TOMSK POLYTECHNIC UNIVERSITY

PROFESSIONAL COURSE IN ENGLISH

"FUNDAMENTALS OF PETROLEUM REFINING"

Unit 6. Atmospheric Distillation of Crude

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Introduction

- **Crude distillation unit** is at the front-end of the refinery, also known as **topping unit**, or **atmospheric distillation unit**.
- Many crude distillation units are designed to handle a variety of crude oil types.
- The design of the unit is based on a <u>light crude scenario</u> and a <u>heavy crude scenario</u>.

Introduction

The unit produces **raw products** which have to be processed in downstream unit to produce products of certain specifications.

Process Description

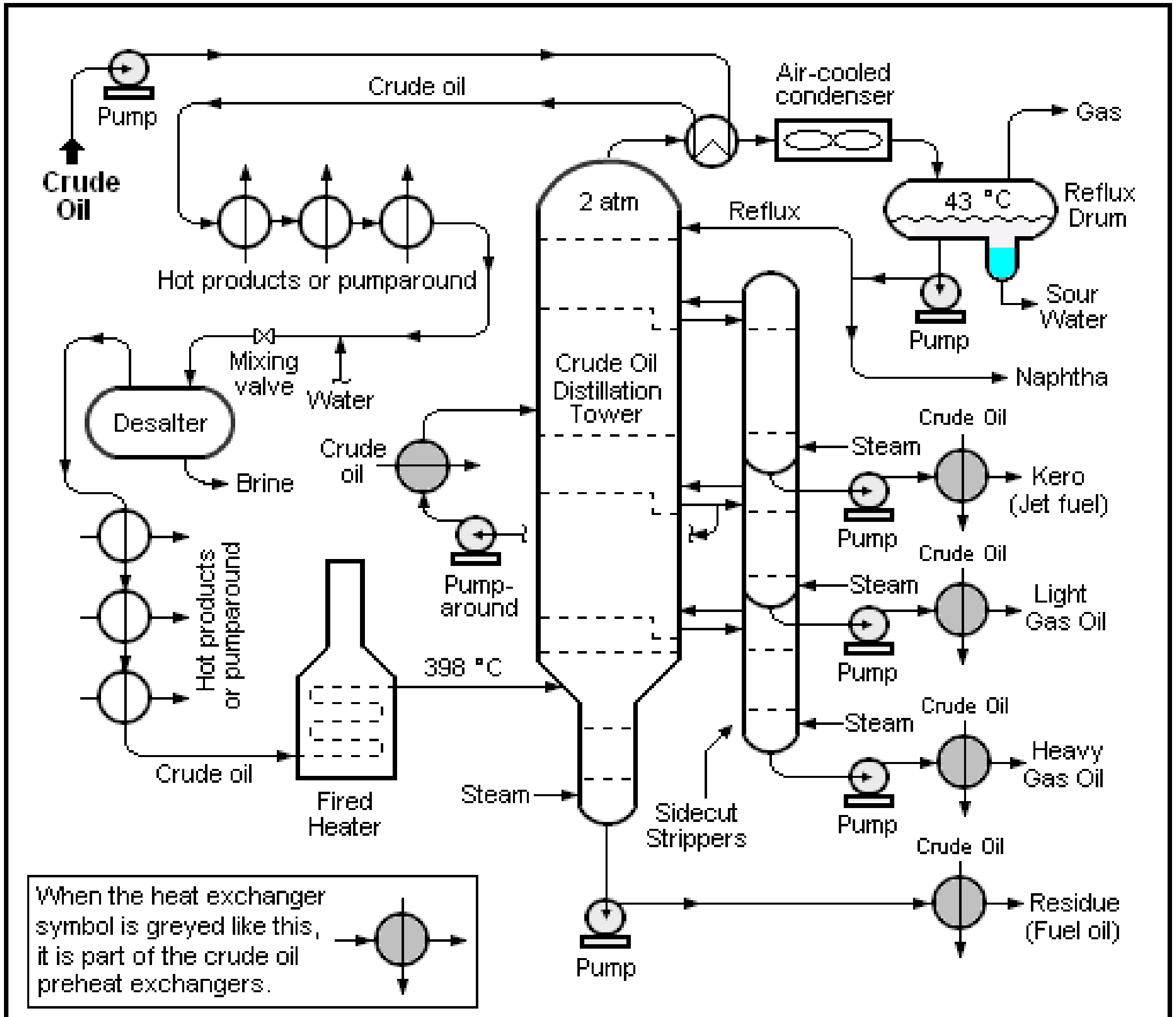


Figure 1. Schematic flow diagram of a typical crude oil distillation unit

- The incoming crude oil is preheated by exchanging heat with some of the hot, distilled fractions and other streams.
- It is then desalted to remove inorganic salts.
- Following the desalter, the crude oil is heated by exchanging heat with some of the hot, distilled fractions and other streams.

Process Description

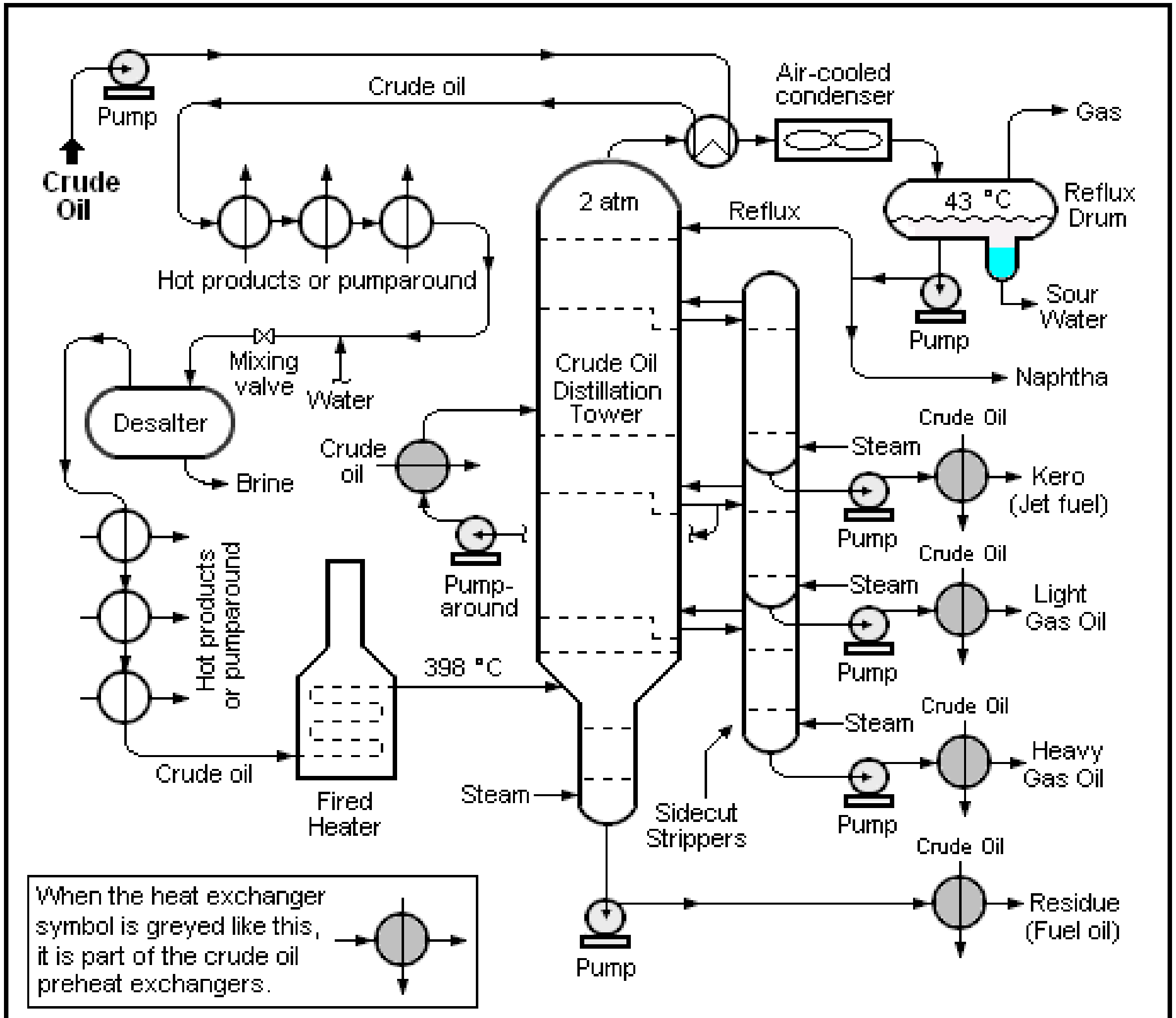


Figure 1. Schematic flow diagram of a typical crude oil distillation unit

- It is then heated in a fuel-fired furnace to a temperature of about 398 °C and routed into the bottom of the distillation unit.
- The cooling and condensing of the distillation tower overhead is provided partially by exchanging heat with the incoming crude oil and partially by either an air-cooled or water-cooled condenser.

Process Description

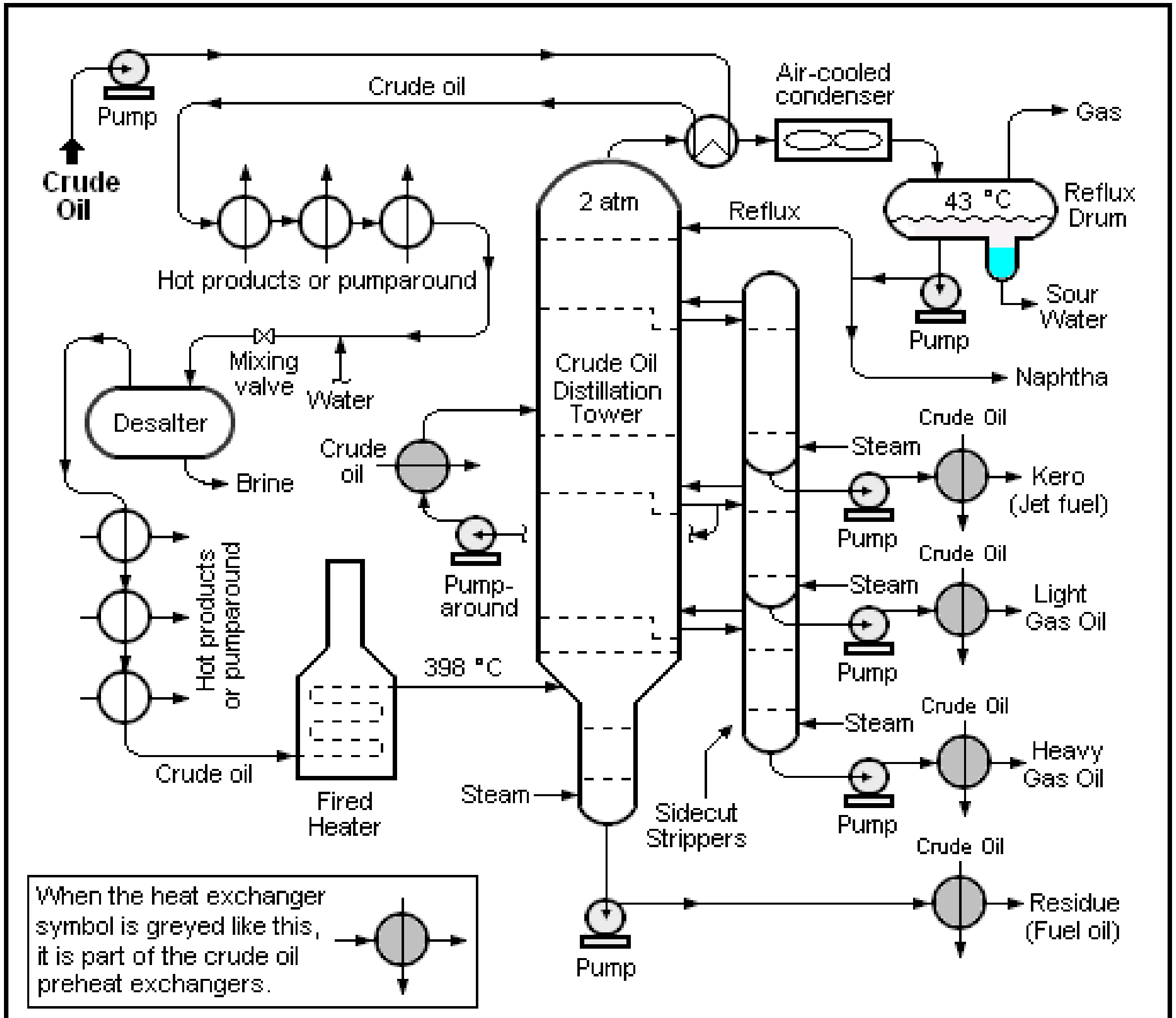


Figure 1. Schematic flow diagram of a typical crude oil distillation unit

- Additional heat is removed from the distillation column by a pumparound system.
- The **overhead distillate** fraction from the distillation column is **naphtha**.
- The **fractions removed from the side of the distillation column** at various points between the column top and bottom are called **sidecuts**.

Process Description

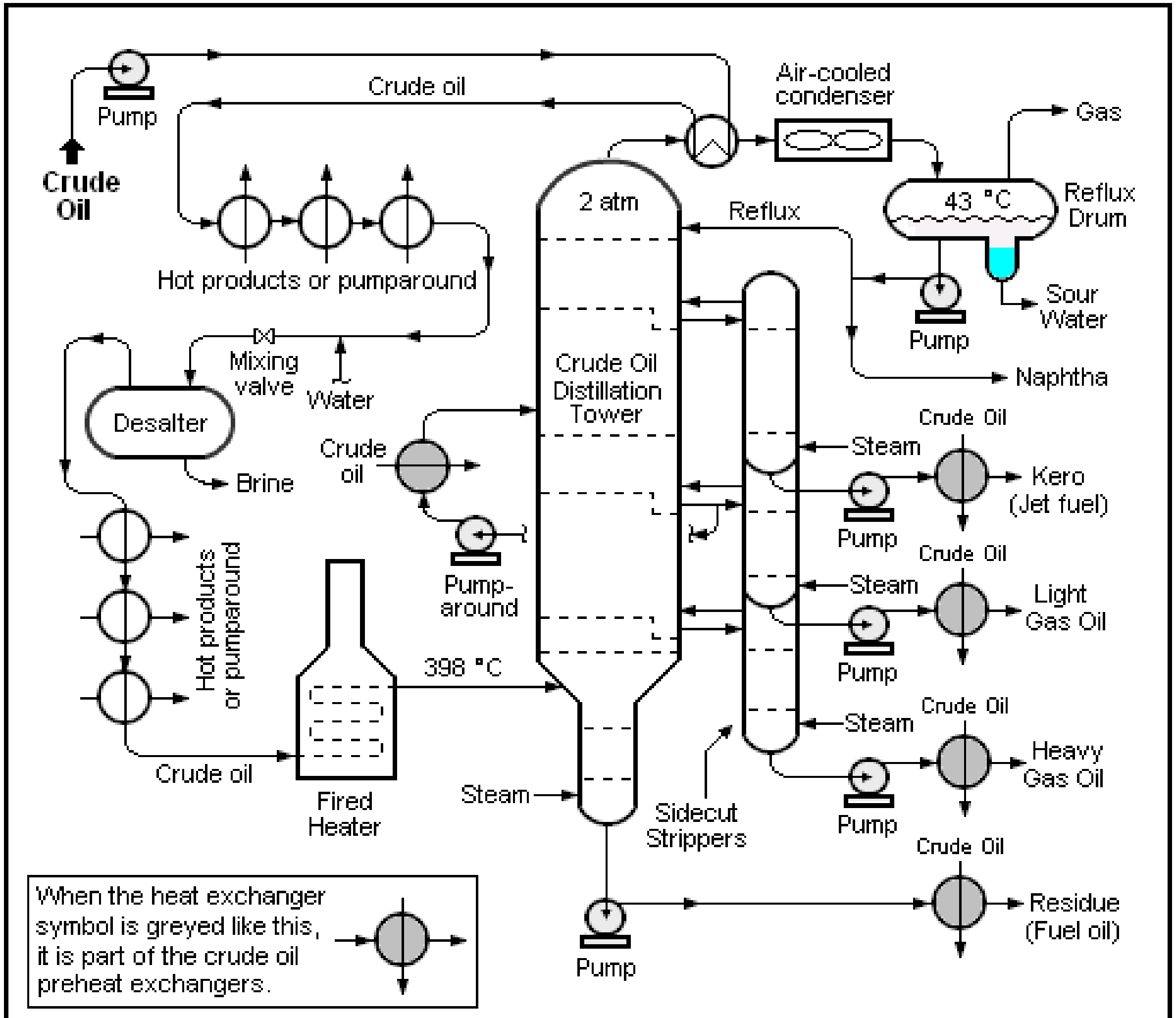


Figure 1. Schematic flow diagram of a typical crude oil distillation unit

- Each of the sidecuts (i.e., the kerosene, light gas oil and heavy gas oil) is cooled by exchanging heat with the incoming crude oil.
- All of the fractions (i.e., the overhead naphtha, the sidecuts and the bottom residue) are sent to intermediate storage tanks before being processed further.

Typical products from the unit are:

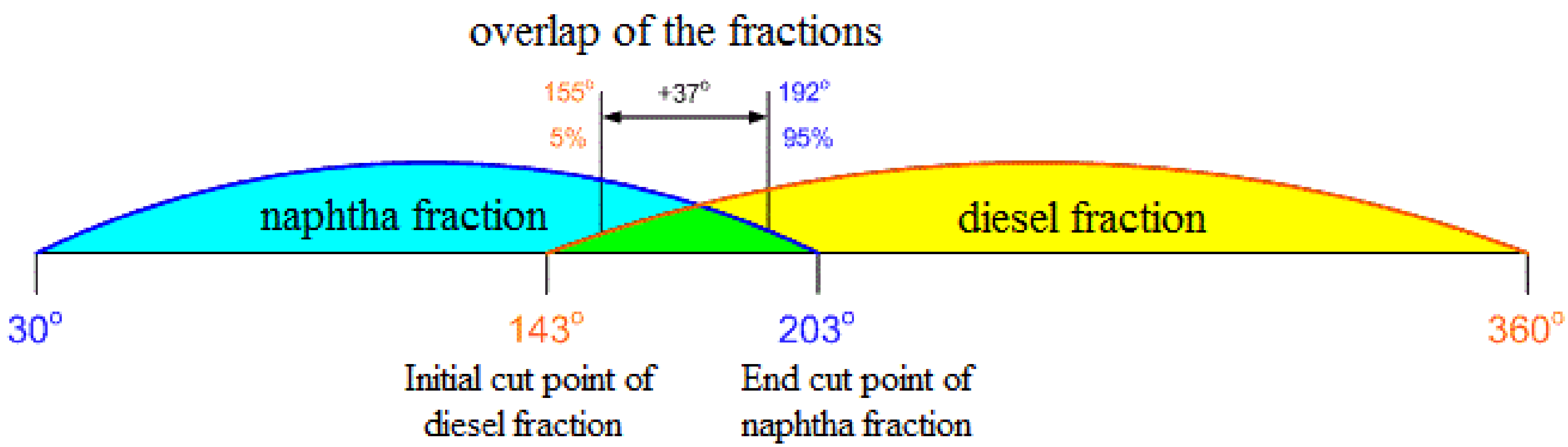
- Gases
- Light straight run naphtha (also called light gasoline or light naphtha)
- Heavy gasoline (also called military jet fuel)
- Kerosene (also called light distillate or jet fuel)
- Middle distillates called diesel or light gas oil (LGO)
- Heavy distillates called atmospheric gas oil (AGO) or heavy gas oil (HGO)
- Crude column bottoms called atmospheric residue or topped crude.

Crude distillation unit operation

Specific operational aspects which characterize the crude distillation unit operation:

- Cut points
- Degree of fractionation
- Overflash (Reflux)
- Column Pressure
- Overhead Temperature

Cut points


overlap of the fractions
155°
5%
+37°
192°
95%
naphtha fraction
diesel fraction
30°
143°
203°
360°
Initial cut point of diesel fraction
End cut point of naphtha fraction

Cut points

- The cut points in the crude distillation unit are controlled by the overhead vapour temperature which determines how much vapour goes to the condensers to produce light naphtha.
- The cut points are also controlled by the flow rate of the various products straight from the column or the side stream strippers.

Cut points

- The atmospheric residue level control inside the column determines its flow rate and thus its initial cut point.

- The amount of light naphtha is determined by the dew point of the naphtha at its partial pressure, which is close to the overhead temperature.

Cut points

The residue flow rate, the internal reflux rate, and the pumparounds are also affected.

- **The internal reflux rate** affects the degree of fractionation.
- It can be increased by increasing the heater outlet temperature, and by lowering the pumparound duty in the lower section of the column.
- When less heat is removed by the lower pumparound, more vapours will be available up the column and more internal reflux is produced as the vapours are condensed.

Degree of Fractionation

The **fractionation quality** between two consecutive streams is affected by several factors such as

- the vapour and liquid flow rates in the column zone between these two streams
- the number of trays
- the heat extracted by the pumparound.

Degree of Fractionation

- **Fractionation quality** is formulated in terms of gap or overlap of the products.
- For perfect fractionation, zero gap and overlap are required.
- This means that the end boiling point of the light cut would be the initial boiling point of the heavier cut and so on.

Overflash (Reflux)

- In order to fractionate the crude oil into the various products, it has to be heated to a temperature between 330 and 385 ºC, depending on the crude composition.

- The partially vaporized crude is transferred to the flash zone of the column located at a point lower down the column.

Overflash (Reflux)

- The furnace outlet temperature should be enough to vaporize all products withdrawn above the flash zone plus about 3–5 vol % of the bottom product.

- This overflash has the function of providing liquid wash to the vapours going up the column from the flash zone, and improving fractionation on the trays above the flash zone, thereby improving the quality of the heavy gas oil and reducing the overlap with the bottom products below the flash zone.

Overflash (Reflux)

- The **overflash** provides heat input to the column in excess to that needed to distill the overhead products.
- It also prevents coke deposition on the trays in the wash zone.

Column Pressure

- The pressure inside the distillation column is controlled by the back pressure of the overhead reflux drum at about 0.2–0.34 bar gauge.
- The top tray pressure is 0.4–0.7 bar gauge higher than the reflux drum.
- The flash zone pressure is usually 0.34–0.54 bar higher than the top tray.

Overhead Temperature

- The overhead temperature must be controlled to be 14–17 ºC higher than the dew point temperature for the water at the column overhead pressure so that no liquid water is condensed in the column.

- This is to prevent corrosion due to the hydrogen chloride dissolved in liquid water (hydrochloric acid).