**Pretreatment Crude Oil Distillation Processes**

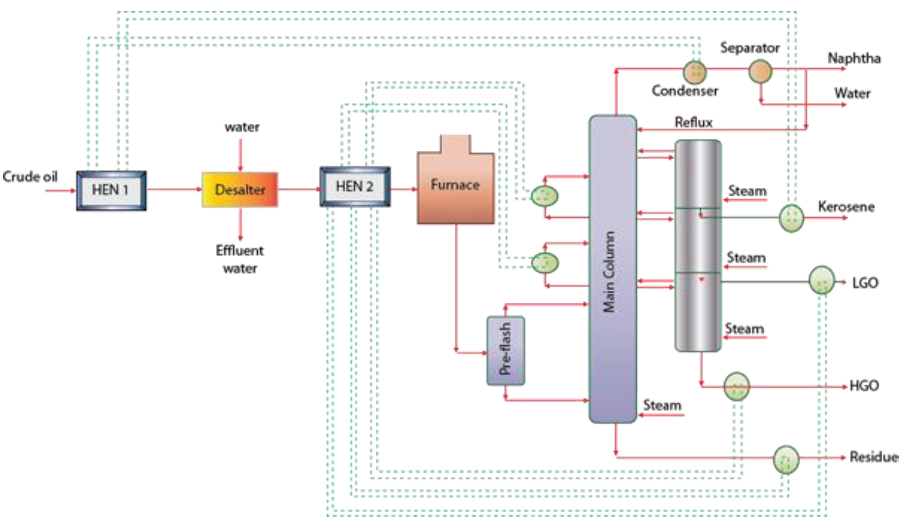
The first essential task for the crude oil consisting of more than 108 compounds is to separate its major components based on boiling point differences.

- **Storage tanks in refineries:** [Homework]

****



**Process flow-sheet**



The conceptual process flow-sheet for the petroleum refinery (Figure above) consists of the following important sub-processes:

- Crude desalter

- Furnace

- Pre-flash column

- Crude distillation column supplemented with side columns. These columns produce the desired products

- Pump around heat exchanger units

- Heat exchanger network that facilitates energy recovery from hot product and reflux streams to heat the crude oil.

**- Heat Exchangers:** A heat exchanger is a device that is used to transfer thermal energy (enthalpy) between two or more fluids, between a solid surface and a fluid, or between solid particulates and a fluid, at different temperatures and in thermal contact.

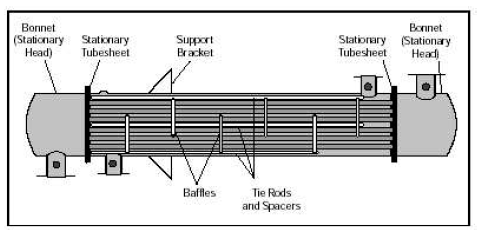
**Shell and Tubes type:**

The shell and tube heat exchanger is further divided into three categories as:

1. Fixed tube sheet

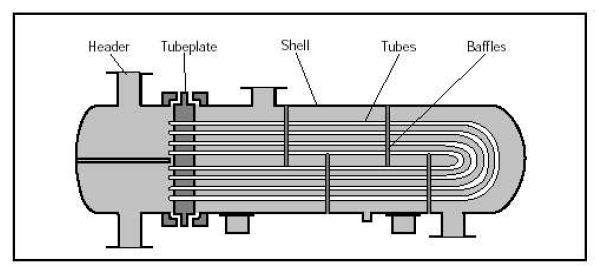
2. U tube

3. Floating head



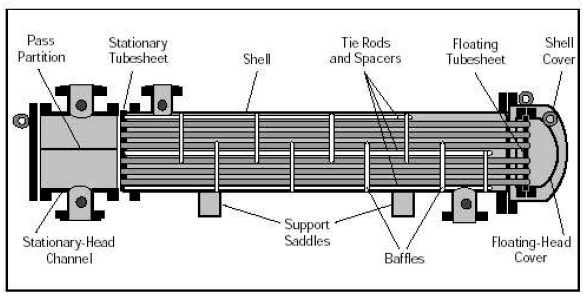
Fixed tube sheet

The fixed tube sheet construction is its low cost because of its simple construction. In fact, the fixed tube sheet is the least expensive construction type, as long as no expansion joint is required.



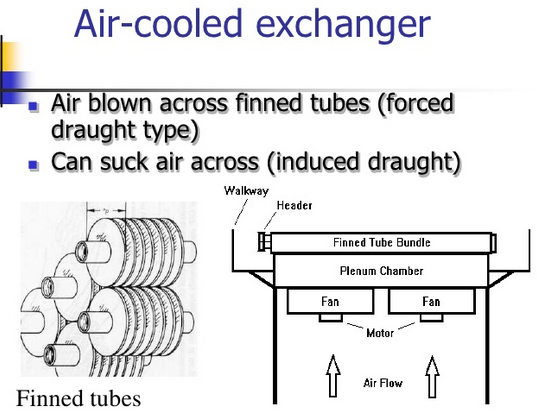
U-Tubes type

* U-tube heat exchanger as one end is free, the bundle.
* Can expand or contract in response to stress differentials.
* In addition, the outsides of the tubes can be cleaned, as the tube bundle can be removed.



Floating head type

In this design, one tube sheet is fixed relative to the shell, and the other is free to ”float” within the shell. This permits free expansion of the tube bundle, as well as cleaning of both the insides and outsides of the tubes. Thus, floating-head SHTEs can be used for services where both the shell side and the tube side fluids are dirty-making.



**Desalting and Dewatering:**

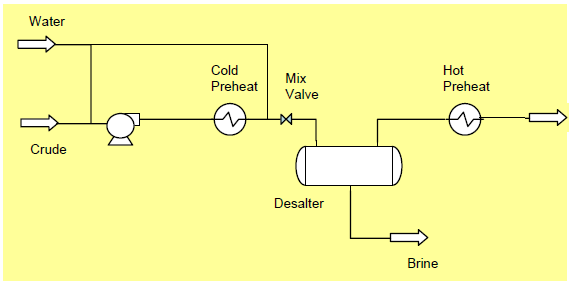
Crude oil is recovered from the reservoir mixed with a variety of substances: gases water and dirt (minerals). Desalting is a water – washing operation performed at the production field and at the refinery site for additional crude oil cleanup.

**Crude desalter**

- Crude oil consists of dissolved salts and they tend to cause operating problems such as fouling, plugging, catalyst deactivation and corrosion in various process equipments. Therefore, dissolved salts need to be removed using a separation process.

- The crude desalting unit is a separation process. Here, water along with other trace chemicals such as caustic and acid are allowed to enter a mixing unit along with the crude oil.

- The mixture of crude oil and water is subsequently passed through an electrostatic precipitator cum gravity settler. The electrostatic field enables the agglomeration of water droplets and aids faster gravity settling.

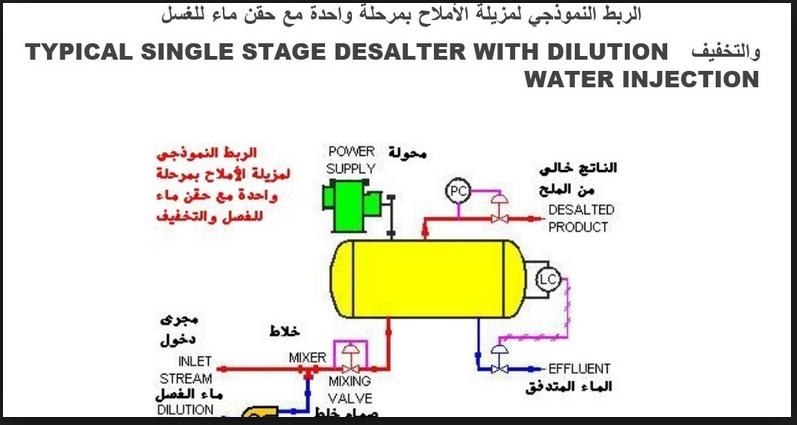


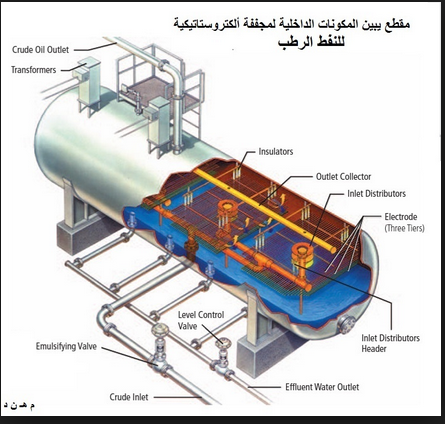
- An essential issue for the good performance of crude desalter is the temperature of the operation. Usually, high efficiency of salt removal is possible between 100 – 300 oF.

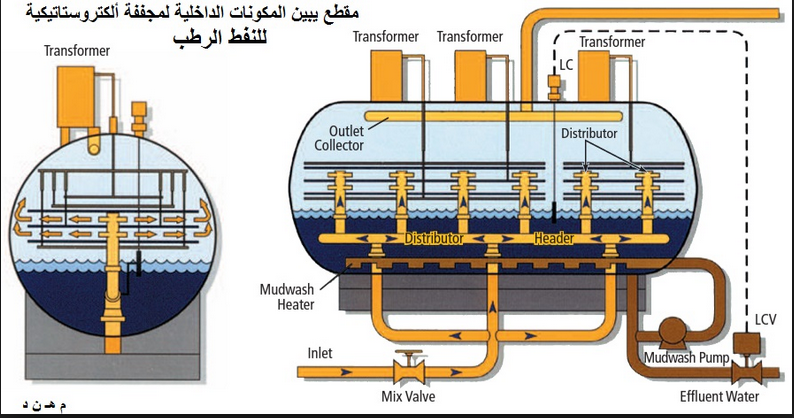
- Therefore, the crude oil is heated to about 250 oF before it enters the desalter unit.

- The clean desalted crude oil flows from the top of the gravity settler and the water along with other dissolved impurities is removed as a bottom product from the gravity settler unit.

- A high degree of salt removal is desired (95 – 99% removal of the dissolved salt in the crude oil). Usually, a two stage desalting process is deployed. When higher salt removal efficiencies are desired, three stage units are deployed.







**Furnace:**

The feed to a distillation tower is heated by flow through pipes arranged within a large furnace. The heating unit is known as a pipe still heater or pipe still furnace, and the heating unit and the fractional distillation tower make up the essential parts of a distillation unit or pipe still.

* Here, fuel oil and fuel gas (heavier products) obtained from the refining process itself are burnt to increase the crude oil temperature.
* Depending upon the quality of the crude, the desired temperature for the crude oil is about 600 - 700 oF.
* The pipe still furnace heats the feed to a temperature at which a portion of the feed will change into vapor.
* The vapor is held under pressure in the pipe in the furnace until it discharges as a foaming stream into the fractional distillation tower.
* Here the unvaporized or liquid portion of the feed descends to the bottom of the tower to be pumped away as a bottom nonvolatile product, whereas the vapors pass up the tower to be fractionated into gas oils, kerosene, and naphtha.
* Live steam is also used in the recent designs. The live steam is usually at about 50 psig.

The basic principles of using live steam are:

1. Upon condensation, oil and water are very easy to separate.
2. Steam can take significant amount of heat in term of enthalpy.

3- Steam enables enhancement in relative volatility.

- Live steam cannot be just fed at one section of the CDU. It needs to be fed at various sections to ensure both good heat distribution and reduce relative volatilities of the hydrocarbons at various sections of the main and secondary towers.

Therefore, live steam will enable good product quality as lighter hydrocarbons with higher relative volatilities in the bottom heavy product liquid streams will be easily stripped and carried along with the vapor.

* **What primary disadvantage exists by using live steam in the CDU columns?**

1- Live steam once it enters the column does not condense anywhere, as we don’t want any condensation to happen.

2- When live steam is used, vapor load increases significantly in the column.

3- This increases the diameter of the column at various sections. There will be of course a section that has maximum vapor load and this section will have the maximum diameter.

**Pre-flash column**

- The crude oil enters the pre-flash column after leaving the furnace

- The pre-flash tower separates the lighter fractions of the already heated crude oil.

- The heavier fractions of the crude oil leave from the bottom section of the pre-flash tower.

- Both lighter and heavier streams emanating from the pre-flash tower are fed to the main crude distillation column at various sections

- Pre-flash column enables better refluxes in the main column by distributing the streams effectively between various processing zones of the crude oil.

- Pre-flash column may or may not be included i.e., it is optional. In other words, the pre-flash column can be avoided and the heated crude oil from the furnace can be fed to the main column directly.