# Tikrit University

# The College of Petroleum Processes Engineering

# Petroleum and Gas Refining Engineering Department

An Introduction to Petroleum Technology

First Class

Lecture (17)

By

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## Crude oil refinery

Oil refining is the necessary process by which crude oil can be processed, by cracking the latter into its original components, rearranging them and making them into usable products.

## oil refinery

An oil refinery is a facility that receives crude oil and separates its materials into a large number of consumer oil products, such as gasoline, diesel, jet fuel, motor fuel, white

oil, and other waste and scrap. The refinery generally consists of:

1 Separation towers.

2. Heat exchangers.

3. Electric or steam pumps.

4. Chemical reactors.

5. Containers and tanks for separation and storage.

6. Automatic and manual valves and controls.

7. In addition to thousands of tons of electrical wires and precision devices.

**The oil passes through the refineries in three stages:**

1. Separation :

The different substances are separated by heat, the high-boiling compounds remain at the bottom of the tower and the low-boiling compounds rise to the top of the tower and are withdrawn from it.

2. Transfer:

Conducting some chemical processes to convert some compounds from the tower into desirable products such as polymers and plastics.

3 Processing  treatment:

Purification of oil products from impurities and preparing them for consumption, and gases are also extracted to benefit from them in the rest of the production processes, such as the production of hydrogen gas from heavy waste to benefit from it in Hydrocracking units where the last drop of crude oil is used.

## Refining operations

The oil refinery facility is a large facility estimated at an area of tens of football fields, and it operates 24 hours a day throughout the year, and the thermal separation tower works around the clock, which is continuously supplied with crude oil or crude blasting.

The refinery needs hundreds of workers to operate, and the costs of its establishment and operation are estimated at billions of dollars. Also, this equipment cannot be operated without supporting units such as power supply, maintenance and equipment.

**The physical processes of “separation”**

1- Distillation:

the fractional distillation process.

In it, the lighter particles with lower boiling points are separated by boiling and condensation as follows:

1- Primary or atmospheric distillation: splitting crude oil into cuts, each of which has a group of hydrocarbon components, by heating it so that:

Crude oil is lifted by pumps from its warehouses to a furnace, but usually a process of gradual heating is carried out using heat exchangers that exchange between cold crude oil coming from the reservoirs and between the products of the injection tower and the generators.

The work helps reduce the costs of cooling, as it also prevents the charring of the oil that occurs when the oil is suddenly heated and then enters the furnace and partially evaporates. The steam passes to the fractionation tower. The gaseous components rise gradually through the tower trays.

The vapor from the components rises, the temperature decreases, and part of it condenses on each “tray” of the “trays” that make up the fractionation tower. If one of the trays is full, the excess liquid on it overflows and falls on the tray that follows it. And each Chinese is usually less that is, the higher the location of the tray, the less dense the materials

accumulated on it. light that may be mixed with the liquid, it separates in a shape again and moves to the tray above it.

The temperature of the fractionation tower can be controlled by passing the liquid at the bottom of the tower, into a furnace to boil it again, and the temperature at the top of the tower can be controlled by re-pushing a certain part of the liquid after the mixture is pumped out of the product.

Although on each of the fractionation tower trays a liquid with a slightly different boiling point is collected, a certain part of the product will condense, even though its boiling point is lower than the boiling points of most of the liquid collected? Then the liquid is drawn from special trays to the highest side towers. In these towers, the liquid overflows passing a few trays, while the rising vapors expel less dense materials and thus determine the boiling point of the produced liquid, and the hydrocarbons that are expelled return to the degassing.

2- Distillation under vacuum  pressure: This method is used to split heavy fuel oil  resulting from the primary distillation process into bitumen “asphalt” and “saturated fats” and others It can also be used in thermal cracking processes or with catalysts.

We point out that the temperature needed to evaporate the largest part of the heavy fuel oil must be reduced to obtain the asphalt because the boiling point of the liquid can be reduced

by decreasing the pressure on it. In this method, vacuum devices or pumps are used to maintain low pressure, and pumps are used to raise the oil through the furnace to the distillation tower under low pressure.

## The difference between simple distillation and fractional distillation in terms of use:

### Simple distillation:

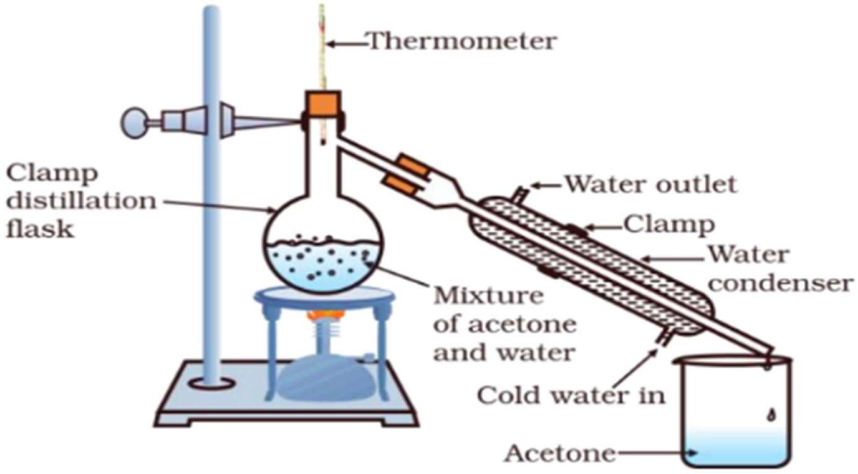
It is used to separate two or more liquids, depending on the boiling point of more than 50 degrees Celsius

It is used to measure the true boiling point of liquids

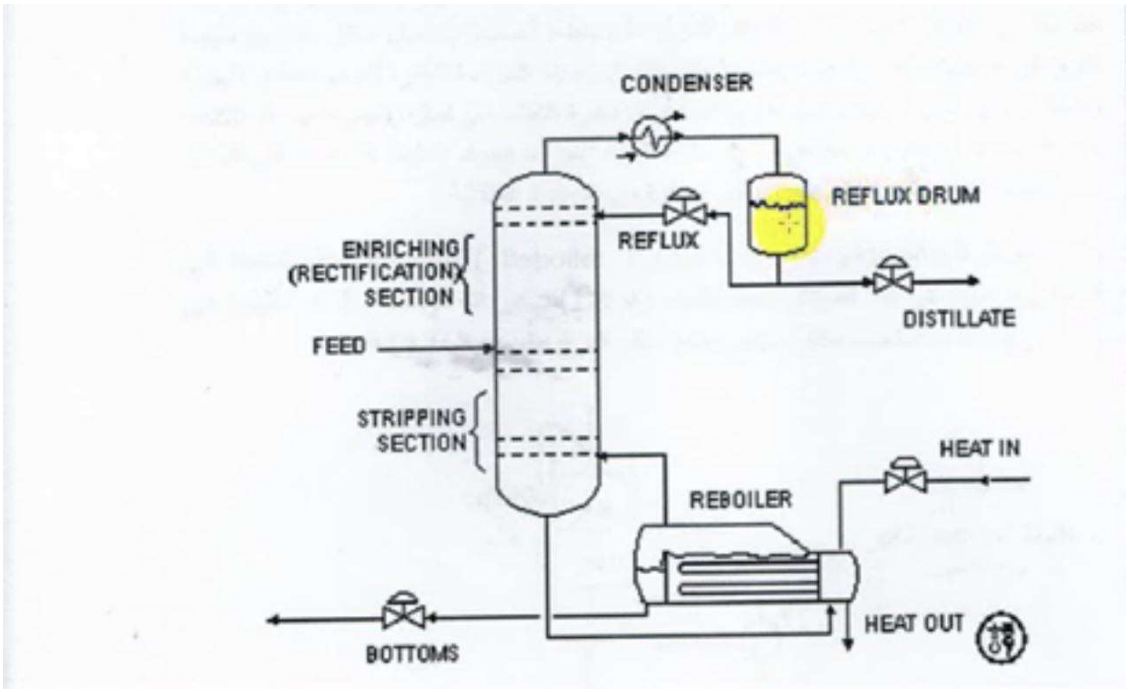
### Fractional distillation:

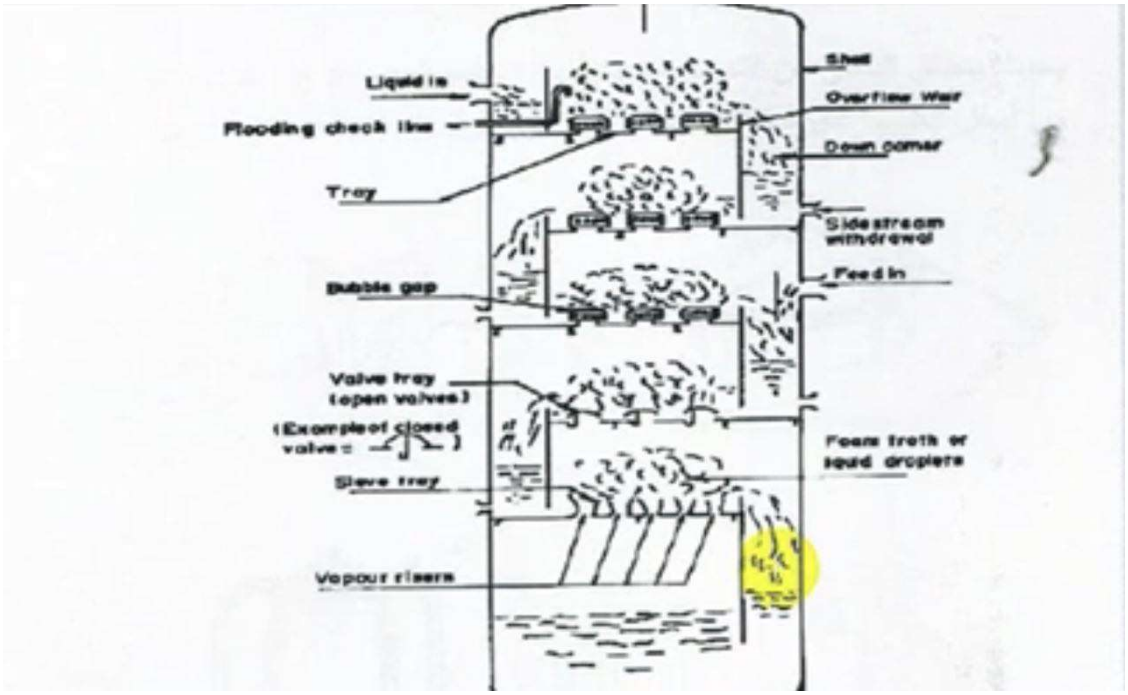
It is used to separate a mixture of liquids with a difference in their boiling point, such as:

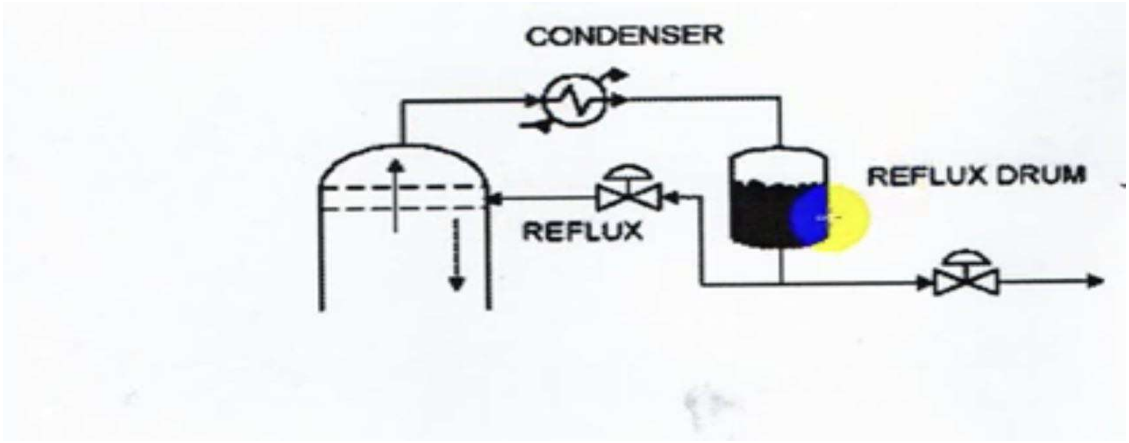
gasoline and water , methanol and water .

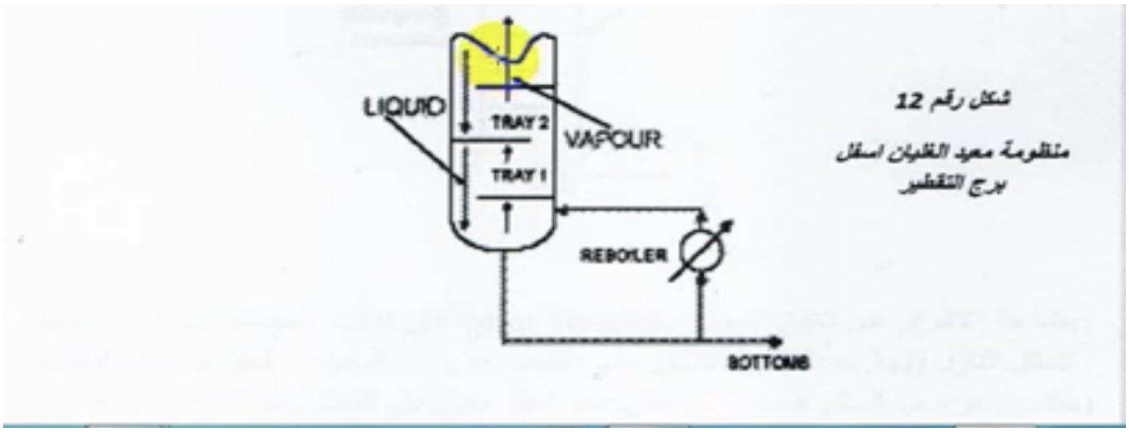

Thermometer
Clamp
distillation
flask
Water outlet
Clamp
Water
condenser
Mixture
of acetone
and water
Cold water in
Acetone

# Processes that occur inside the distillation tower:





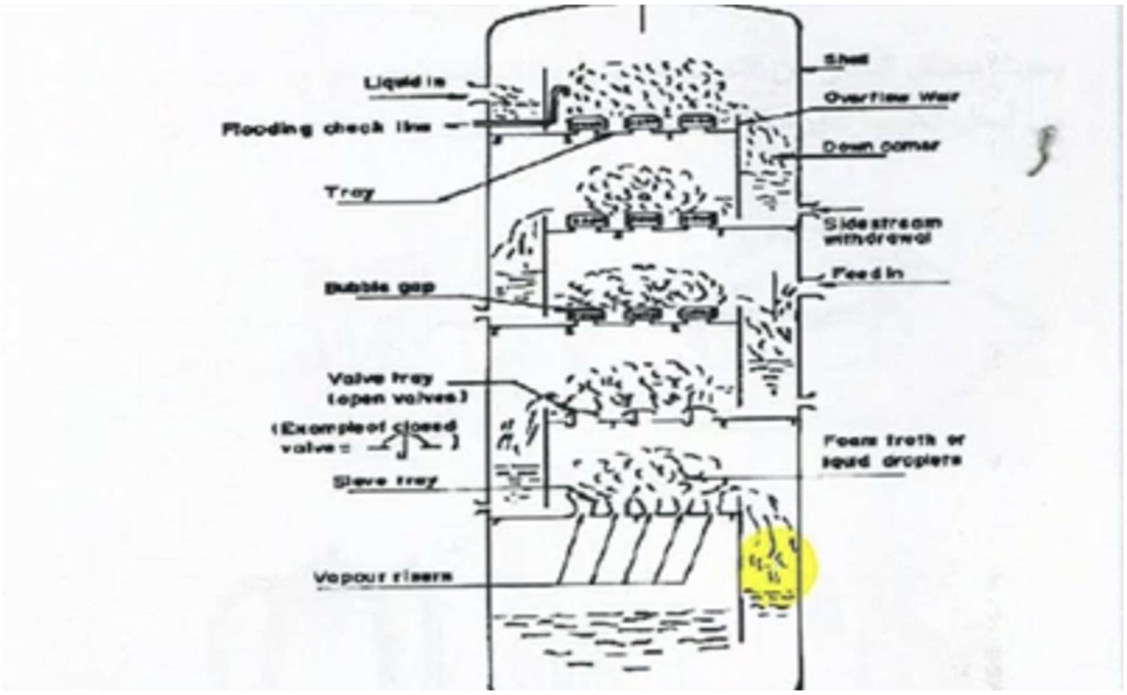




شكل رقم 12

منظومة معيد الغليان اسفل برج التقطير

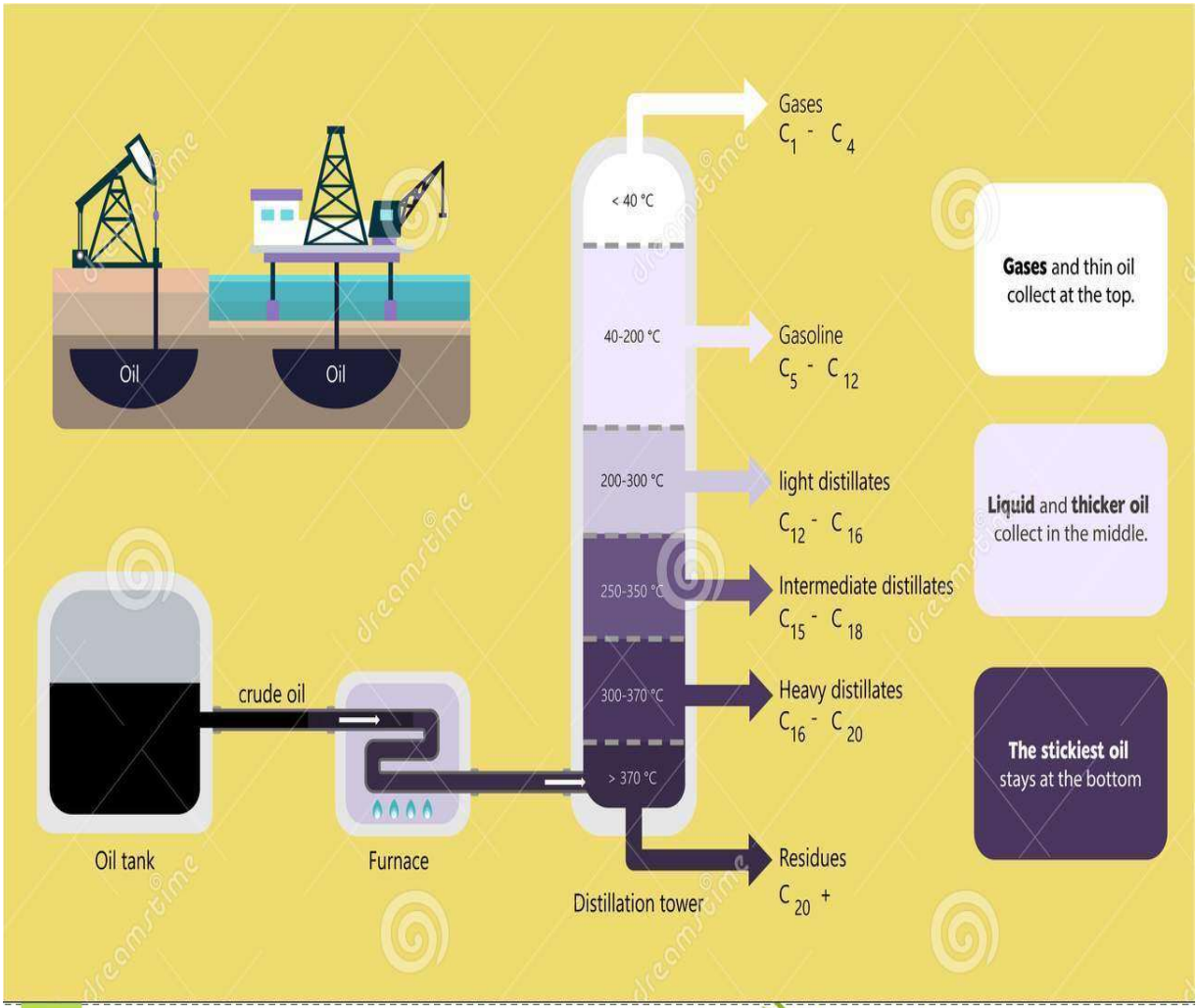
## The most famous types of Tray Tower:

1- Sieve plates.
2- Valve plates.
3- Bubble cup plates.




## Problems that occur inside the distillation tower:

1- **Entrainment:** It is a phenomenon that occurs when the vapor pressure is higher than the required so that the liquid is carried from one tray to another higher than it
2- **Flooding:** It is the arrival of the vapor-bearing liquid to the upper tray of the distillation tower and its entry into the upper condenser.



## The most important oil derivatives are as follows:

1- Liquefied Petroleum Gases (L.P.G), which is a mixture of propane and butane, with a boiling point of less than 20 degrees Celsius, which can be converted into liquid under high pressure, and used as fuel in homes, as a source of energy in some factories, and as fuel for the engines of some cars and buses.

2- Naphtha : the types of naphtha are divided into two types: light naphtha and heavy naphtha. It is primarily used in the production of automobile gasoline and is also used in chemical industries such as the preparation of ethylene and propylene. These products are used in the manufacture of plastics such as polyethylene and polypropylene.
Light naphtha is the fraction boiling between 30 °C and 90 °C and consists of molecules with 5–6 carbon atoms.
Heavy naphtha boils between 90 °C and 175 °C and consists of molecules with 6–12 carbon atoms.

3- Car fuel (Gasoline): It is a complex mixture of hydrocarbons that are mostly alkanes and a few aromatic hydrocarbons and contain no alkenes or alkynes.
and consists of molecules with 5–12 carbon atoms.
boils between 40 °C and 175 °C.

4- Kerosene: is one of the most important products of refineries, and it is located within a temperature range of 150 to 250 degrees Celsius, and contains a number of

paraffins and naphthenates, and is used as a household fuel for cooking and heating.

It consists of molecules with C10–C15 carbon atoms

5- Jet fuel This type of fuel is known as jet fuel (aircraft kerosene), and it is used to power turbine engines that run continuously, unlike the engines of internal combustion cars. When preparing jet fuel, a large number of important specifications are taken into account, for reasons of safety and security. The flash point should not be less than 38 degrees Celsius, and its freezing point is minus 50 degrees Celsius, so that it remains liquid in cold areas and in the upper layers of the atmosphere.

The extent of its distillation is limited to between 160 and 240 degrees Celsius, and the percentage of aromatic substances in it does not exceed a certain limit.

Civil jet fuel is called **JP1**, while military jet fuel is called **JP4**, because it is characterized by a wide distillation range between 50 and 240 degrees Celsius, a greater proportion of aromatic materials, a percentage of sulfur materials that may reach 0.4%, and its freezing point is about 65 degrees Celsius below Zero.

6- Diesel or Solar ( gasoil ) is the world's common name for a type of fuel that is less flammable and explosive than gasoline. That is why it is mainly used in military vehicles and trucks, in addition to some cars, home

heating and the like. It consists of molecules with C13–C18 carbon atoms

Diesel is obtained in a cut at a temperature of 250 to 350 degrees Celsius, and is characterized by its transparent pale yellow color. This type of product is used as fuel for heavy machinery, and for some car engines.

The combustibility of diesel is measured by what is known as the "**cetane number**", and the higher the cetane number, the better the fuel's combustion performance, meaning that ignition can be started at low temperatures. This type of fuel should have an appropriate degree of viscosity and contain a certain percentage of sulfur, as the increase of this element in the fuel leads to engine wear in a relatively short time.

7- Fuel Oil This type of fuel is widely used in industry. It has replaced coal since the beginning of the twentieth century, as it is currently used to operate thermal power plants, and in heavy industries such as mining, cement and glass industries to secure the thermal energy needed for their operation.

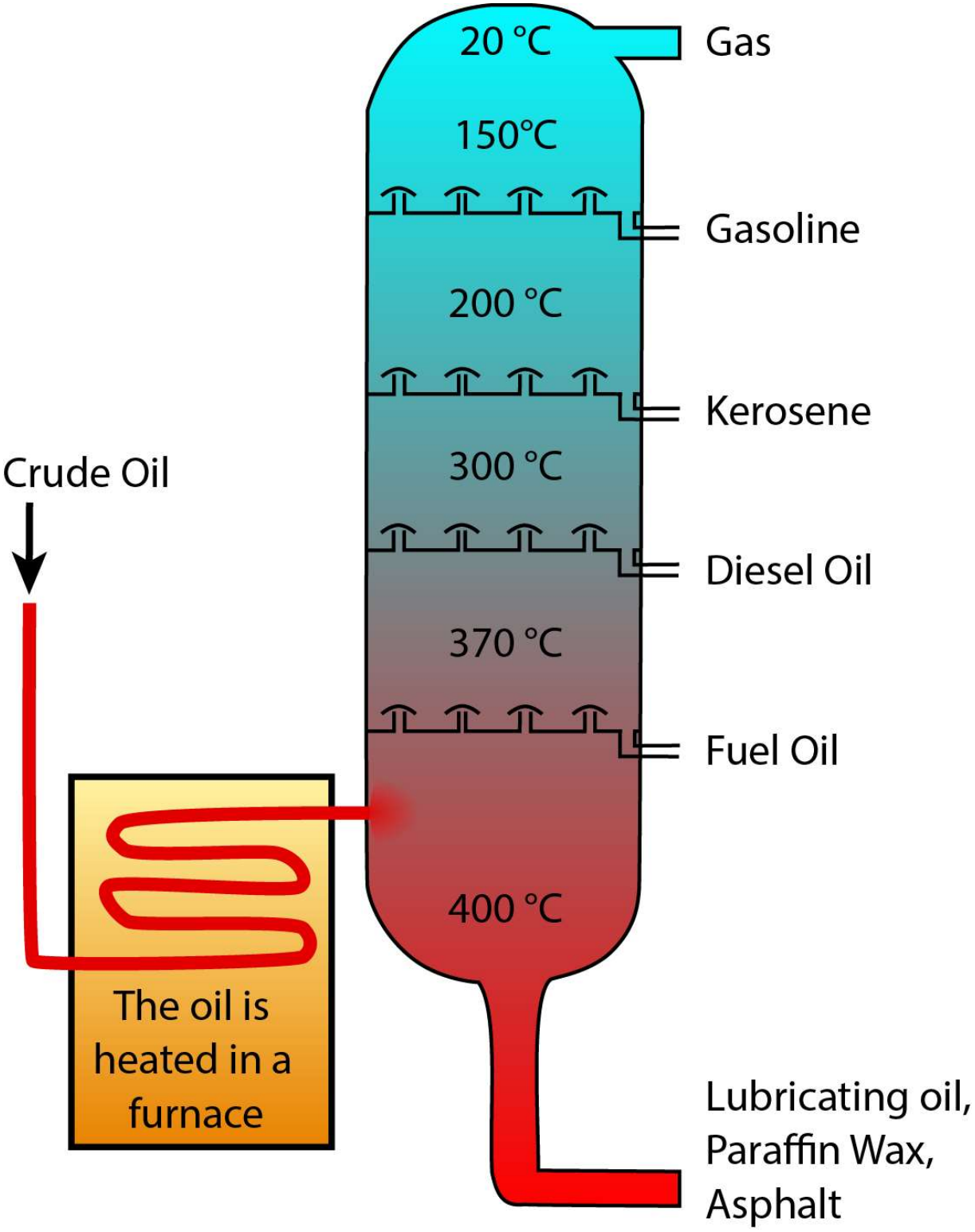
It is obtained from the distillation tower immediately after diesel, and its boiling point ranges between 300 and 350 degrees Celsius.

Light fuel oil LFO (lubricating oil) C17-C19

Heavy fuel oil HFO C18-C20

8- Lubricating Oils are products of the vacuum distillation process, and their boiling range varies between 350 and 500 degrees Celsius. Within the range of 350 to 400 degrees Celsius, oils are classified as light, and within a range of 400 to 450 degrees Celsius, oils are classified as medium. Heavy, its boiling range is from 450 to 500 degrees Celsius.

9- Asphalt is the substance remaining at the bottom of the vacuum distillation tower. Some people call it tar, from which bitumen or asphalt is extracted. It is a mixture of high-viscosity chemical compounds, black in color, and it is the heaviest oil derivative and the highest in the boiling point.
It contains varying proportions of sulfur and some heavy metals. It is used in paving roads and insulating the roofs of houses. It was also used previously in making incendiary catapult shells that were ignited and thrown at enemies.


20 °C
Gas
150°C
Gasoline
200 °C
Kerosene
Crude Oil
300 °C
Diesel Oil
370 °C
Fuel Oil
400 °C
The oil is heated in a furnace
Lubricating oil, Paraffin Wax, Asphalt