Tikrit University

College of Petroleum Processes Engineering

Department of Petroleum Refining Engineering

Specialized Petroleum Processes

Fourth Class

Lecture 4

By

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Crude Oil Processing from Oilfield to Refinery

2. Oil Dehydration and Emulsion Treatment

Emulsion Treatment

As explained previously, using chemicals followed by settling can break some emulsions. Other emulsions require heating and allowing the water to settle out of the bulk of oil. More difficult (tight) emulsions require, however, both chemicals and heat, followed by coalescence and gravitational settling. Basically, a dehydration process that utilizes any or a combination of two or more of the treatment aids (heating, adding chemicals, and an applying electrical field) is used to resolve water–oil emulsions.

A. Heating

Heating is the most common way of treating water–oil emulsions. Heating of water–oil emulsions aids in the resolution of the emulsion and the separation of the emulsified water in several ways. The fuel used to supply heat in oil-treating operations is practically natural gas. Under some special conditions, crude oil may be used. Heaters are generally of two basic types:

- Direct heaters, in which oil is passed through a coil exposed to the hot flue gases of the burned fuel or to introduce the emulsion into a vessel heated using a fie tube heater.
- Indirect heaters, in which heat is transferred from the hot flue gases to the emulsion via water as a transfer medium. The emulsion passes through tubes immersed in a hot water bath.

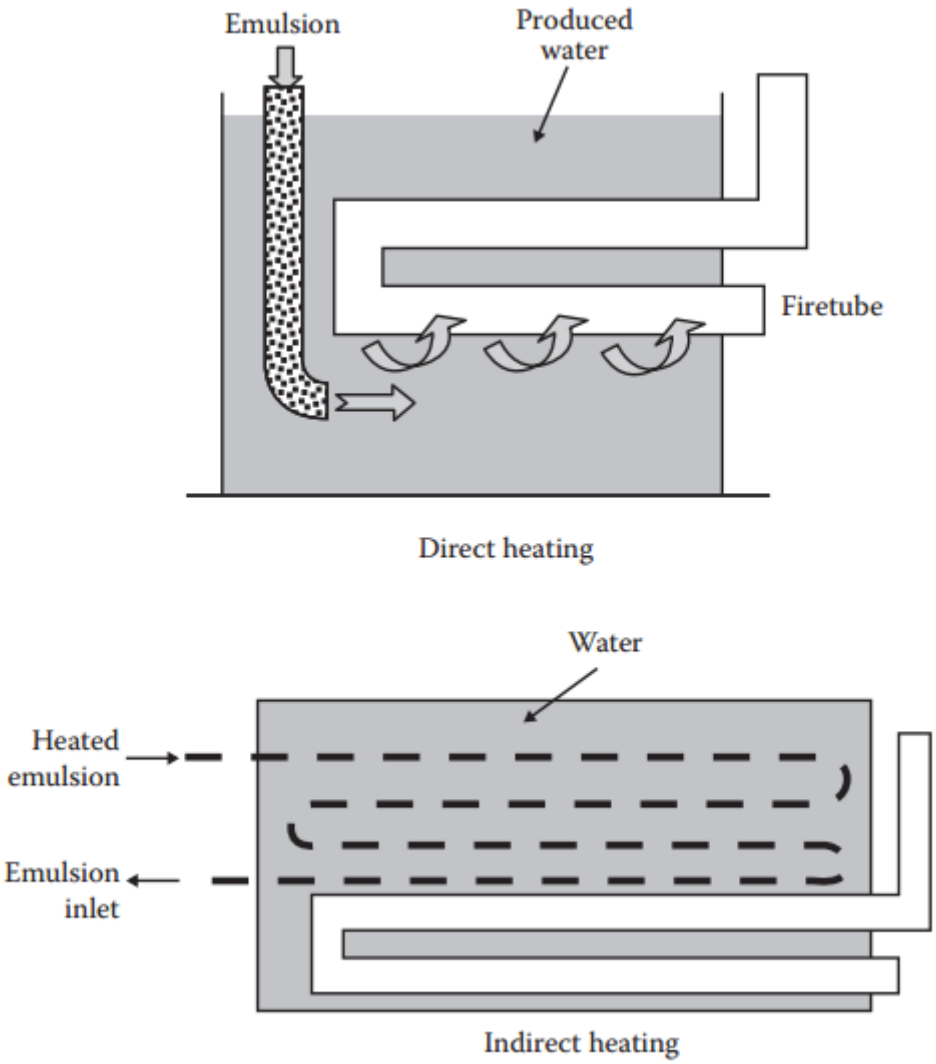

Figure 1: Two basic methods of heating emulsions.

In general, the amount of free water in the oil emulsion will be a factor in determining which method is to be used. If free water is found to be 1%–2%, then use an indirect heater. If the free-water content is enough to hold a level around the fire tube.

B. Chemical Treatment

Some oil emulsions will readily break upon heating with no chemicals added; others will respond to chemical treatment without heat. A combination of both aids will certainly expedite the emulsion breaking process. Chemical additives, recognized as the second aid, are special surface-active agents comprising relatively high-molecular-weight polymers. These chemicals (de-emulsifiers), once adsorbed to the water–oil interface, can rupture the stabilizing film and displace the stabilizing agent due to the reduction in surface tension on the inside of the film (i.e., on the water side of the droplet). In other words, when the de-emulsifiers are added to the oil, they tend to migrate to the oil–water interface and rupture the stabilizing film. The de-emulsifier, as it reaches the oil–water interface, functions in the following pattern: flocculation, then film rupture, followed by coalescence. The faster the de-emulsifier reaches the oil–water interface, the better results it achieves. Figure 2 illustrates these steps.

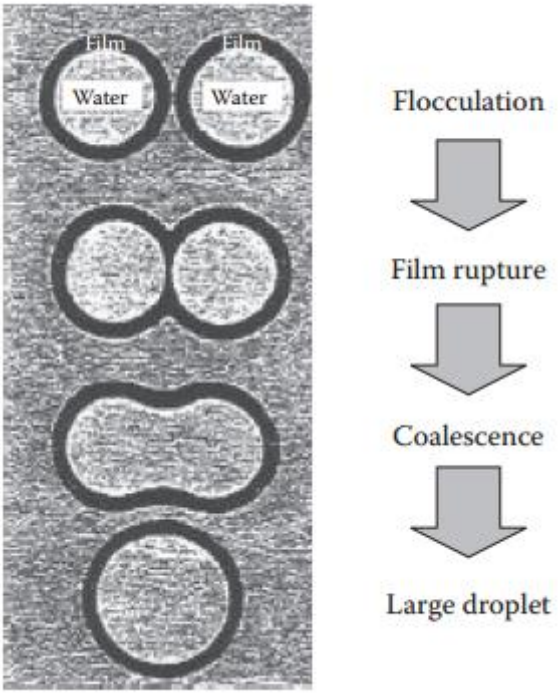

Figure 2: How de-emulsifiers lead to larger oil drops.

The point of injection of de-emulsifiers will depend largely on the type used. For the case of water-soluble de-emulsifiers, injection is carried out after free water has been removed; otherwise, most of the chemical is lost down the drain. Three points of injection are recommended:

- Upstream of the choke: where violent agitation takes place in the choke as the pressure is lowered from wellhead to that corresponding to the gas–oil separator.

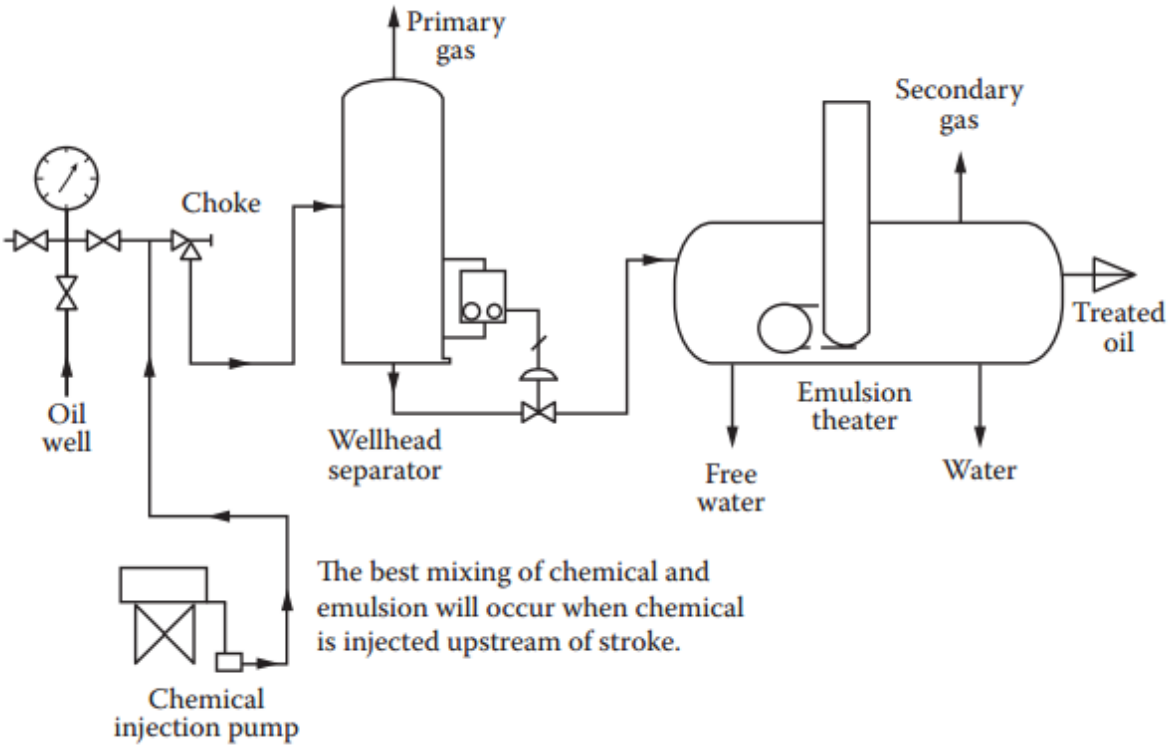

Figure 3: Chemical injection: upstream of the choke

- Upstream of the level control valve on the separator, where agitation occurs in the valve as the pressure is lowered, as shown in Figure 4.

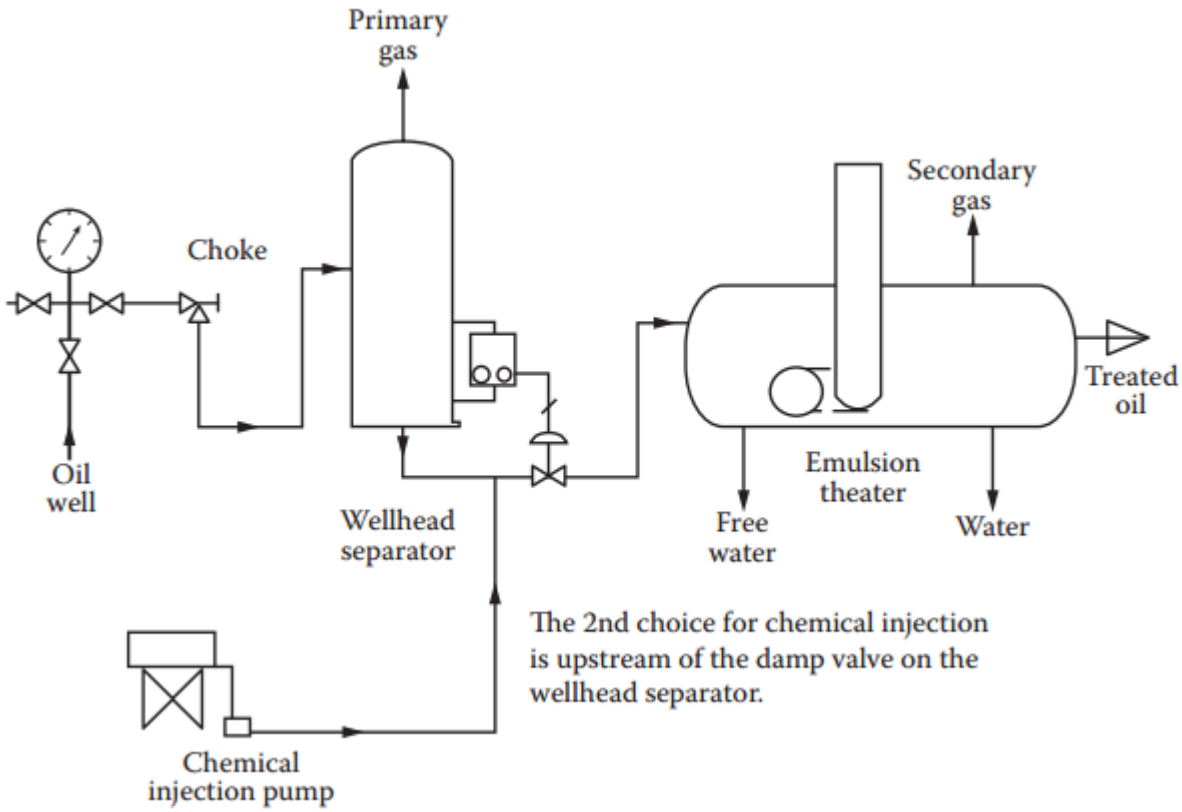

Figure 4: Chemical injection upstream of the control valve of the gas–oil separator

- For the case in which the treating system does not include a gas–oil separator, the injection point is placed 200–250 ft from the emulsion treater.

C. Electrical Aid

Electrical is the third aid of emulsion treating in crude oil dehydration. However, it should be realized that both heating and chemical treating work in order to break the emulsion, whereas electrical emulsion treating is aimed at speeding up coalescence, hence settling. In other words, electric dehydration does not break the emulsion electrically. The principle underlying the breaking oil–water emulsions using electrical current is known as electrostatic separation. A high-voltage field (10,000 to 15,000 v) is used to help dehydration according to the following steps:

- The water droplet is made up of polar molecules
- As a result of the high-voltage field, the water droplets vibrate rapidly, causing the stabilizing film to weaken and break.
- The surface of the water droplets expand (their shapes change into ellipsoids); thus attracted to each other, they collide and then coalesce, as depicted in Figure 5.
- As the water droplets combine, they grow in size until they become heavy enough to separate by settling to the bottom of the treater.

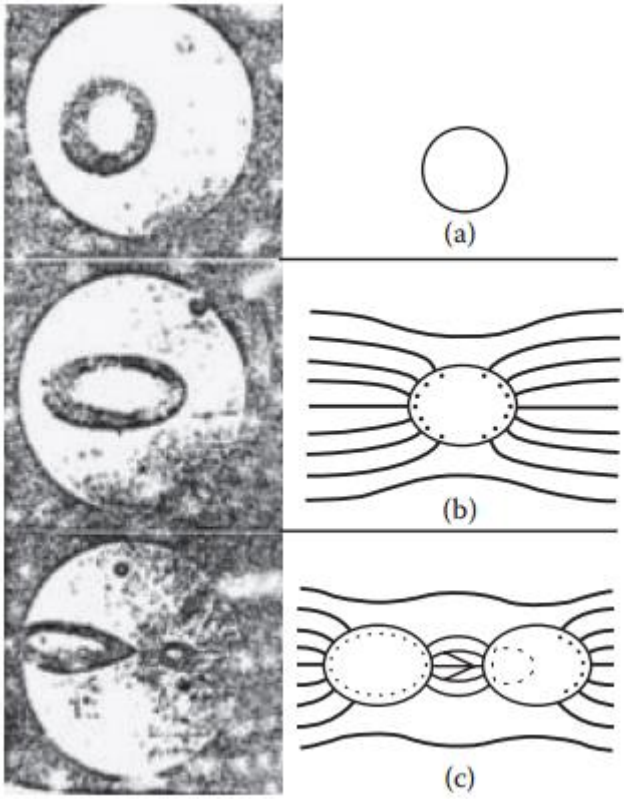

Figure 5: Emulsion breaking by electric current. (a) Breaking of stabilized fim, (b) expansion of water surface into ellipsoid, and (c) attraction of two water drops.

D. Chemielectric Dehydrators (Emulsion Treaters)

Chemielectric dehydrator is used to indicate that both chemical and electrical aids are used (in addition to heating) in the treatment. Figure 6 is a diagram for a typical chemielectrical treater. Once the oil is heated, it flows to the settling section. Free water separates from the emulsion (under the effect of both heat and chemicals) and settles to the bottom. The water content in the oil could be reduced to 1%–0.5% before it gets to the electric grid. The oil on the other hand moves slowly upward, passing across the electric grid in the settling section, where remnant emulsified water is separated. Finally, clean oil flows to the top of the treater.

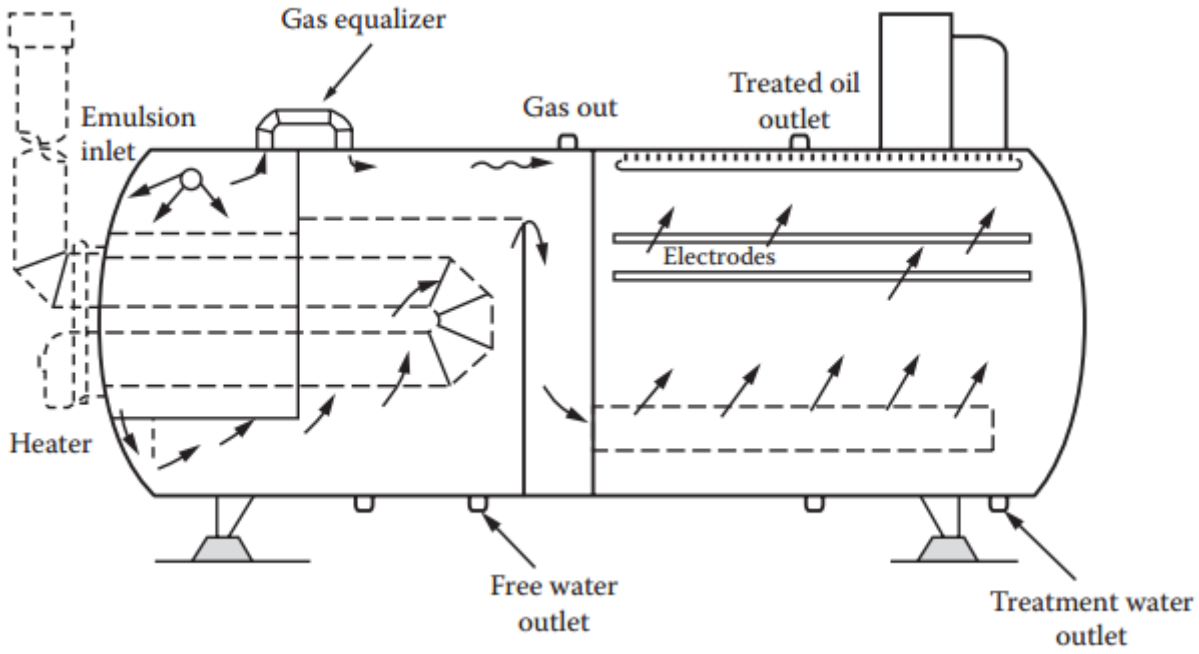

Figure 6: Chemielectrical dehydrator.