

# BERTHOLD WEBINAR

Improving desalter performance for opportunity crudes



**BERTHOLD**

**FRAMES**

## Agenda

- Introduction
  - Berthold
  - Frames
- Desalter Basics
- Opportunity Crudes
  - Influence on Desalting systems
- Importance of Level Control
- Desalting Variables
- Frames Case Study
- Berthold Case Study
- Questions and Answers





Berthold -  
Experience Around the World



## Where is Berthold?

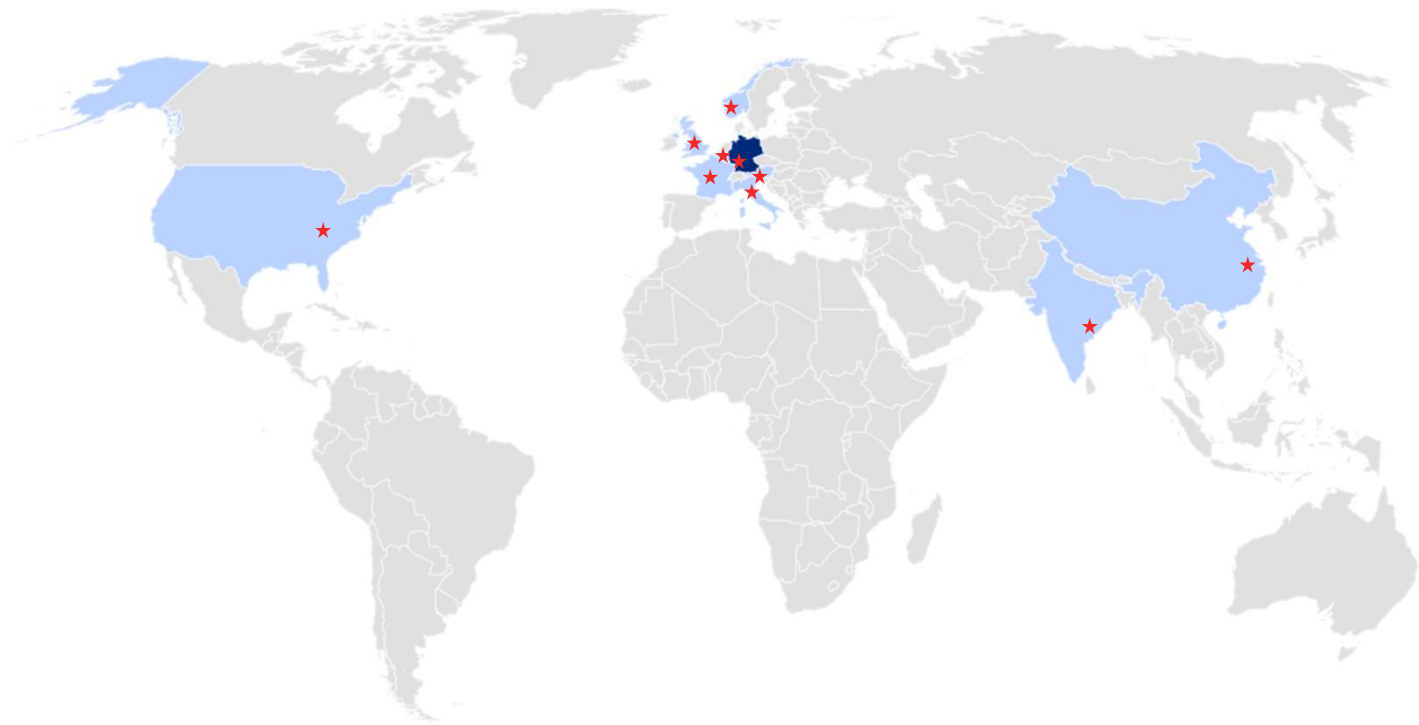
- Located in Bad Wildbad, South West Germany
- Specialized in radiometric process measurements since 1949
- World Leader in process radiometric measurements
- Family run company
- >20,000 nuclear gauges in operation



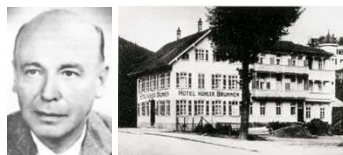
## Where is Berthold?

9 Subsidiaries around the world

- Germany
- Austria
- Belgium
- China
- France
- India
- Italy
- Norway
- United Kingdom
- United States
- **350 employees worldwide**
- And Representatives all over the world



... and where we came from



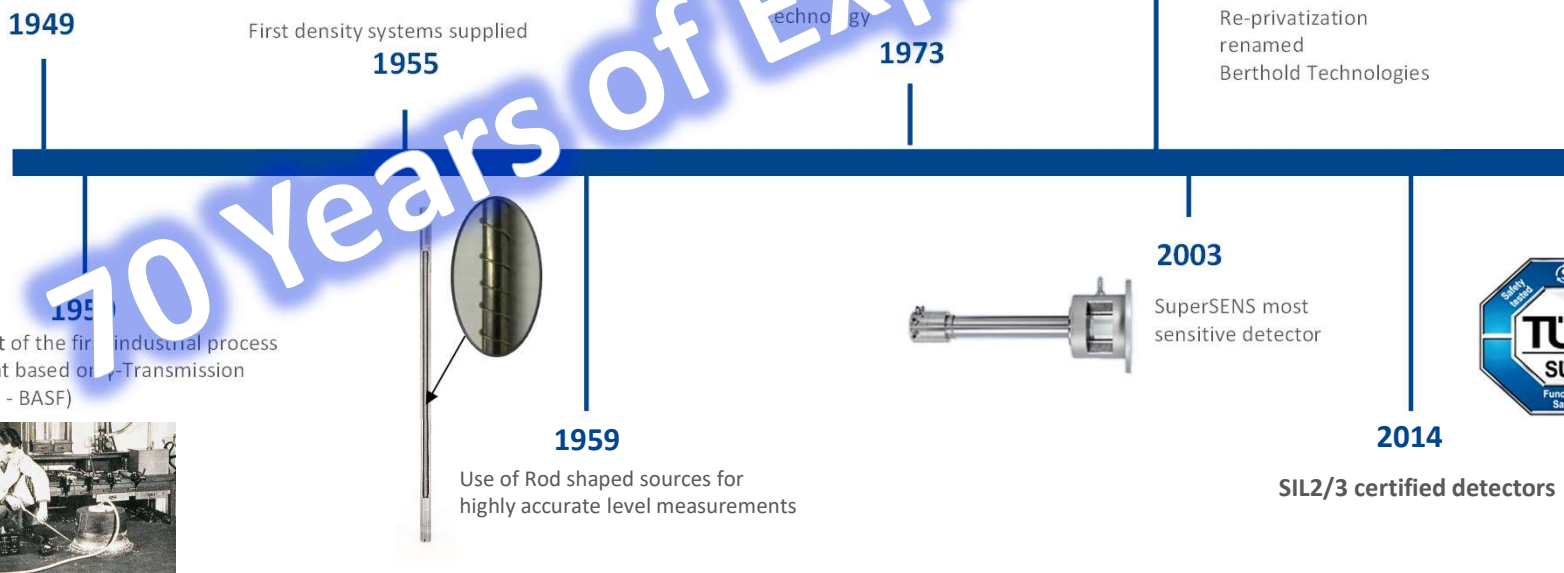
Prof. Dr. Rudolf Berthold founded the company „Laboratorium Prof. Dr. Rudolf Berthold“



High-sensitive oscillators replaced Heiglmüller technology



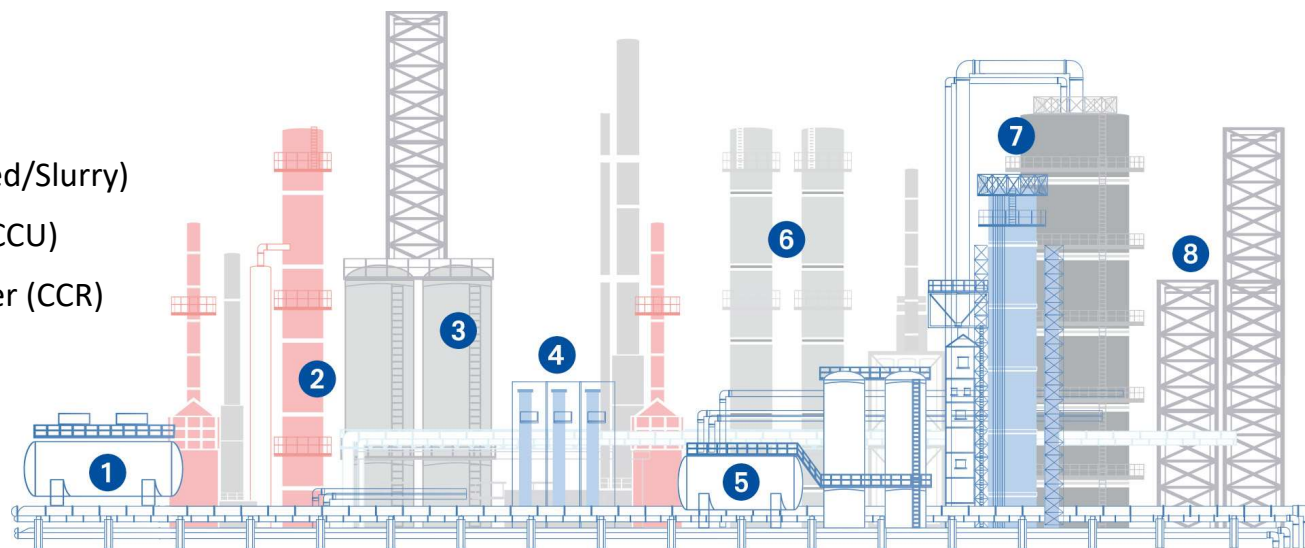
Re-privatization renamed Berthold Technologies



# Radiometric Measurements

Applications - Refinery

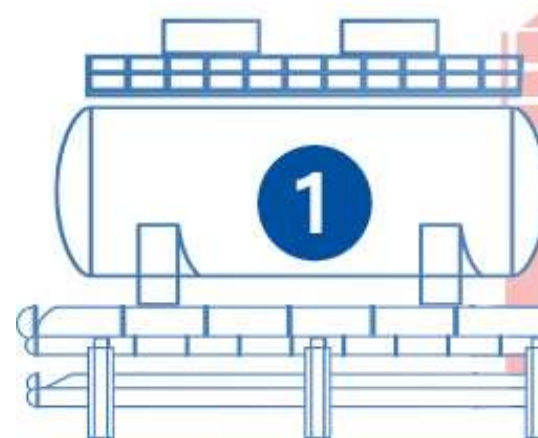
1. Desalters
2. Crude towers/Vacuum towers (CDU)
3. Delayed Cokers (DCU)
4. Solvent Deasphalting (SDA)
5. Alkylation
6. Resid Hydrocrackers (Ebullated/Slurry)
7. Fluidized Catalytic Cracker (FCCU)
8. Continuous Catalytic Reformer (CCR)



## Radiometric Measurements

### Applications - Refinery

1. Desalters
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## Frames Introduction

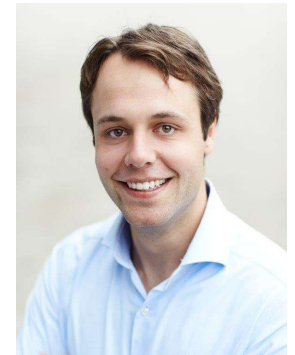
- Dutch Technology House for Energy Solutions
- Worldwide presence
- 275 skilled employees
- € 80 MLN Annual turnover (2019)
- Founded in 1984

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Electrostatic Coalescers

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*Frames Desalter for Saudi Aramco*

# Frames Portfolio

Oil



Bulk Separation  
Dehydration  
**Desalting**  
**Distillate Treating**  
Stabilization

Water



Deoiling  
Absorption  
Degassing  
Stripping  
Desanding  
Sand Cleaning  
Biofouling Prevention

Gas



Separation  
Sweetening  
Dehydration  
Dew Point Control  
Hydrate Inhibition  
Light Hydrocarbon Recovery  
Flare Gas Recovery

Flow Control  
& Safeguarding



Wellsite Packages  
Safety Instrumented Systems  
Chemical Injection  
Hydraulic Systems  
Valve Automation Center

Renewables



Biogas Upgrading  
Synthesis Gas Upgrading  
CO2 Capture  
Hydrogen  
Off-grid Power Solutions

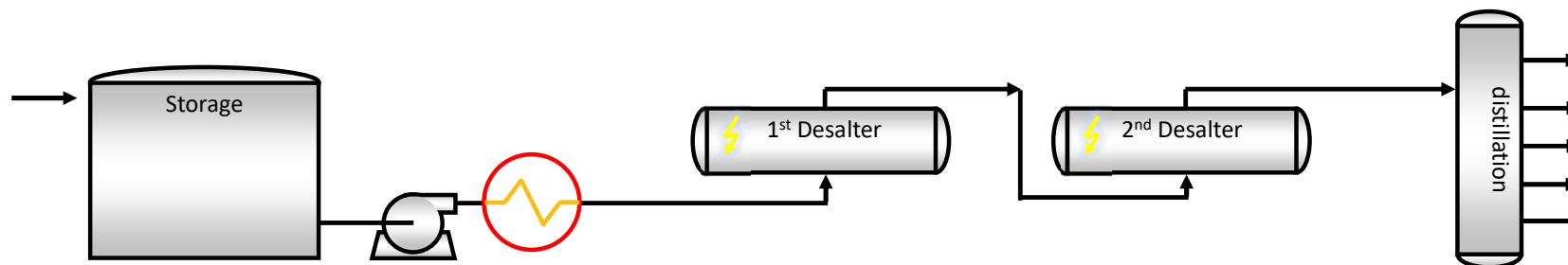
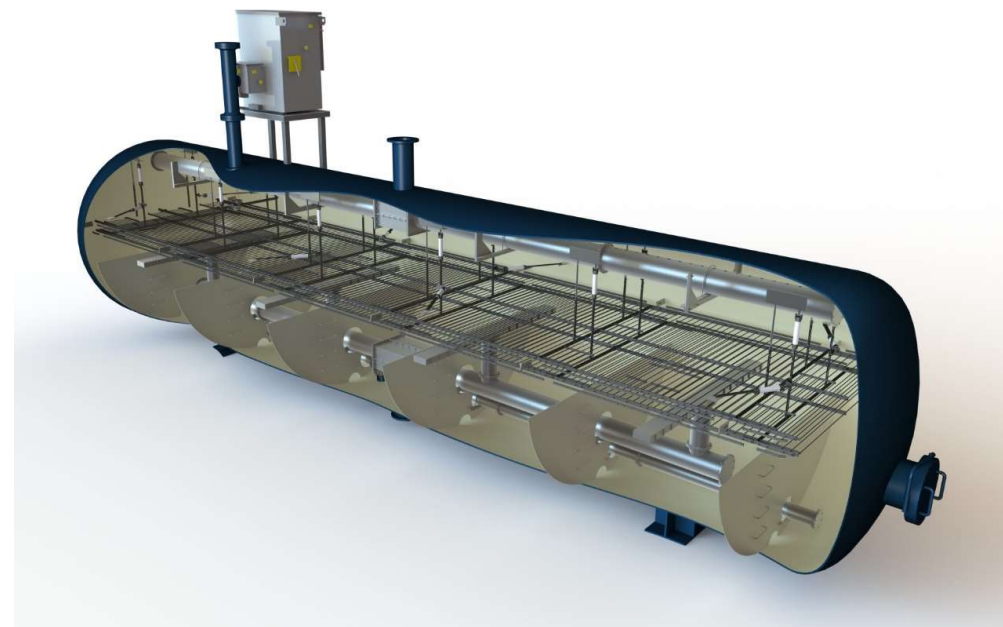
Services



Asset Life Cycle Management  
Maintenance & Field Services  
Commissioning & Start-up  
Spare Parts  
Operator Training

## Desalters in Refineries

- One of the first processes in refinery
- Deep dehydration (~0.2 %vol)
- Deep desalting (1 ptb range)
- Relatively large, multiple transformers
- Relatively high operating temperatures (~140 C/280 F)



## Desalters

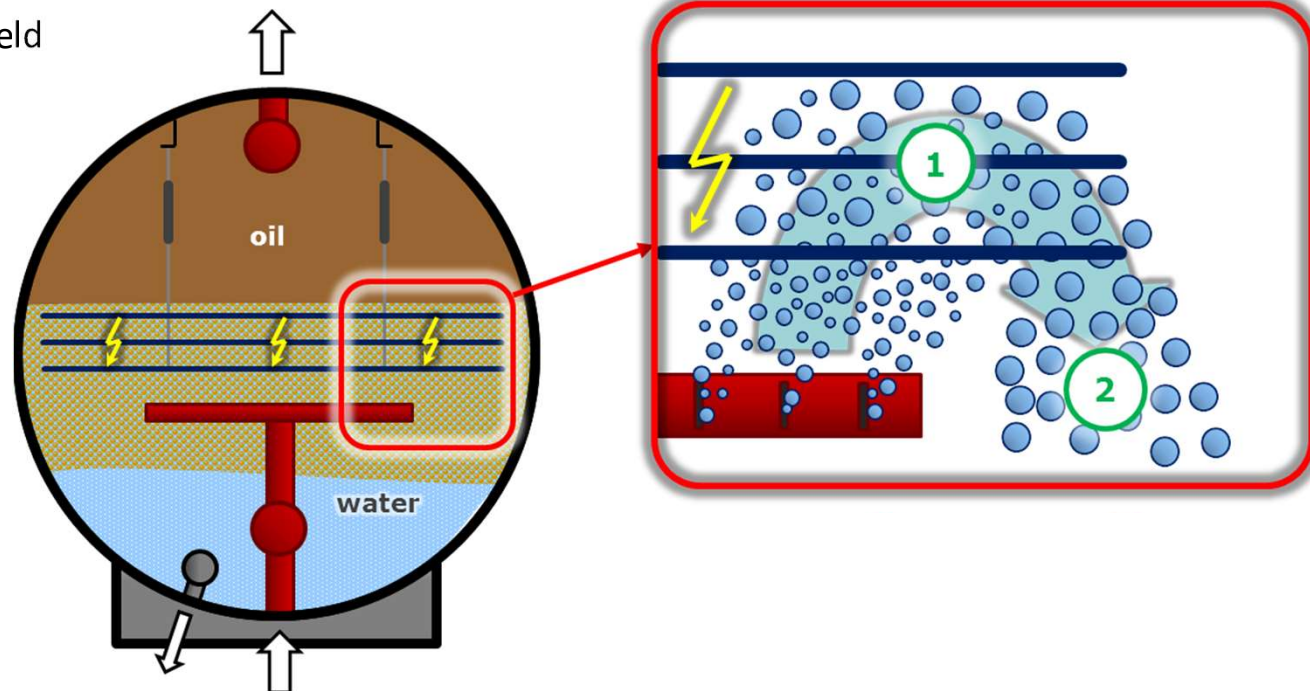
Separation of (emulsified) water from crude

Droplets coalesce in electrostatic field

- Big, heavy droplets fall out

Salts are dissolved in the water, not in the crude

- Removal of water means automatically removal of salt



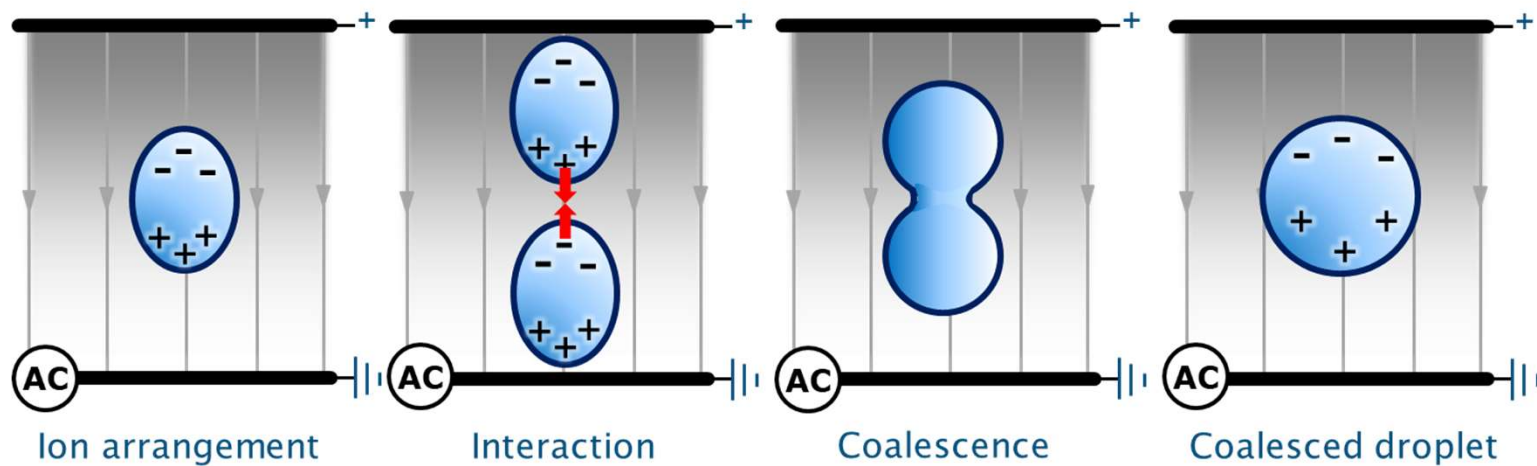
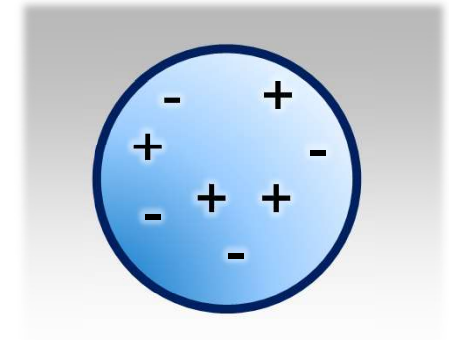
## Electrostatic Separation: AC Coalescence

Salts are present in the droplets as ions

- Positive and negative charges

Electrostatic field pulls and repels *ions*

- Two adjacent droplets attract each other: coalescence



## Two-Stage Desalting

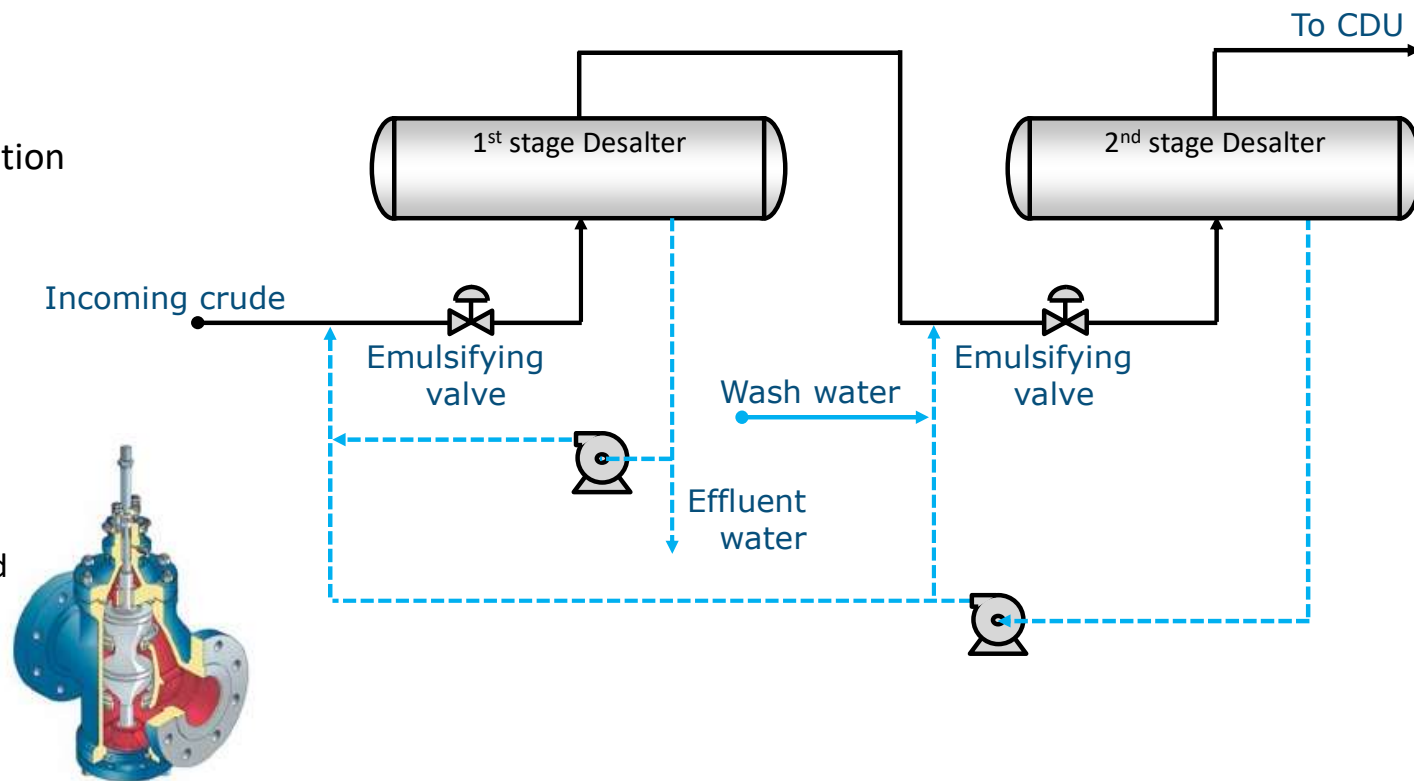
Wash water added to dilute the produced water in the main stream

Additional recycling to ensure dense droplet population

- ~4 % for light crudes
- ~10% for heavy crudes

Mixing valves

- Mix added water stream with main stream
- Differential pressure controlled



## Opportunity crudes

- Challenging to process, but discounted
- Features
  - Quality variations, mixes, diluted crudes
  - High in naphthenic acids / High TAN
  - High in Alkali (Ca, Mg), heavy metals (As, Ba)
  - Production chemicals (H<sub>2</sub>S scavengers, biocides, scale control etc)
  - High conductivity
- Examples:
  - DOBA crude
  - Light tight oil (LTO) from hydraulic fracking
  - Heavy Canadian and South American crudes



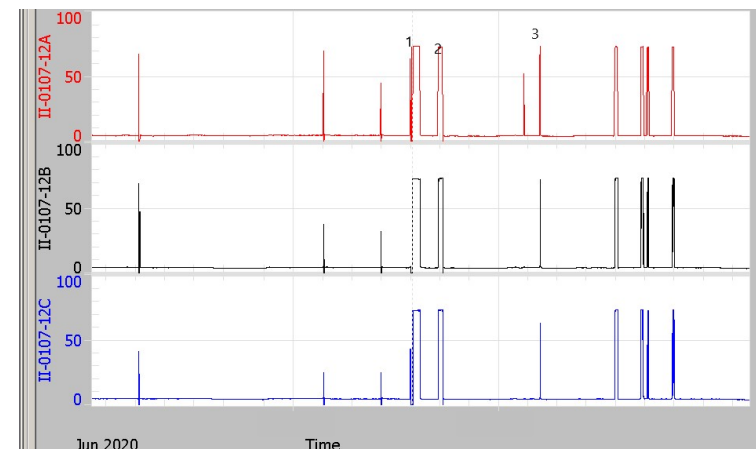
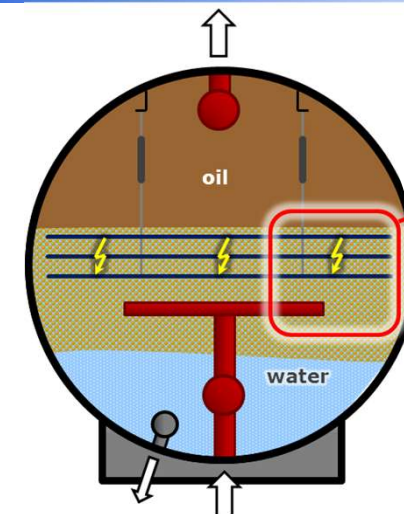
## Processing opportunity crudes

### Challenging for Desalters

- Stable emulsion formation
- Mud built-up
- High power consumption
  
- Increased water and salt in outlet to CDU
- Oil carry over into water treatment system
  
- Risks: CDU corrosion, fouling, catalyst poisoning

### Indications:

- Current spikes, high outlet water
- Fluctuating interface level, interface sludge built-up







Berthold -  
EmulsionSENS

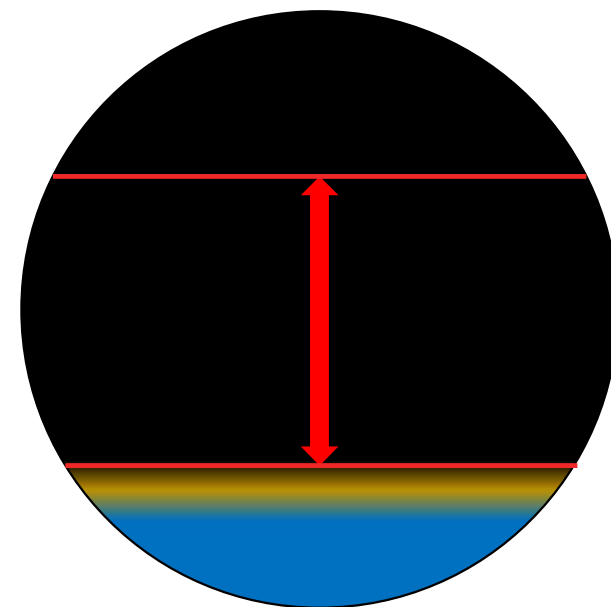


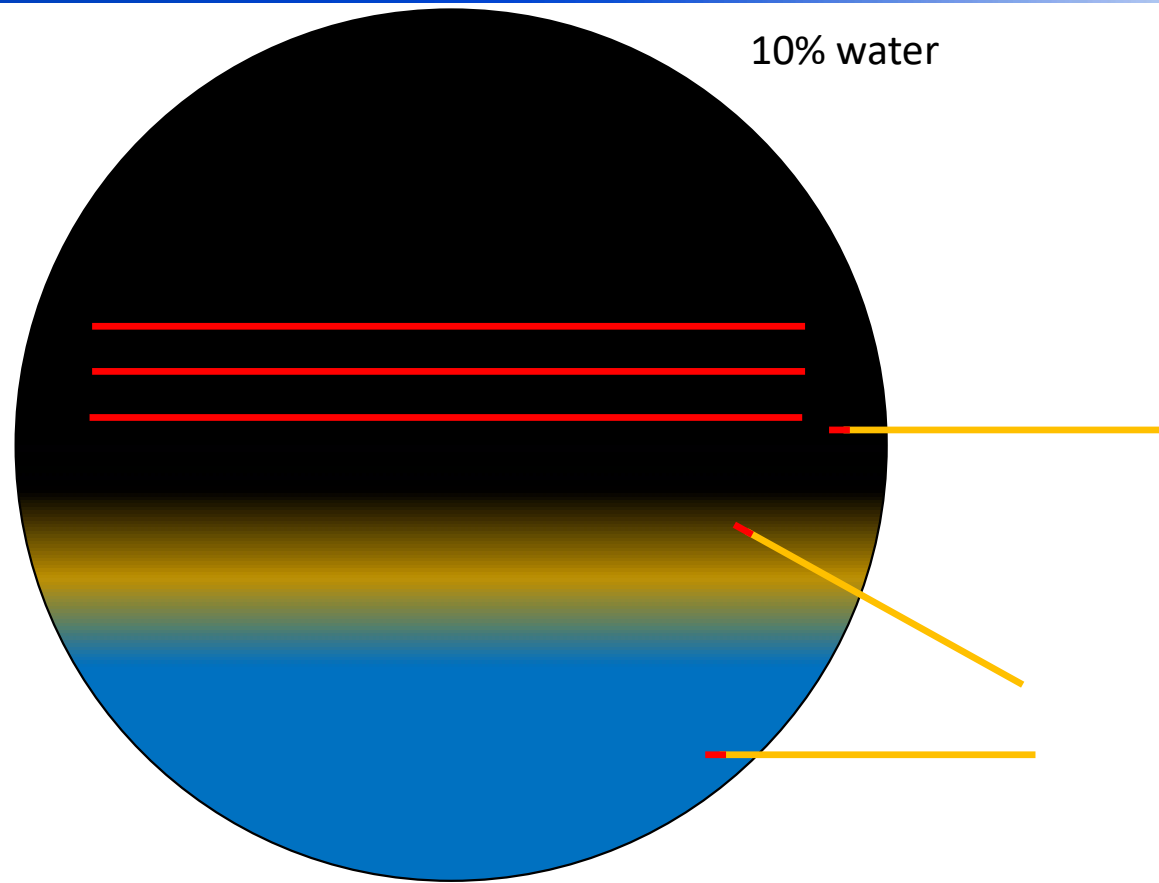
## Level Control

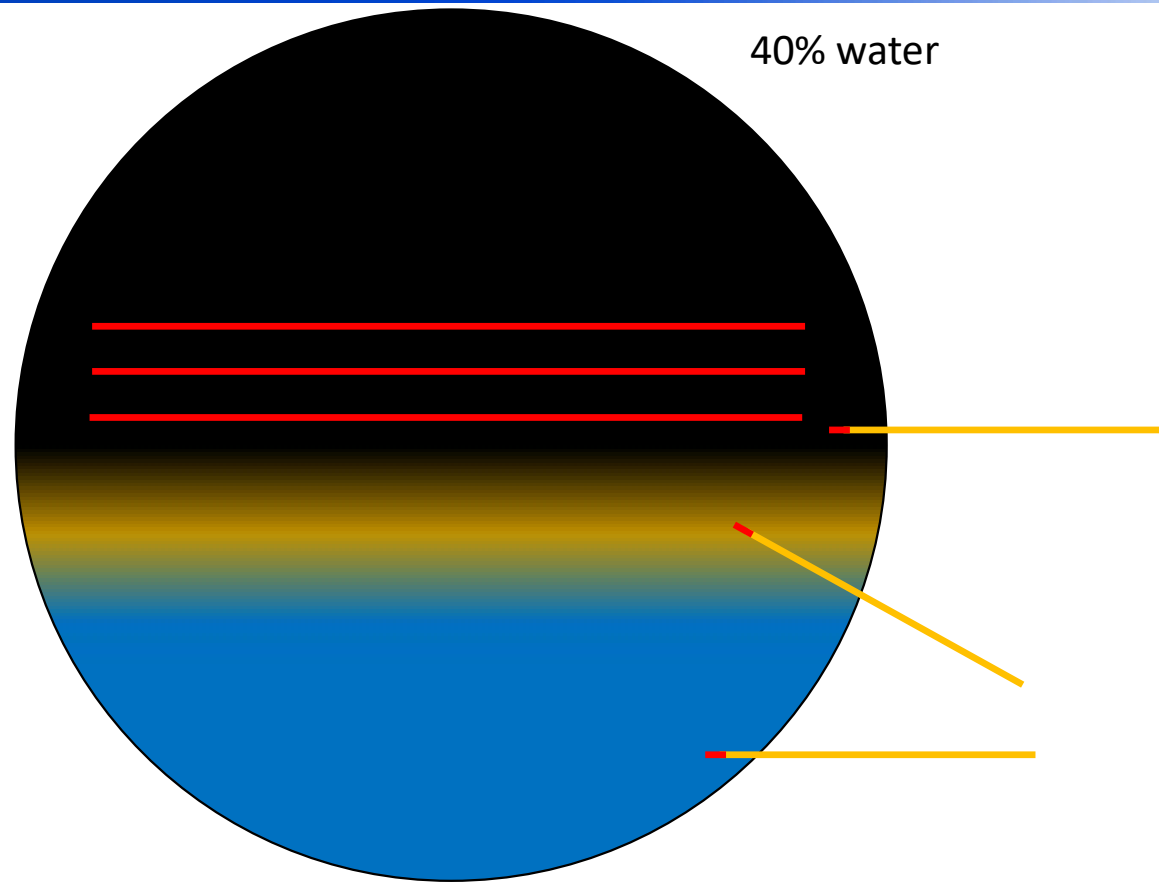
**“The second important control function for a desalter is the interface level control. The current trend to operate on heavy crudes can lead to heavier rag layers in desalters, which makes it difficult to control the interface level.”**

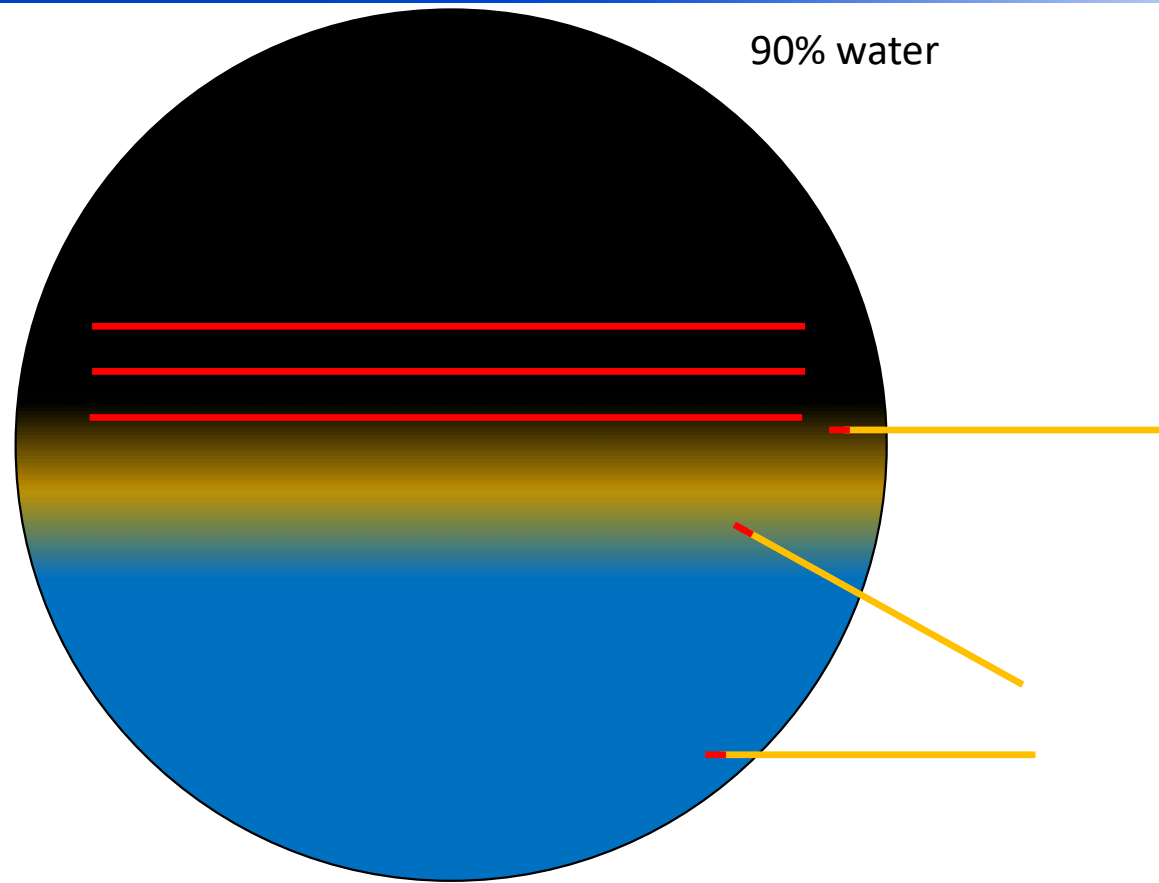
From “Modeling and Optimization of Crude Oil Desalting” by Shahrokh Ilkhaani MSc Chem Eng pg 30

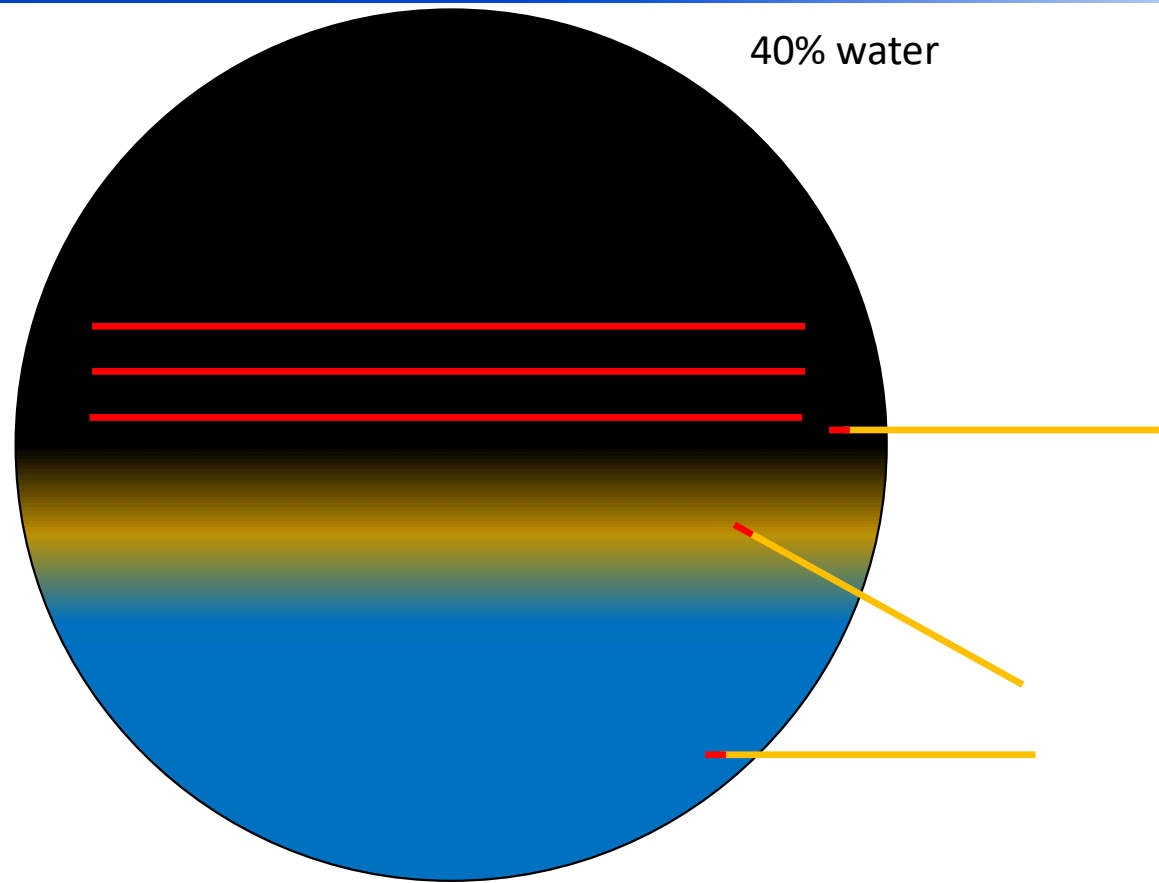
- Proper Level Control
  - Allows for maximizing residence time in the vessel
  - Ensure level is at the proper part of the vessel to allow the longest setting time.
  - Ensures water does not get too high to short the electrostatic grids
  - Ensures crude does not get carried out with water outlet.

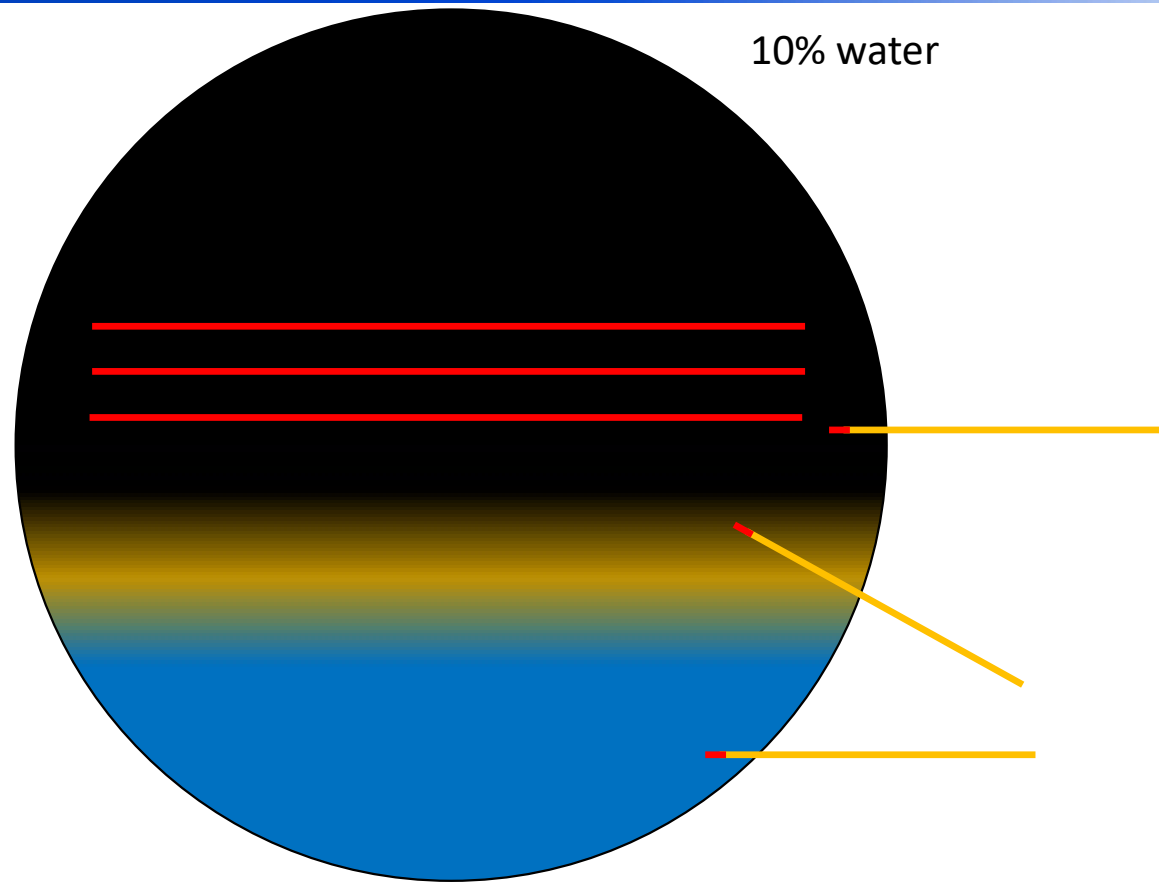












## Desalter Interface level

### Problem

- Refineries reconfigurations
  - Heavy crude (low API)
  - High asphaltene content
  - High TAN crudes
  - High percent solids
- Harder to achieve separation of oil and water
  - Significant Rag Layer Present
  - Hard to control particularly with water slugs
- To optimize desalter operation you must understand the dynamic process in the desalter and see it changing
  - Is it really a level or Is it a gradient of emulsion from water to oil
  - Early detection of rag layer buildup



## Multiphase Level Measurements

### Applications

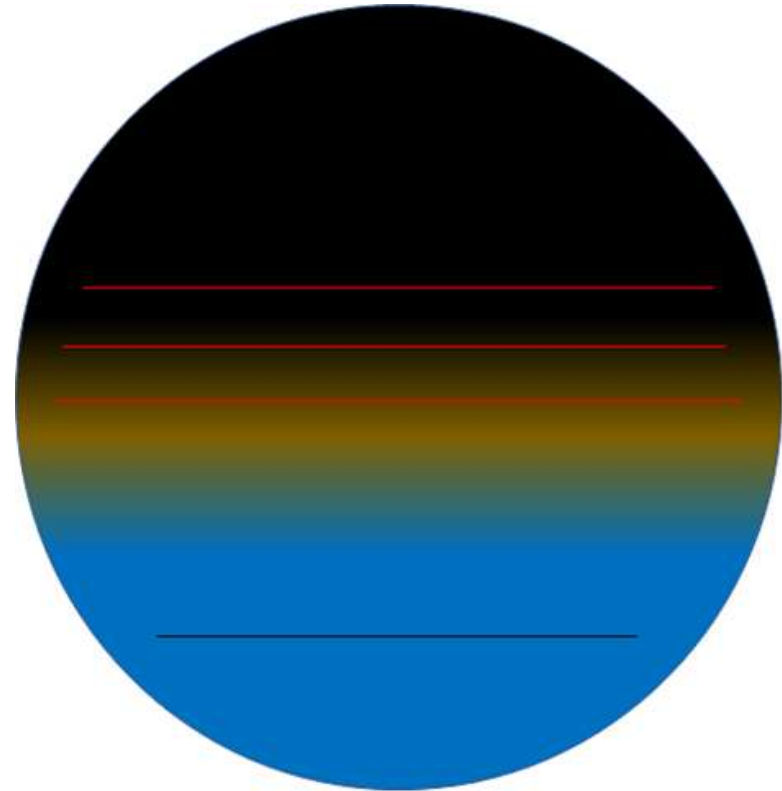
- **More than two layers** occur
- **Density profile** is necessary to reliably monitor the separation process
- **More** than one interface is measurement is needed.
  - Interface between water and emulsion
  - Interface between emulsion and oil



## Desalter Interface level

Why is level critical – Too High

- Grids short out
- Carryover of water
- Increase chemical usage
- Carryover of Salt and Minerals (Fe)



## Desalter Interface level

### Current Situation

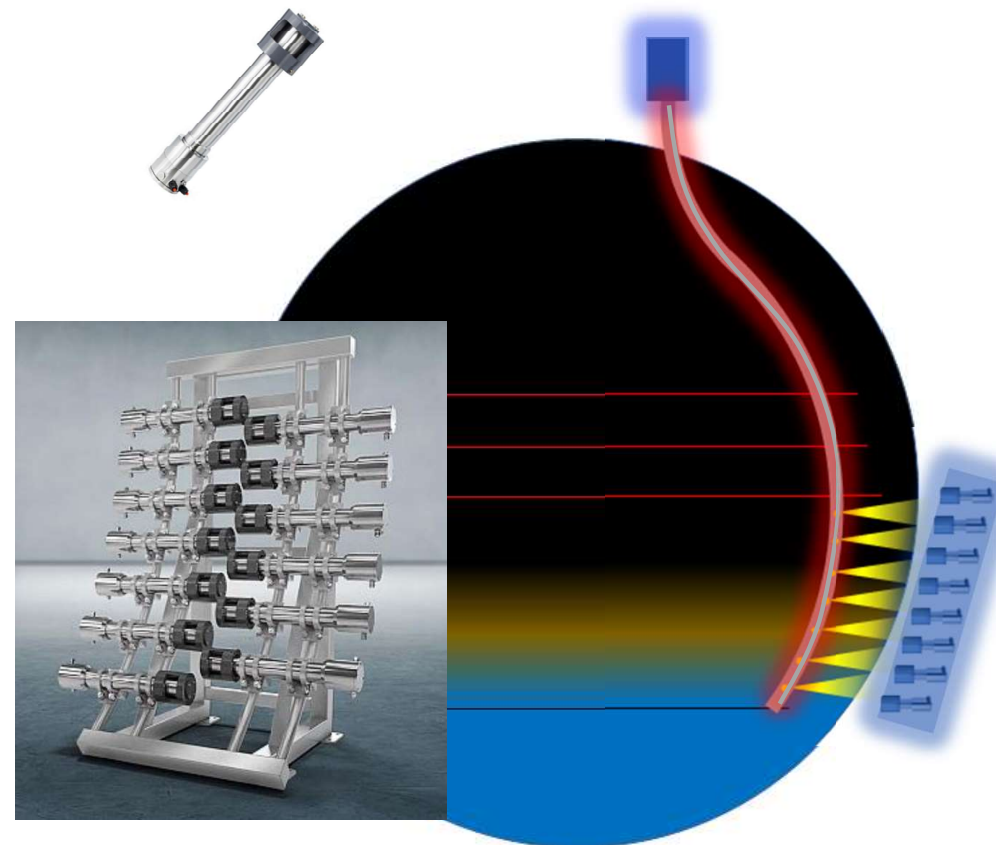
- Tryline sampling
  - Typically, what we see manual samples
  - Other instrumentation is not trusted
  - Difference in level from person to person



## EmulsionSENS' components

### Overview

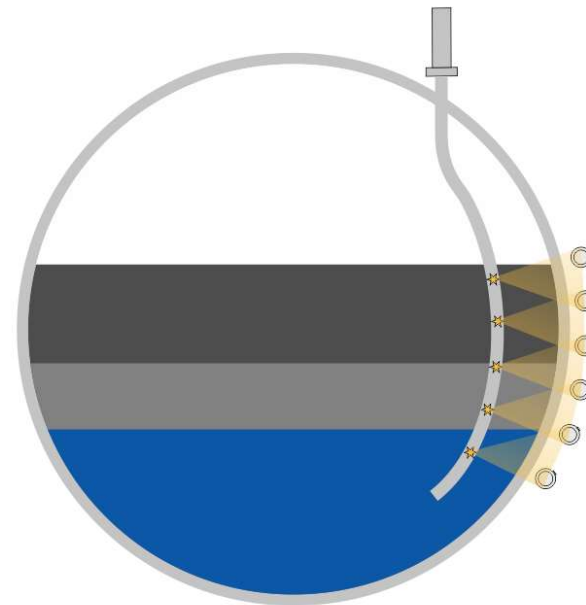
- Multiple point **sources** (usually Cs-137), processed as flexible rod sources, inserted in
- One (curved) **dip pipe**
- Flange **shield**
- Multiple density **detectors** LB 480 mounted on
- **Mounting structure**
- Optional: Control cabinet incl. **transmitter** LB 478 and extension modules



## Staggered Arrangement

Good for level control.

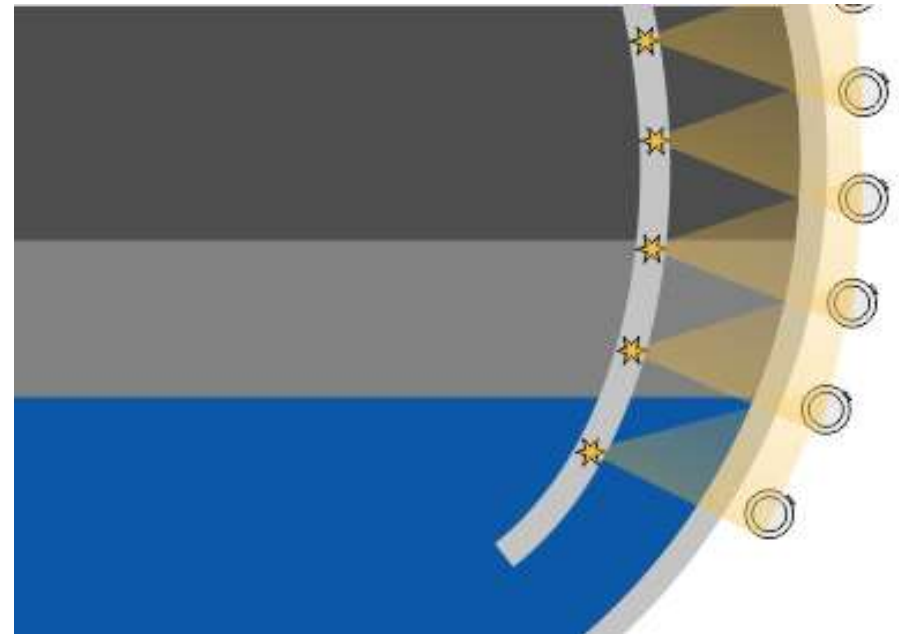
- Coverage of complete measuring range
- Measurement of small sections of level (density value averaged over triangle)
- Position and thickness of the different layers can be determined



## Staggered Arrangement

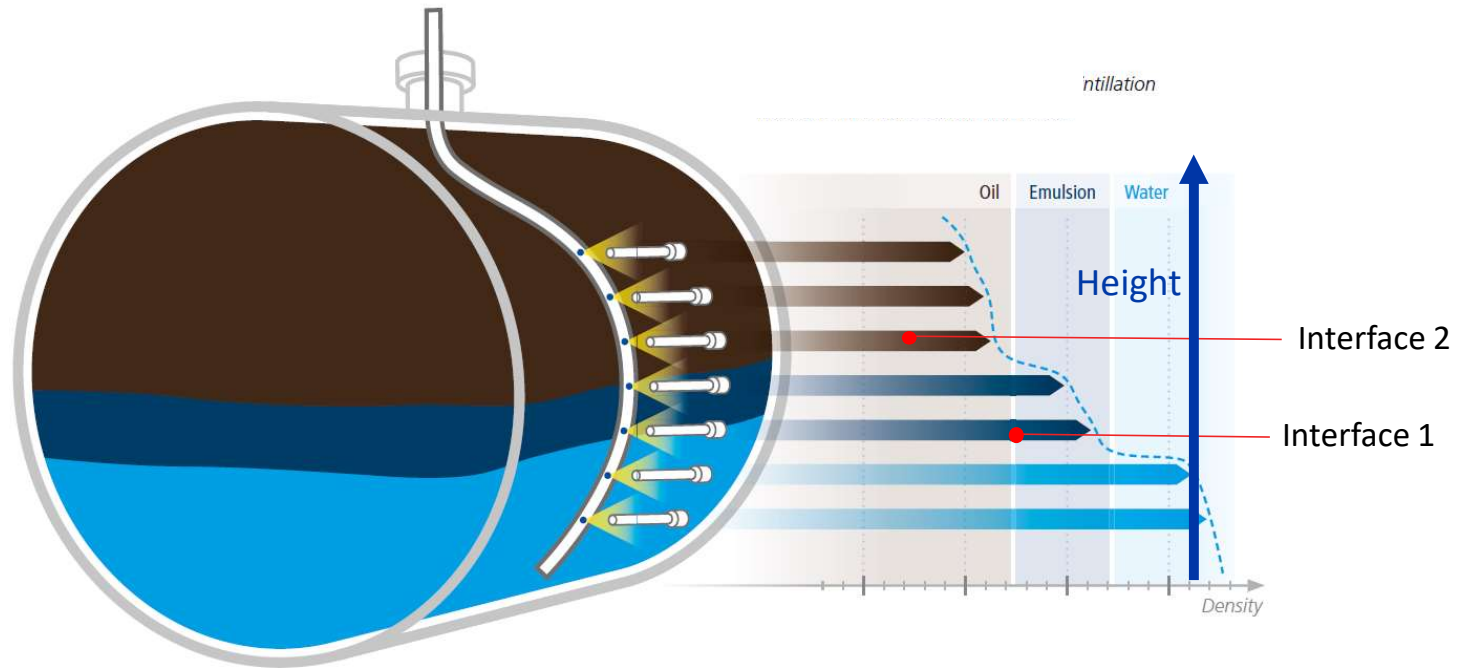
Good for level control.

- Coverage of complete measuring range
- Measurement of small sections of level (density value averaged over triangle)
- Position and thickness of the different layers can be determined



# Staggered Arrangement

Redundant Values: Density and Level



## Desalting variables

- Important for stable desalting operations in general
- Paramount importance for treating opportunity crudes

### *Checklist:*

- Interface control (already discussed by David)
- Desalter size
- Internals type (modern vs outdated)
- Temperature
- Transformer size
- Chemical injection program
- Water injection and recycling
- Mud removal





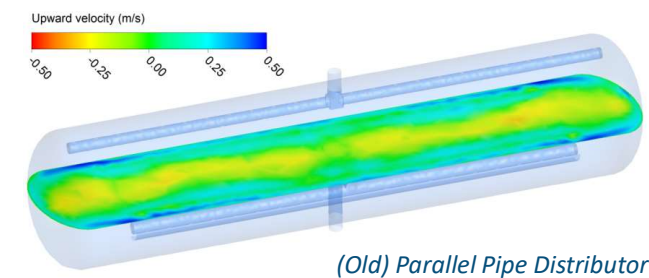
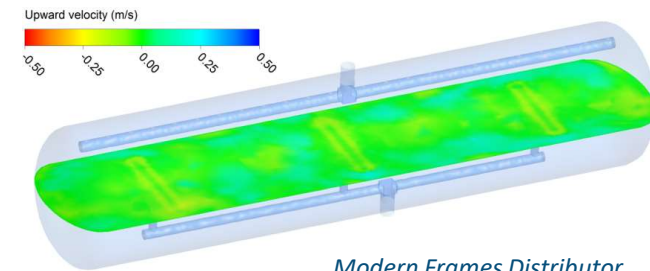
## Desalter size & temperature

### Desalter size

- Opportunity crudes generally require larger vessels
- Upgrade: use existing desalters parallel, new 1<sup>st</sup> stage vessel
- Upgrade: internals to modern standards

### Operating temperature

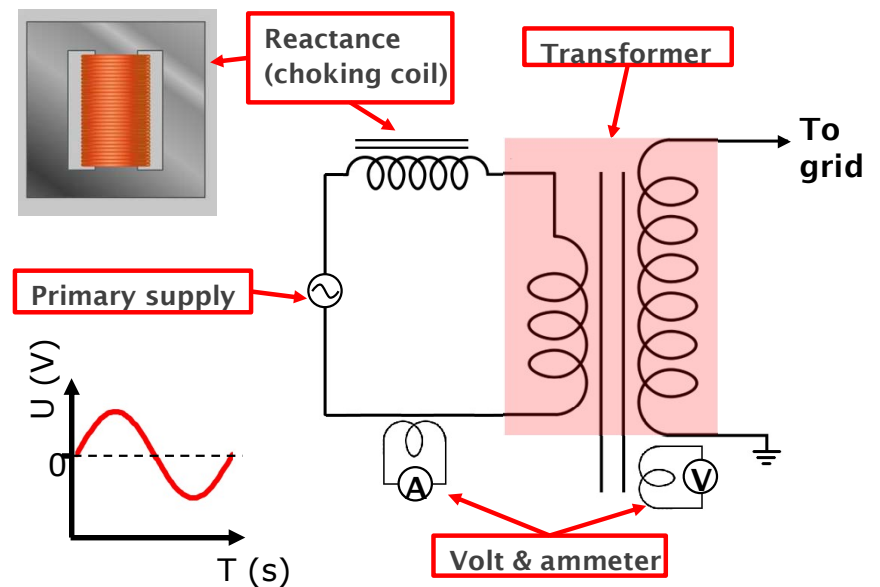
- Typically 140-150 C (280-300 F)
- Higher temperature leads to
  - Lower viscosity and better performance
  - Risk of asphaltene precipitation, interface rag layer built up
  - Increase in Conductivity



*Process Control*

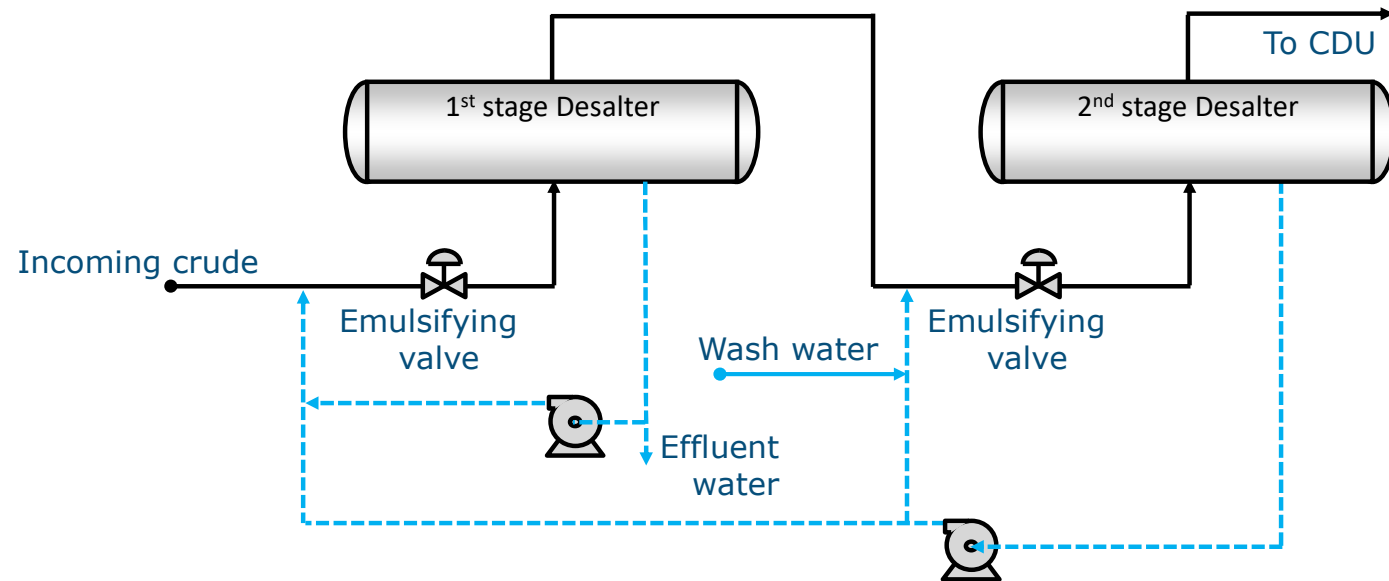
## Power unit sizing

- Combination of transformer and choking coil
- Normally operated at <20% of rated capacity
- At higher power consumption, too much choking
  - Field strength in desalter reduced
  - Reduced performance
- Upgrade potentially required with
  - More conductive crudes
  - More grid layers (3 vs 2)
  - Higher temperatures



## Other variables

- Chemical injection program
  - Demulsifiers
  - Acidification of water
  - Caustic addition downstream
  
- Water injection program
  - Water properties
    - Low hardness, ammonia, solids
  - Injection temperature
  - Mixing valve size/type
  
- Mud removal



## Case study: processing 100% DOBA

- European Refinery
- Upgrade to 100% DOBA processing
- 2 stage desalting system

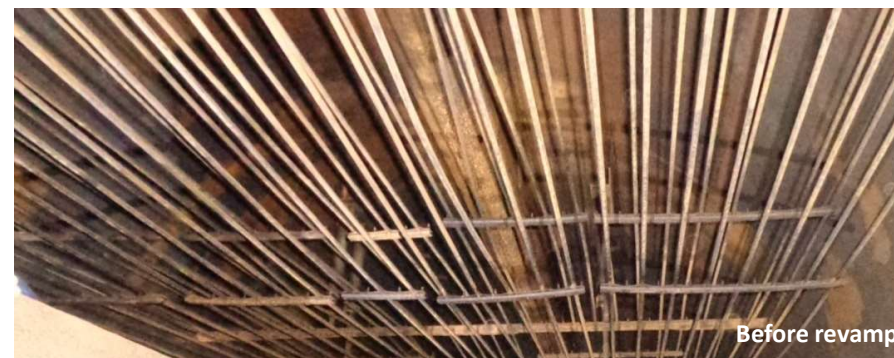
DOBA: High in Calcium Naphtanates

- Not water soluble, emulsion stabilizing
- Hydrolyzing chemicals injected upstream
  - Make the Calcium Naphtanate water soluble



## Case study: processing 100% DOBA

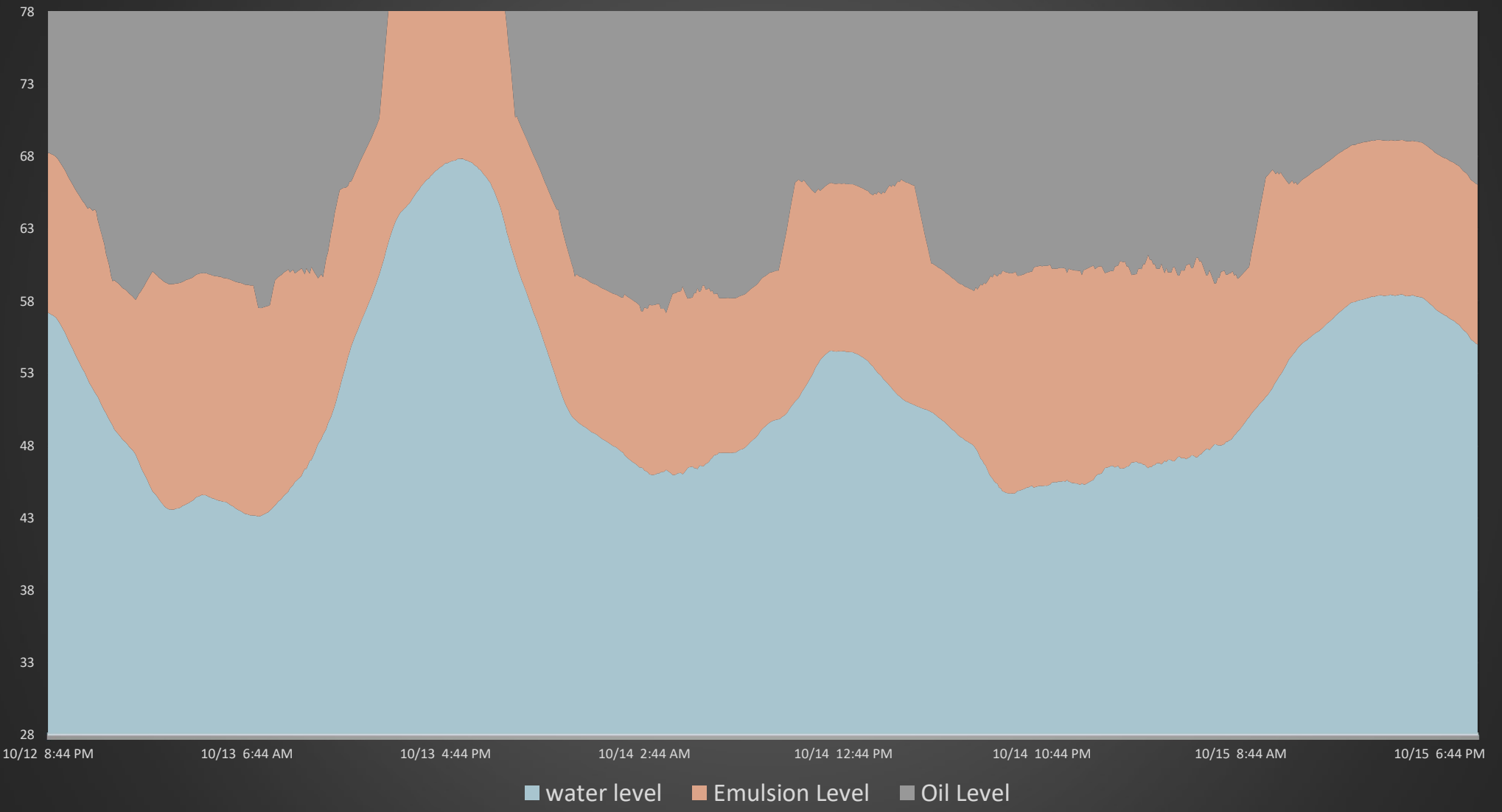
- Upgrade to 3 grid layers
- Larger transformers
- Adjusted plan for wash water injection, recycling streams and chemical injection
- Running 100% DOBA
  - >90% of Calcium Naphtenates & salts removed
  - Meets design specifications



# Before Control

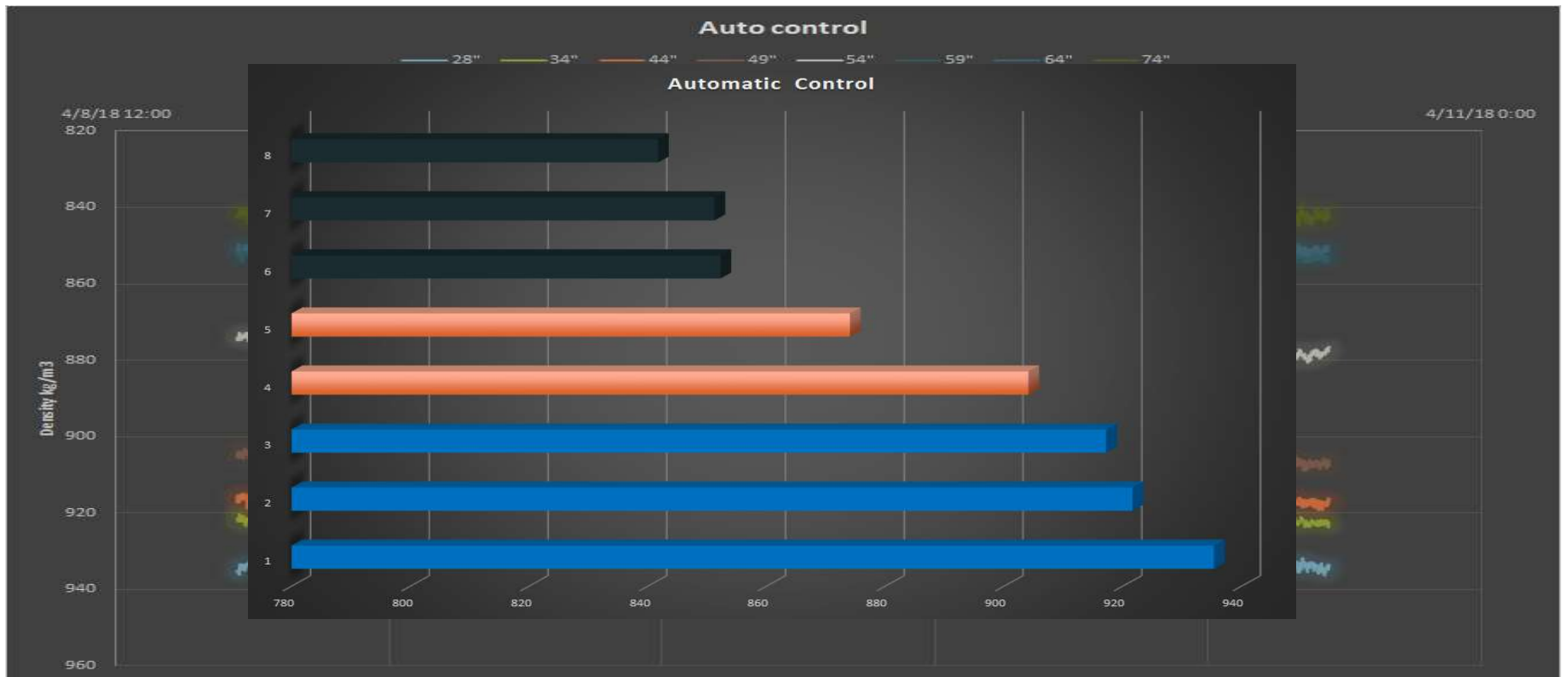


# No Control

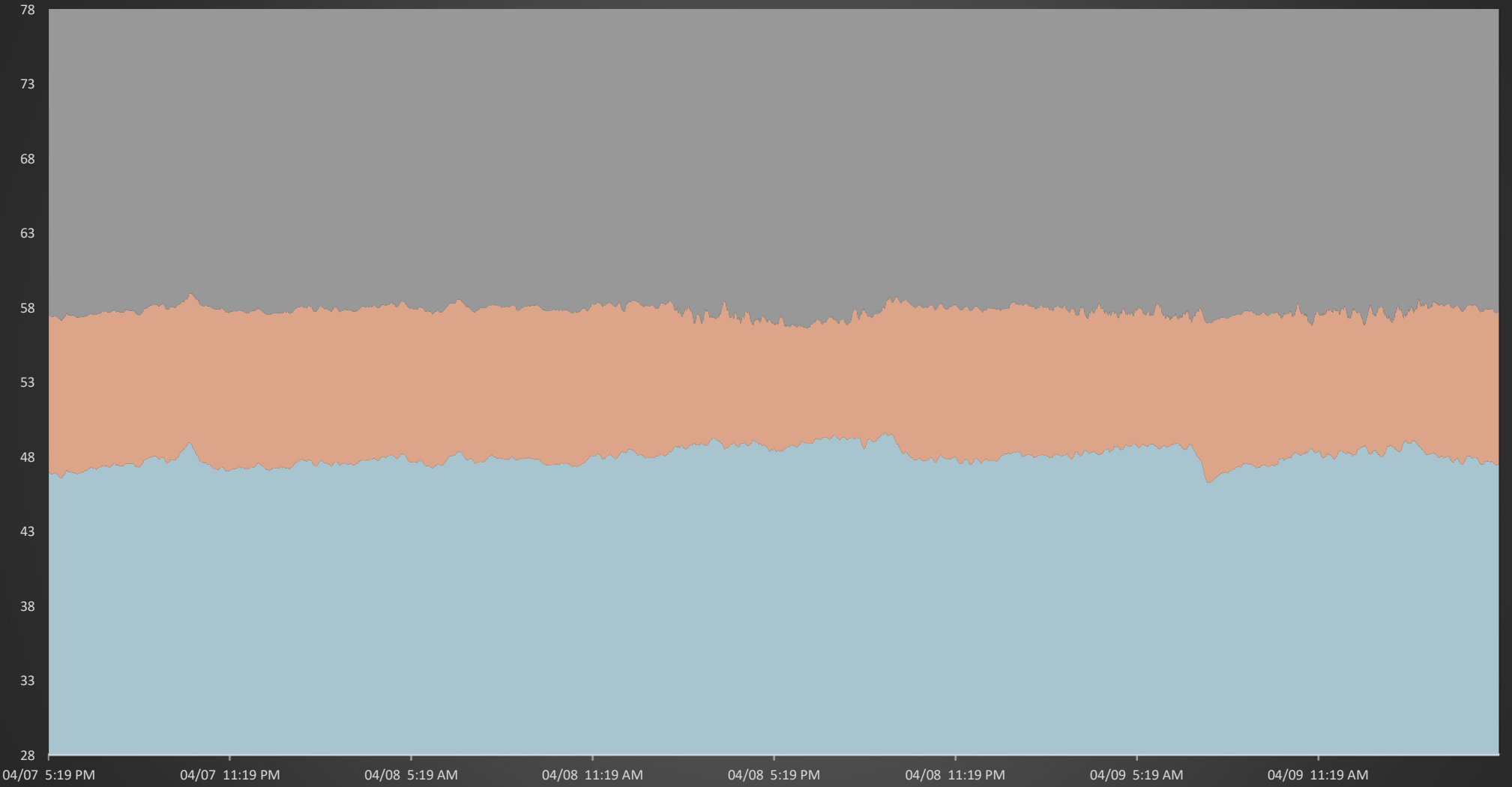




# After Control



# Control



■ water level ■ Emulsion Level ■ Oil Level

# BERTHOLD WEBINAR

Questions?

 **BERTHOLD**

 **FRAMES**

## Contacts

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## Questions?

