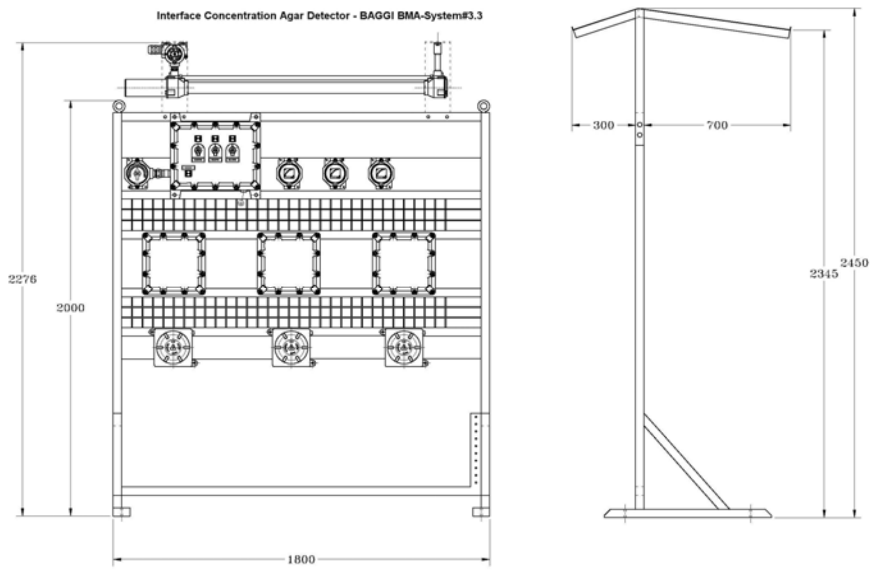
ELEMENTS OF BMA-SYSTEM in the DESALTER INTERFACE CONTROL



The BMA Desalter Control System uses from two to four instruments, with each providing information on the water content of the desalting system at different locations. Three of these instruments, the ID's, are located in the vessel, monitoring the water content at three different elevations. A profile of the emulsion layer and its effect on the effluent phases can be monitored and controlled. The OW is installed in the crude oil feed line to the desalter and monitors the crude feed for water concentration trends and slugs from the tank farm.

The remote Evaluation Unit are available in different configuration to satisfy the specific technical norms.



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