The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Separating Different Components from a Crude Oil

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Topic: Supply/Production
Tags: crude oil, oil production, oil refineries, tech talk [list all tags]

In this series of tech talks, I have been writing about the progress of crude oil as it passes from the reservoir up through the production casing, and out to the GOSP, where water, oil, natural gas, sand and sulfur products can be separated. The example video that I referred to last week dealt with treating Canadian Oil Sands, and the oil that is coming from them.

What I want to talk about today is the differences that exist in what to some folk is just "crude oil," with the assumption that it is all the same. In writing about coal, it is fairly simple to show that the different stages of coal as it changes from peat to anthracite. This means that you get different amounts of energy from it, and it can be extracted with differing amounts of energy. The fact that there is a fair bit of difference in crude oils is not always as easily understood. This then will be a relatively simplistic look at the different potential hydrocarbons that might make up a crude oil, and how we can get them apart.

Crude oil is made up of a mixture of hydro-carbons, which are the different ways in which carbon and hydrogen can combine, starting with such simple compounds as methane (CH_4) and progressing to more complex ones with greater numbers of carbon atoms.

fraction	no. carbons	b.p.	% (*)
Gases	1-4	<0	2
Light Naphtha	5-7	27-93	34
Heavy Naphtha	6-10	93-177	
Kerosene	10-15	177-293	11
Light Gas Oil	13-18	204-343	21
Heavy Gas Oil	16-40	315-565	31
Residuum	>40	>565	
(*) percentage composition for Gippsland Crude Oil			

Typical crude oil fractions

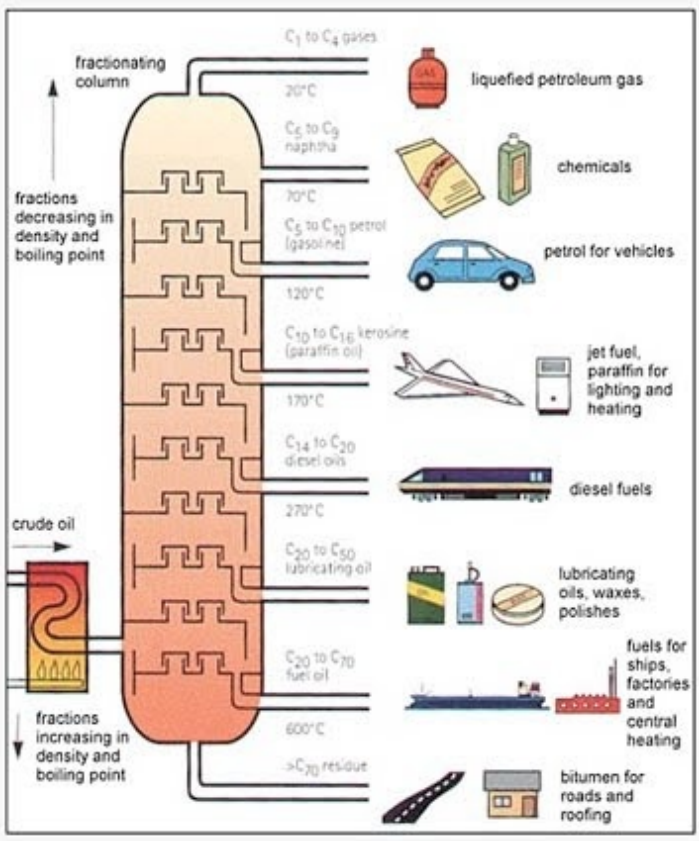
Oils from different places have different combinations of the major constituents, for example, this is from Kuwait.

Constituent	Quantity
Sulfur	2.44% by weight
Nitrogen	0.14% by weight
Nickel	7.7 ppm
Vanadium	28 ppm
Naptha fraction (boiling pt. from 20 to 205° C)	22.7% by weight
High boiling fraction (boiling pt. above 205° C)	77.3%
Aromatics	23.3% by weight
Parrafins	20.9% by weight
Insolubles	3.5% by weight

Constituents of a typical Kuwaiti crude oil

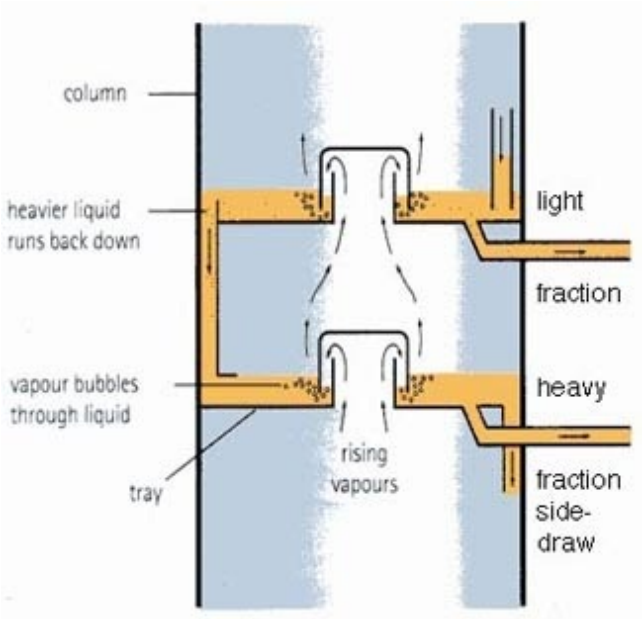
Because they are fluids mixed together, it is not very easy to separate out the different valuable parts (known as fractions) by a mechanical means. However, if you heat up the crude oil blend, then all the constituents will vaporize.

But the different fractions of the oil will boil at different temperatures (or boiling points (b.p.)), at which point they turn into gas. And so the first part of the treatment that the oil gets, when it reaches a refinery is that it is heated, so that it will all turn into such a gas, and then it is cooled in stages, so that the different fractions will condense back out. The total process is known as crude oil distillation and the UK Schools site has a simple sectional picture of what such a distillation column might look like.



Simplified representation of a distillation column.

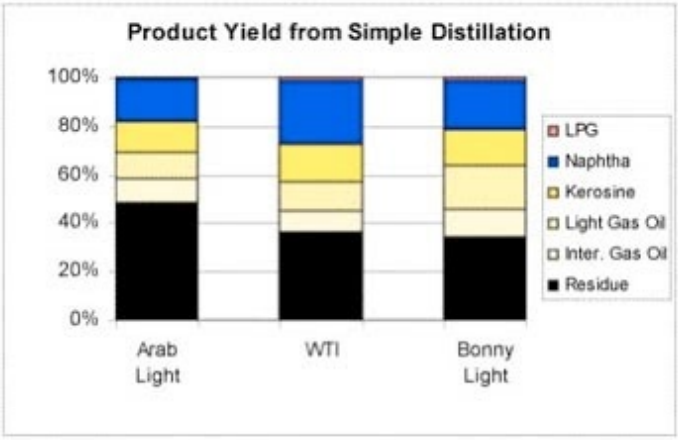
As the combined vapors from the heated crude enter at the bottom of the tall tower (called a column), they pass up through different trays that are placed at set heights up the column. When the gas reaches a tray it passes up through it into a bubble cap, this is a cover over the hole that pushes the gas down so that it has to bubble up through the liquid that has already condensed onto that tray.



Schematic showing construction of the individual bubble caps

The liquids in each tray, as the vapor rises higher in the column, are kept at lower temperatures,

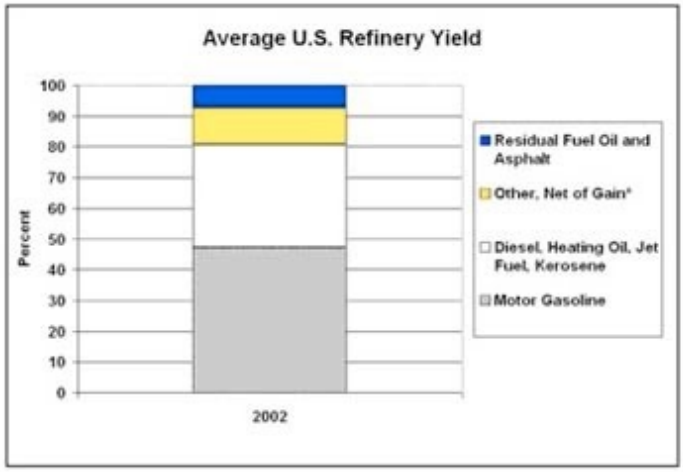
so that the heavier oils, that condense at a higher temperature, will condense lower down the column. As the lighter vapor rises through successive trays, the temperature of the liquids drops, and lighter fractions of the oil also begin to condense out, until the very lightest are collected at the top, still as gas, and are fed on to a cooler. The liquids then drain, either back down to a lower tray, or through a side-draw pipe that taps the fluid from the trays and takes it away for either further division or for storage and sale. A typical initial distillation might yield:



Typical range of distillation products.

Each year the EIA publishes its world distillation capacity which is the necessary part of getting from crude to useful product.

I will continue this further in a later post, talking about the further stages in refining, and cracking of compounds to break them into lighter fractions, so that the next product from a refinery might at the end, look something like this (courtesy of the EIA).



Typical products of a refinery

I hope that each of you has a Prosperous and Successful life in the year ahead.