3. Diethanolamine (DEA):

DEA is a weaker base (less reactive) than MEA. This has allowed DEA to be circulated at about twice the solution strength of MEA without corrosion problems. DEA systems are commonly operated at strengths up to 30 wt. % in water, and it is not unusual to see them as high as 35 wt. %. This results in the DEA solution circulation rate usually being a little less than MEA for the same system design parameters.

Crude Oil Pre-treatment

In a producing oil field, the fluid produced at the wellhead consists usually gas, oil, free water, emulsified water (water–oil emulsion) salt and solid particles .
The fluid obtained at the wellhead is submitted to :

1. Degassing Operation

2. Desalting operation (if required)

3. Dehydration operation

Degassing

At the high pressure existing at the bottom of the producing well, crude oil contains great quantities of dissolved gases. When crude oil is brought to the surface, it is at a much lower pressure. Consequently, the gases that were dissolved in it at the higher pressure tend to come out from the liquid.

Two-Phase (Gas–Oil Separation)

High-pressure crude oils containing large amounts of free and dissolved gas flow from the wellhead into the flow line, which routes the mixture to a gas–oil separator plant (GOSP) .In the GOSP, the pressure of the gas–oil mixture is successively reduced to atmospheric pressure in a few stages. In the separator, crude oil separates, settles, and collects in the lower part of the vessel.
Gas goes out the top of the separators to a gas collection system, a vapor recovery unit (VRU), or a gas flow line. Crude oil, on the other hand, goes out the bottom and is routed to other stages of separation, if necessary, and then to the stock tank (***Fig. 3***).

Volatile components are either sent to consumer centers as natural gas or used to re-pressurize the oil field.

The stripped liquid components are marketed as stabilized natural gasoline.

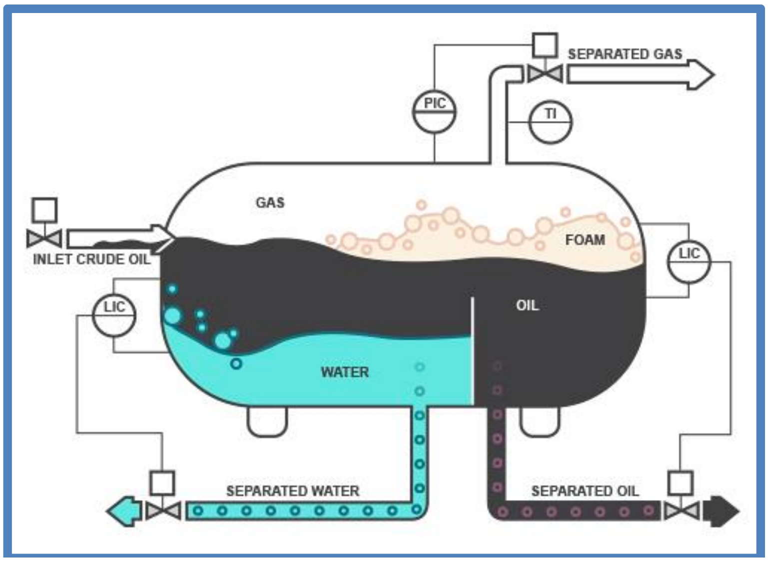

Figure 3 Gas –water- oil separation vessel tank.

Desalting

The first step in the refining process is to remove salt and solids to reduce corrosion, plugging, and fouling of equipment and to prevent poisoning of the catalysts in processing units.

Desalting crude oil is an essential part of the refinery operation. The salt content of the crude measured in pounds per thousand barrels (PTB) can be as high as 2000 PTB. ***The salt content should be lowered to between (2 and 5 PTB)***.

The two most typical continuous methods of crude-oil desalting, chemical and electrostatic separation, use hot water as the extraction agent.

In chemical desalting, water and chemical surfactant (demulsifies) are added to the crude, heated so that salts and other impurities dissolve into the water or attach to the water, and then held in a tank where they settle out.

In Electrical desalting the application of high-voltage electrostatic charges to concentrate suspended water globules in the bottom of the settling tank. Surfactants are added only when the crude has a large number of suspended solids. ***Figure 4***

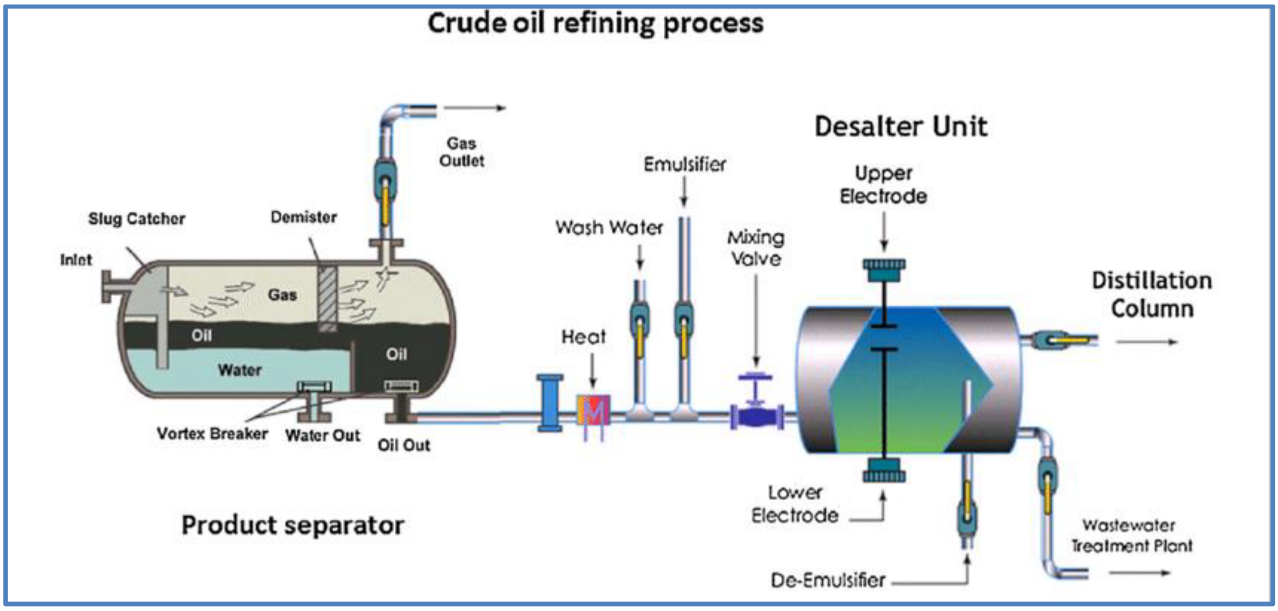

Figure 4 Process flow diagram of dating unit

In both methods, the feedstock crude oil is heated to between 150° and 350°F to reduce viscosity and surface tension for easier mixing and separation of the water.

In both methods, other chemicals may be added. Ammonia is often used to reduce corrosion. Caustic or acid may be added to adjust the pH of the water wash.

Wastewater and contaminants are discharged from the bottom of the settling tank to the wastewater treatment facility. The desalted crude is continuously drawn from the top of the settling tanks and sent to the crude distillation (fractionating) tower.

Dehydration

The basic principles for the treatment process are as follows:

(a)Removal of free water.

(b)Resolution of Emulsified Oil.

(a) Removal of free water.

Free water is simply defined as that water produced with crude oil and will settle out of the oil phase if given little settling time despite in ***Fig.5***.

There are several good reasons for separating the free water first:

1. Reduction of the size of flow pipes and treating equipment.
2. Reduction of heat input when heating the emulsion (water takes about twice as much heat as oil).
3. Minimization of corrosion because free water comes into direct contact with the metal surface, whereas emulsified water does not.

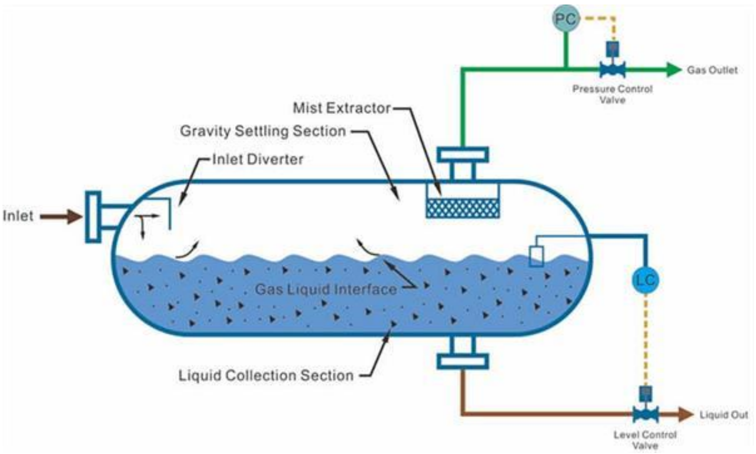

Figure 5 Two-phase separator unit (oil-water)

(b) Resolution of Emulsified Oil

An emulsion can be defined as a mixture of two immiscible liquids, one of which is dispersed as droplets in the other (the continuous phase), and is stabilized by an emulsifying agent. Oil emulsions are mixtures of oil and water.

In the oilfield, crude oil and water are encountered as the two immiscible phases together. They normally form a water-in-oil emulsion (W/O emulsion), in which water is dispersed as fine droplets in the bulk of the oil. This is identified as a type (a,b, and c) in ***Figure 6***.

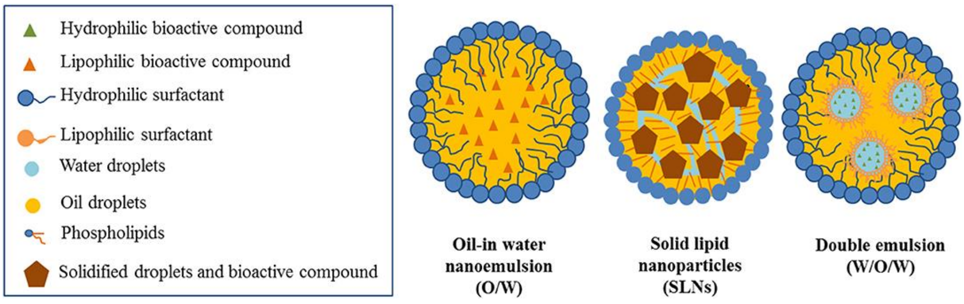

Figure 6 Water/ oil emulsion system

For two liquids to form a stable emulsion, three conditions must exist:

1. The two liquids must be immiscible.
2. There must be sufficient energy of agitation to disperse one phase into the other.
3. There must be the presence of an emulsifying agent.

Some of the common emulsifiers are as follows:

1. Asphaltic material
2. Resinous substances
3. Oil-soluble organic acids
4. Finely dispersed solid materials such as sand, carbon, calcium, silica, iron, zinc, aluminum sulfate, and iron sulfide.

Thermal Properties

(1) Specific Heat cp:

The specific heat is the amount of heat per unit mass required to raise the temperature by one degree Celsius.

It depends on the temperature, where it increases with increasing in temperature and decreasing in density. The following eq. can be used to estimate *Specific Heat cp.*

$$\boxed{c_p^L = 4.1868\left(\frac{0.415}{\sqrt{\rho_L^{15.6}}} + 0.0009\left(T - 288.15\right)\right)}$$

cp in J/g.K , T in K, and $\rho_L^{15.6}$ is the density of oil at 15.6^0C, g/cm^3.

Also, ***Figure 7a*** below is used to find the Specific heat cp of Mid liquids oils with a correction factor for other bases of oils.

For **hydrocarbon gasses**, the Figure below is used to find the Specific heat of Mid oil vapours with a correction factor for other bases of oils shown in ***Figure 7b***.

To calculate the heat required for the system (KJ or Btu)

$$Q = m\ cp\ \Delta T$$