Process Descriptions of Refinery Processes

Process Description of the Desalting Process

Lecture 5

Desalting Process

The desalting process is accomplished through the following steps:

Water washing:

- Water is mixed with the incoming crude oil through a mixing valve.
  - The water dissolves salt crystals, and the mixing distributes the salts into the water, uniformly producing fine droplets.
  - Demulsifying agents are added to break the emulsion by removing the asphaltenes from the surface of the droplets

Heating:

- The crude oil temperature should be in the range of 120–130 °F (48.9–54.4 °C) since the water-oil separation is affected by the viscosity and density of the oil.

Coalescence:

- The water droplets are so fine in diameter in the range of 1–10 µm that they do not settle by gravity. Coalescence produces larger drops that can be settled by gravity.

Coalescence

- This is accomplished through electrostatic electric fields between two electrodes.
  - The electric field ionizes the water droplets and orients them so that they are attracted to each other.
  - Agitation is also produced and assists in coalescence. The force of attraction between the water droplets is given by:

$$F = KE^2d^2\left(\frac{d}{s}\right)^4$$

where

K = a constant

E = Electric field

d = drop diameter

s = the distance between drops centers.

Settling:

According to Stake's law, the settling rate of the water droplets after coalescence is:

$$\text{Settling rate} = \frac{k\left(\rho_{H_2O} - \rho_{oil}\right)d^2}{\mu_{oil}}$$

where

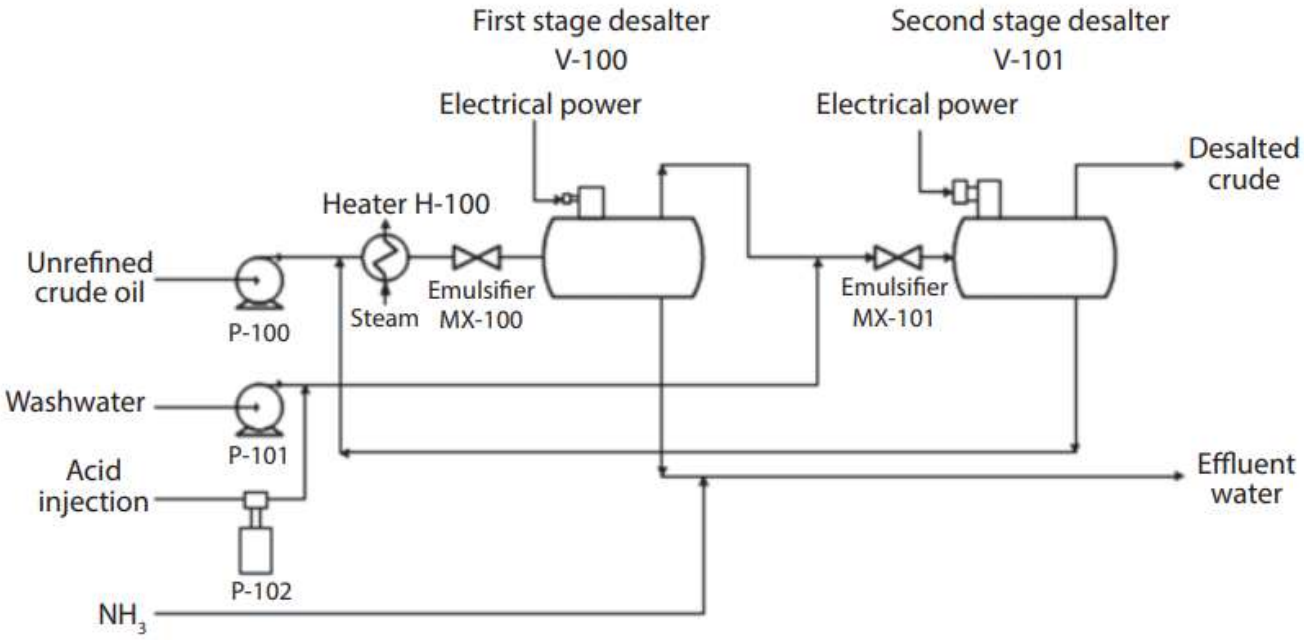
ρ = density

μ = viscosity

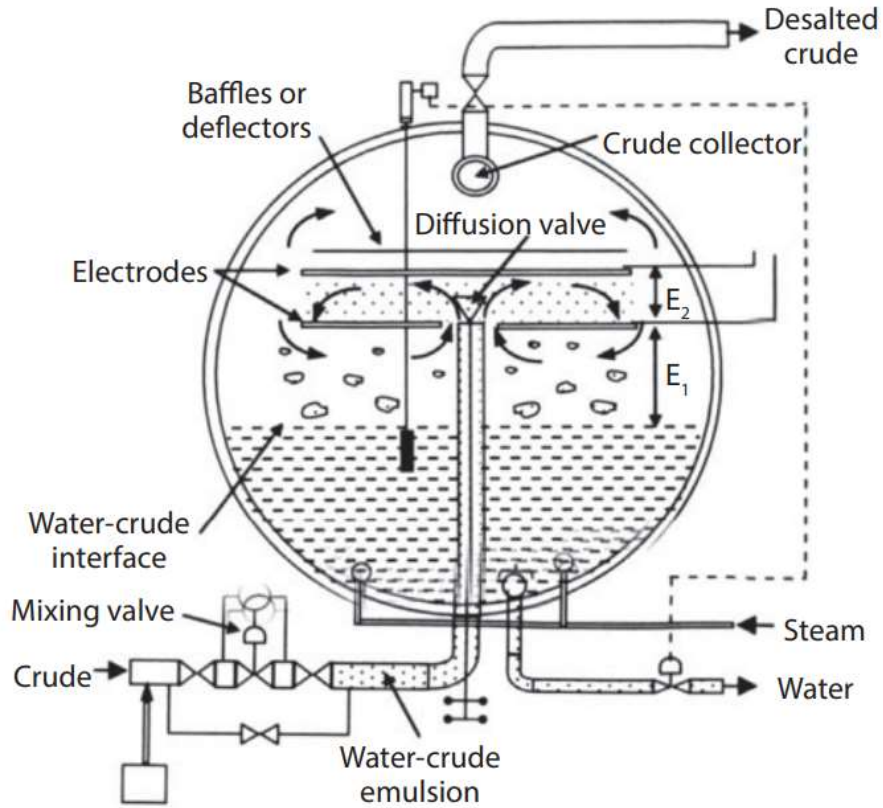
d = droplet diameter

k = a constant

- The crude oil is injected with five to six liquid volume percent water at a temperature 200–300 °F (93– 149 °C).
- Both the ratio of water to oil and the operating conditions are functions of the specific gravity of the crude oil, and typical operating conditions.
- The salts are dissolved in the wash water; oil and water phases are separated in a settling vessel either
- **by adding chemicals to aid in breaking up the emulsion or**
- **by the application of an electrostatic field to coalesce the droplets of salt water.**
  - Either an AC or DC field may be applied at potentials of 16,000–35,000 V. In the desalter, the salts (e.g., magnesium chlorides) selectively migrate to the aqueous phase which forms a brine solution at the bottom of the desalter while the crude oil that floats above forms a separate stream. Efficiencies up to 90–95% water removal are achieved in a single stage and up to 99% in a two-stage desalting process.



Two-stage desalter.

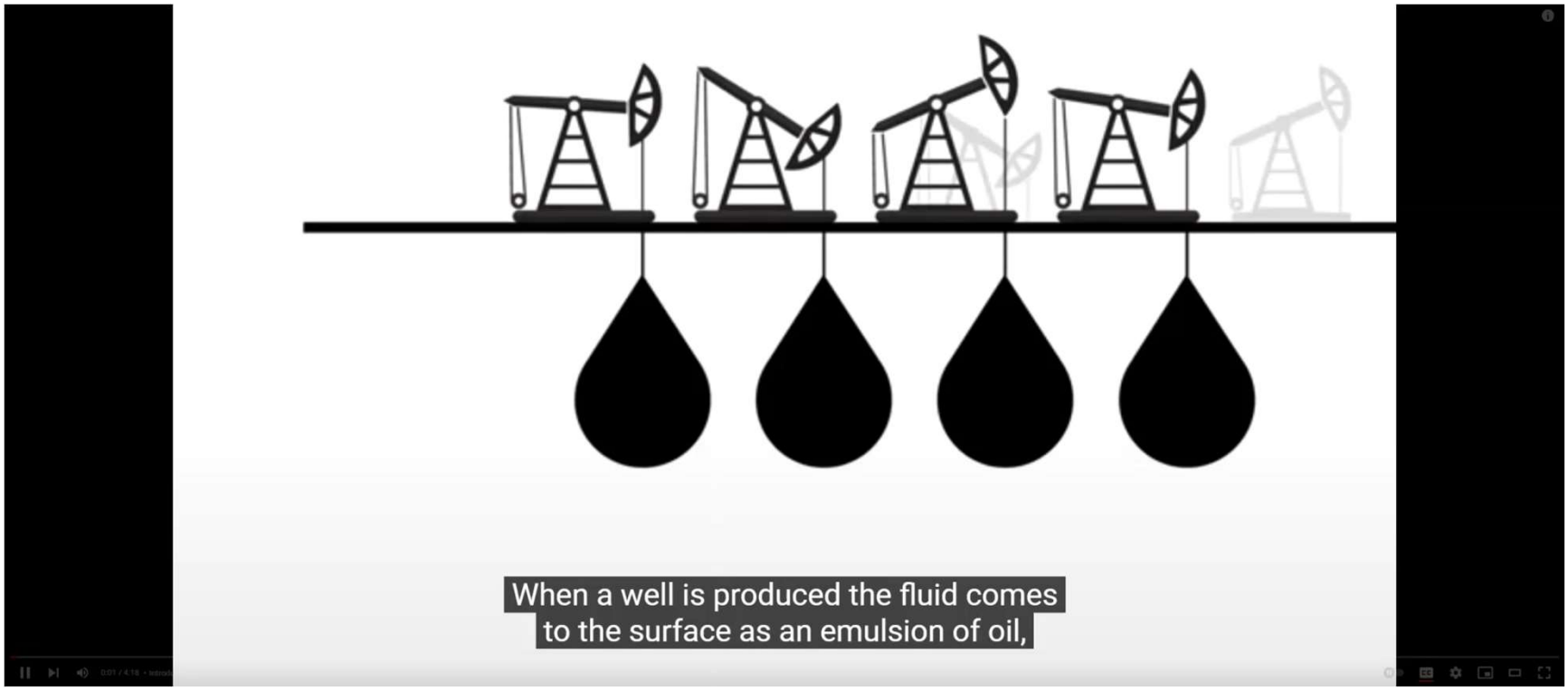

Desalted crude
Baffles or deflectors
Crude collector
Diffusion valve
Electrodes
E_2
E_1
Water-crude interface
Mixing valve
Steam
Crude
Water
Water-crude emulsion

(a)

The application of an electrostatic field to coalesce the droplets of salt water.

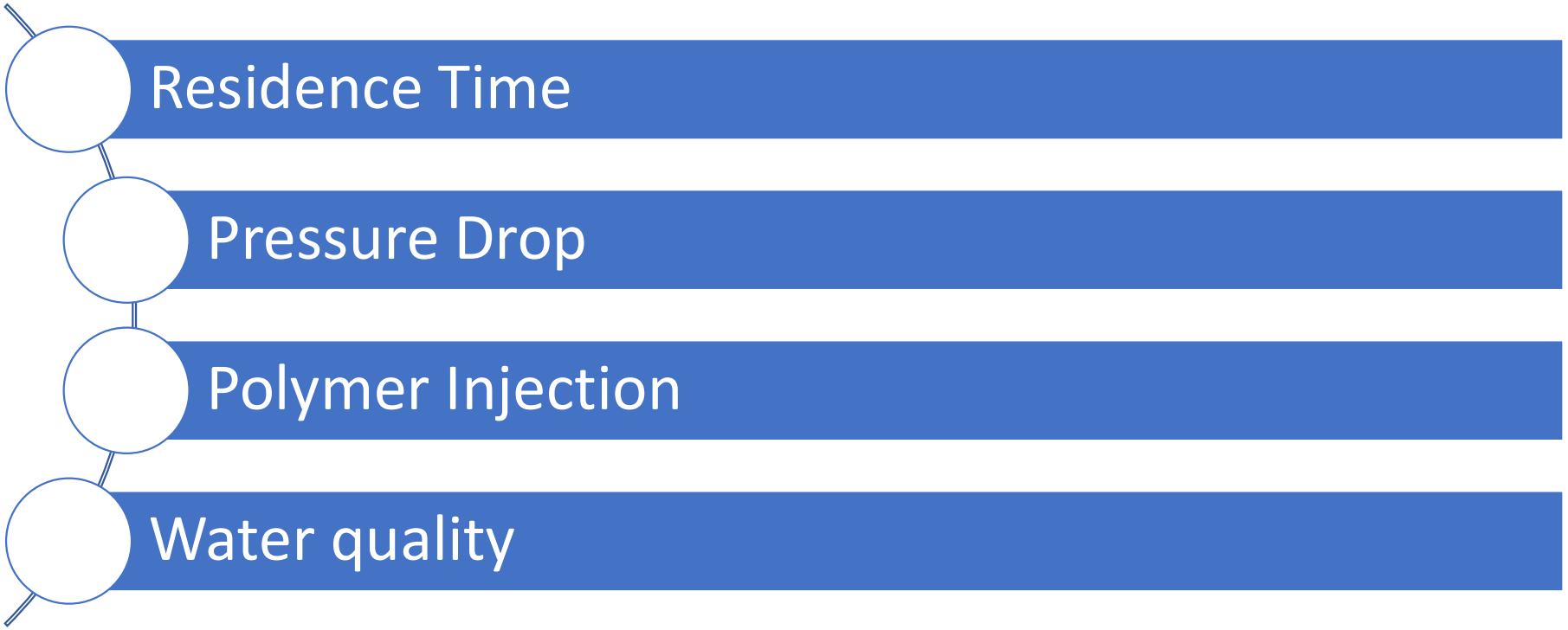
- Either an AC or DC field may be applied at potentials of 16,000–35,000 V. In the desalter, the salts (e.g., magnesium chlorides) selectively migrate to the aqueous phase which forms a brine solution at the bottom of the desalter while the crude oil that floats above forms a separate stream. Efficiencies up to 90–95% water removal are achieved in a single stage and up to 99% in a two-stage desalting process.
- A high-voltage field referred to as the “secondary field” of about 1000V/cm is applied between these two electrodes. Both the ionization of the water droplets and coalescence takes place, and the design achieves ~90% salt removal.

Chemical Demo



Electrostatic Settler

How to achieve the successful desalting process?



Residence Time

- The higher the residence time in a desalter, the better the oil/water separation.
- This variable can be only controlled with the vessel size, operating level in the size or the feed rate. Since the vessel size cannot be increased in size or reduce the feed rate, a small increase in operating level may significantly improve the quality of the brine.

Pressure drop

- This variable can be optimized, which is across the desalter mix valve.
- The higher the pressure drop, the better the mixing and thus the improved removal of salts.
  - However, too high a pressure drop can result in the formation of emulsion layers that are difficult to break.
  - The optimal pressure drop depends on the types of crudes; thus **it is important to perform test runs at dedicated periods to ensure that correct operation is achieved.(Why?)**

Polymer injection:

- Polymers tend to assist in solids separation and emulsion breaking; therefore, correct solution is applied for the system.
- Polymer types can effectively enhance the separation process for the crudes that are used.
- Both the injection type and location are important as the longer a chemical interacts with the crude, the better its separation.
- Polymer injection may be considered for solids separation at the crude tank with another injection for breaking emulsions at the desalter.

Water quality:

- The quality of water employed for desalting is an essential requirement.
- Some refinery facilities utilize stripped sour water as a source for the desalter and contaminants in this waste stream may affect its performance. Therefore, ***monitoring the quality of water is essential so as not to pose problems in the desalter (Why?).***

What does the desalter process provide to the refineries?

- The desalter provides a very critical service for the refinery, and thus requires careful monitoring and regular optimization