FUELS AND DISTILLATION COLUMNS

Crude oil – the Origin of Fuels

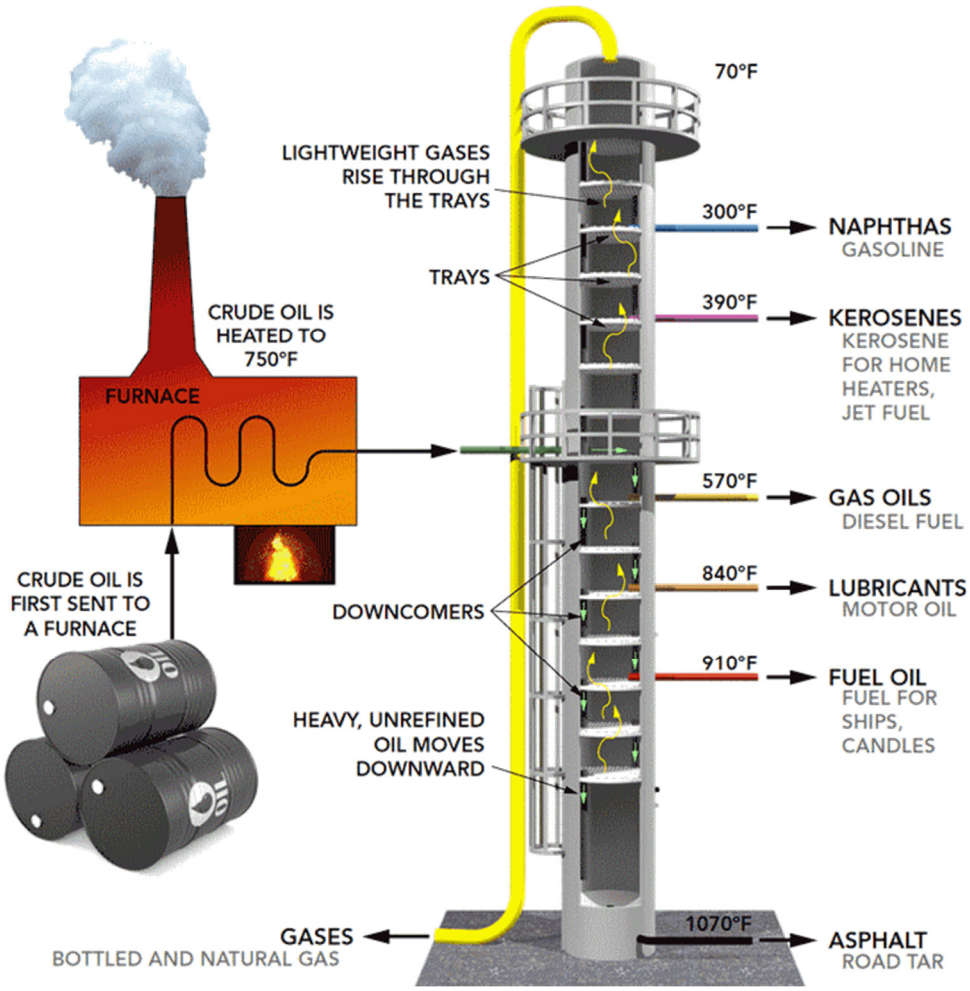
Crude oil is made up of various components which have different sizes, weights and boiling temperatures. These components are separated to create the different kinds of fuels we are familiar with. Because they have different boiling temperatures, they can be separated easily by a process called fractional distillation via a distillation column.

Small molecules like those in propane gas, naphtha, gasoline for cars, and jet fuel have relatively low boiling points, and they are removed at the start of the fractional distillation process.

Heavier petroleum products like diesel and lubricating oil are much less volatile and distill out more slowly, while bunker oil is literally the bottom of the barrel; the only things denser than bunker fuel are carbon black feedstock and bituminous residue which is used for paving roads (asphalt) and sealing roofs.

Very few of the components come out of the fractional distillation column ready for market. Many of them must be chemically processed to make other fractions. For example, only 40% of distilled crude oil is gasoline; however, gasoline is one of the major products made by oil companies. Rather than continually distilling large quantities of crude oil, oil companies chemically process some other fractions from the distillation column to make gasoline; this processing increases the yield of gasoline from each barrel of crude oil.

Distillation Column and Distillation Process



1. Crude oil is heated and introduced into the **Distillation Column**.
2. When the crude oil boils, it forms **vapor** (gases); most substances go into the **vapor** phase.
3. The **vapor** enters the bottom of the long **Distillation Column** (fractional distillation column) that is filled with **trays** or plates. The **trays** have many holes or bubble caps (like a loosened cap on a soda bottle) in them to allow the **vapor** to pass through. They increase the contact time between the **vapor** and the **liquids** in the **column** and help to collect **liquids** that form at various heights in the **column**.
4. The vapor rises in the **column**.
5. As the **vapor** rises through the **trays** in the column, it cools. There is a temperature difference across the **column** (hot at the bottom, cool at the top).
6. When a substance in the **vapor** reaches a height where the temperature of the **column** is equal to that substance's boiling point, it will condense to form a **liquid**. (The

substance with the lowest boiling point will condense at the highest point in the **column**; substances with higher boiling points will condense lower in the **column**.).

7. The **trays** collect the various **liquid** fractions.
8. The collected **liquid** fractions may pass to **condensers**, which cool them further, and then go to storage tanks, or they may go to other areas for further chemical processing.

Fuel Types

Gases

- Bottled/Natural Gases – Natural gas, composed chiefly of methane, can be compressed to a liquid and used as a substitute for other traditional liquid fuels. Its combustion is very clean compared to other hydrocarbon fuels, but the fuel's low boiling point requires the fuel to be kept at high pressures to keep it in the liquid state. Though it has a much lower flash point than fuels such as gasoline, it is in many ways safer due to its higher auto-ignition temperature and its low density, which causes it to dissipate when released in air.

Naphtha

- Gasoline – is the most widely used liquid fuel. Gasoline, or petrol, is made of hydrocarbon molecules forming aliphatic compounds, or chains of carbons with hydrogen atoms attached.

Kerosene

- Kerosene for home heaters/Jet Fuel – is sometimes used as an additive in diesel fuel to prevent gelling or waxing in cold temperatures. However, this is not advisable in some recent vehicle diesel engines, as doing so may interfere with the engine's emissions regulation equipment

Gas Oils

- Diesel Fuel – normally called D-2, is similar to gasoline in that it is a mixture of aliphatic hydrocarbons extracted from petroleum. After distillation, the diesel fraction is normally processed to reduce the amount of sulfur in the fuel. Sulphur causes corrosion in vehicles, acid rain and higher emissions of soot from the tail pipe (exhaust pipe). Legislation has required the sulphur content to be as low as 15ppm in some countries.

Lubricants

- Motor Oil – is any of various well-developed lubricants (comprising oil enhanced with additives, for example, in many cases, extreme pressure additives) that are used for lubrication of internal combustion engines. The main function of these lubricants is to reduce wear on moving parts; they also clean, inhibit corrosion, improve sealing, and cool the engine by carrying heat away from moving parts.
- Motor oils are derived from petroleum-based and non-petroleum-synthesized chemical compounds. Motor oils today are mainly blended by using base oils composed of hydrocarbons, polyalphaolefins (PAO), and polyinternal olefins (PIO), thus organic compounds consisting entirely of carbon and hydrogen. The base oils of some high-performance motor oils however contain up to 20% by weight of esters.

Fuel Oil/Heavy Fuels

- Fuel oil or heavy oil is a fraction obtained from petroleum distillation, either as a distillate or a residue. Broadly speaking, fuel oil is any liquid fuel that is burned in a furnace or boiler for the generation of heat or used in an engine for the generation of power, except oils having a flash point of approximately 40 °C (104 °F) and oils burned in cotton or wool-wick burners. In this sense, diesel is a type of fuel oil. Fuel oil is made of long hydrocarbon chains, particularly alkanes, cycloalkanes and aromatics. The term fuel oil is also used in a stricter sense to refer only to the heaviest commercial fuel that can be obtained from crude oil, i.e., heavier than gasoline and naphtha.
- Bunker fuel or bunker crude is technically any type of fuel oil used aboard vessels and heavy boilers. Bunker A is No. 2 fuel oil, bunker B is No. 4 or No. 5 and bunker C is No. 6. Since No. 6 is the most common, "bunker fuel" is often used as a synonym for No. 6. No. 5 fuel oil is also called Navy Special Fuel Oil (NSFO) or just navy special; No. 5 or 6 are also commonly called heavy fuel oil (HFO) or furnace fuel oil (FFO); the high viscosity requires heating, usually by a recirculated low pressure steam system, before the oil can be pumped from a bunker tank. Bunkers are rarely labeled this way in modern maritime practice.
- In the maritime field another type of classification is used for fuel oils:
    - **MGO (Marine gas oil)** – roughly equivalent to No. 2 fuel oil, made from distillate only
    - **MDO (Marine diesel oil)** – A blend of heavy gasoil that may contain very small amounts of black refinery feed stocks, but has a low viscosity up to 12 cSt so it need not be heated for use in internal combustion engines
    - **IFO (Intermediate fuel oil)** – A blend of gasoil and heavy fuel oil, with less gasoil than marine diesel oil
    - **MFO (Marine fuel oil)** – same as HFO (just another "naming")
    - **HFO (Heavy fuel oil)** – Pure or nearly pure residual oil, roughly equivalent to No. 6 fuel oil
- Marine diesel oil contains some heavy fuel oil, unlike regular diesels.

Asphalt (Bitumen)

- Asphalt – a sticky, black and highly viscous liquid or semi-solid form of petroleum mostly used for road construction