Tikrit University

The College of Petroleum Processes Engineering

Petroleum Systems Control Engineering

Department

Properties of Petroleum & Natural Gas

Third Class

Lecture 5

By

Jasim I. Humadi

Classification of Crude Oil

Classification of crude oil refers to natural and type of crude oil (**type of hydrocarbons in crude oil**) by simplified tests. Four mainly methods are used

A- Watson or UOP characterization factor (Kw):

Watson characterization factor (Kw) can be calculated from the following equation:

$$K_w = \frac{\sqrt[3]{MeABP}}{Sp.Gr\ @\ 60°F} \ldots . 1$$

Kw = Watson characterization factor

MeABP = mean average boiling point temperature in Rankin = **VABP - Δ**

VABP = volume average boiling point temperatures in °F.

VABP can be calculated as the average of the five boiling temperatures at 10, 30, 50, 70 and 90 percent distilled.

Sp.Gr. 60/60°F = Specific Gravity at 15°C (60 °F) = **density crude oil @ 60°F / density of water @ 60°F**

$$Sp.Gr\ @\ 60°F = \frac{141.5}{API+131.5} \ldots . 2$$

Crude oil classifications by Watson characterization factor as follows:

1- Kw = 12.15 – 13 paraffinic (or light) based crude oil

2- Kw = 11.1 – 12.0 mixed (or intermediate) based crude oil

3- Kw = 10 – 11.0 naphthenic (asphaltic or heavy) based crude oil

B- (API gravity)

API = American Petroleum Institute

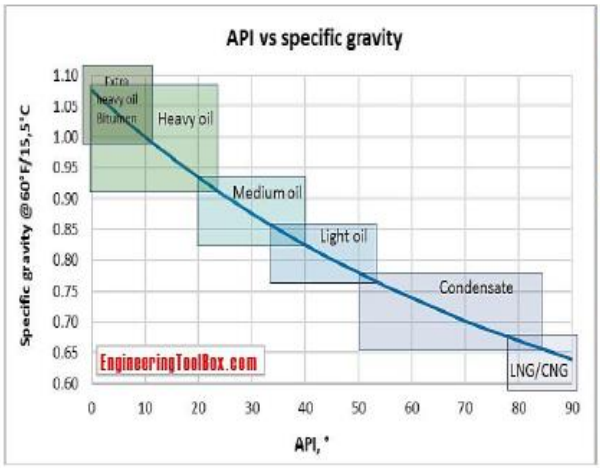
$$API = \frac{141.5}{Sp.Gr.@\ 60°F} - 131.5 \ldots . 3$$

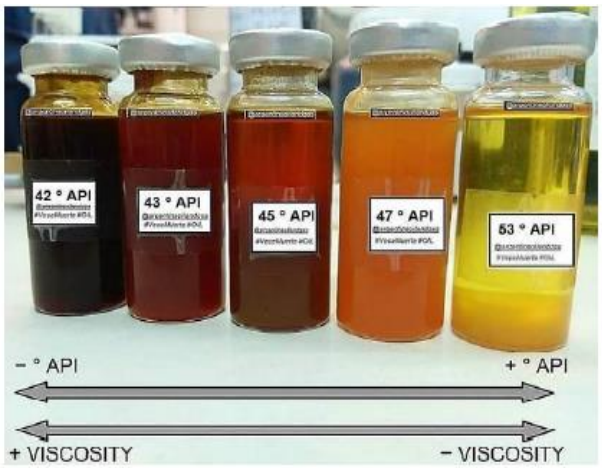
At atmospheric (1 atm), the crude oil classification will be as follows:

1- API gravity > 40 paraffinic (or light) based crude oil

2- API gravity = 33 - 40 mixed (or intermediate) based crude oil

3- API gravity < 33 naphthenic (asphaltic or heavy) based crude oil





C- Correlation Index (C.I)

This method based on the percentages of various hydrocarbons types in the crude oil which are classified into paraffinic or aromatic according to following

$$C.I = 473.7\,SG\ at\ 60F - 456.8 + \frac{48680}{ABP\ °K} \quad ....4$$

ABP: average boiling point in Kelvin

The crude oil can be classified as follow as:

1. C.I. = 0 (normal paraffinic based crude oil)

2. C.I = 0-15 (predominance of n-paraffinic crude oil)

3. C.I = 15 – 50 (paraffinic and aromatic mixture)

4. C.I > 50 (predominance of aromatic crude oil)

5. C.I = 100 benzene (Aromatic)

D- Classification by Viscosity-Gravity Constant

The viscosity gravity constant is of particular value in indicating a predominantly paraffinic or cyclic composition. **The lower the index number**, **the more paraffinic the stock**; for example, napthenic lubricating oil distillates have VGC = 0.876 while raffinate obtained by solvent distillation of lubricating oil distillate has VGC ~ 0.840

$$VGC = \frac{10\,Sp.Gr - 1.0752\,\log(v_{38} - 38)}{10 - \log(v - 38)} \ldots.5$$

V is the saybolt viscosity at 38° C (100°F). For oils so heavy that low-temperature viscosity is difficult to measure, an alternative formula has been proposed in which the **99°C (210°F) saybolt viscosity is used**.

$$VGC = \frac{Sp.Gr - 0.24 - 0.022\,\log(v_{99} - 35.5)}{0.755} \ldots.6$$

The Saybolt universal viscosity (SUS) is the time in seconds required for the flow of 60 ml of petroleum from a container, at a constant temperature, through a calibrated orifice.

VGC:

1) 0.70-0.79 paraffinic hydrocarbon.

2) 0.80-0.90 naphthenic base.

3) 0.91-1.31 aromatic base.

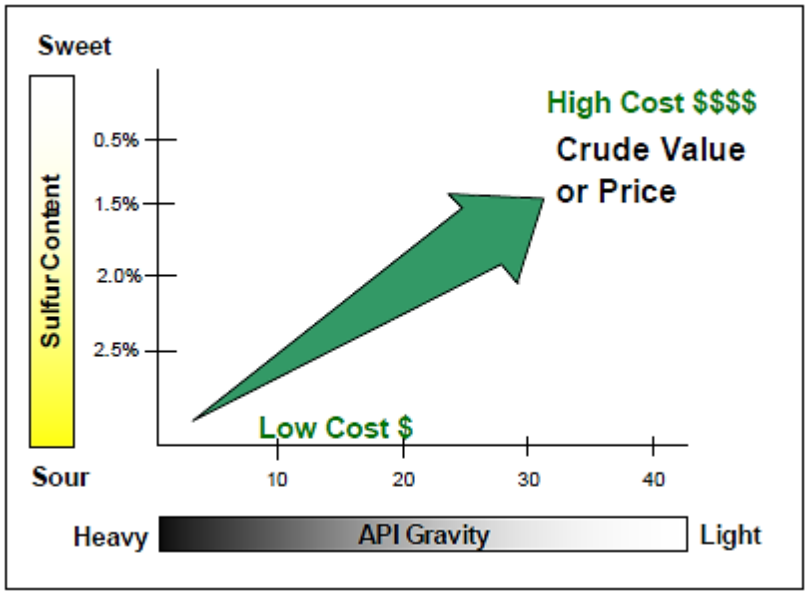
C varies for paraffinic hydrocarbons from 0.74 0.75, for naphthenic from 0.89 to 0.94, and for aromatics from0.95 to 1.13

E - Sulfur Content

• If crude has **less than 0.5%** sulfur content, then it will be considered as **sweet crude oil.**

• **If crude has greater than 2.5% sulfur, then it will be sour crude oil.**

• **Crude with sulfur content between these two end points is called intermediate.**



F- Technological Classification of Petroleum

According to technological classification, the oil can be classified as:

• **Low sulfur oil** containing not more than 0.5% of the sulfur, whereby the gasoline fraction contains less than 0.1% sulfur and diesel fraction less than 0.2%.

• **High sulfur oil** containing over 2% of sulfur.

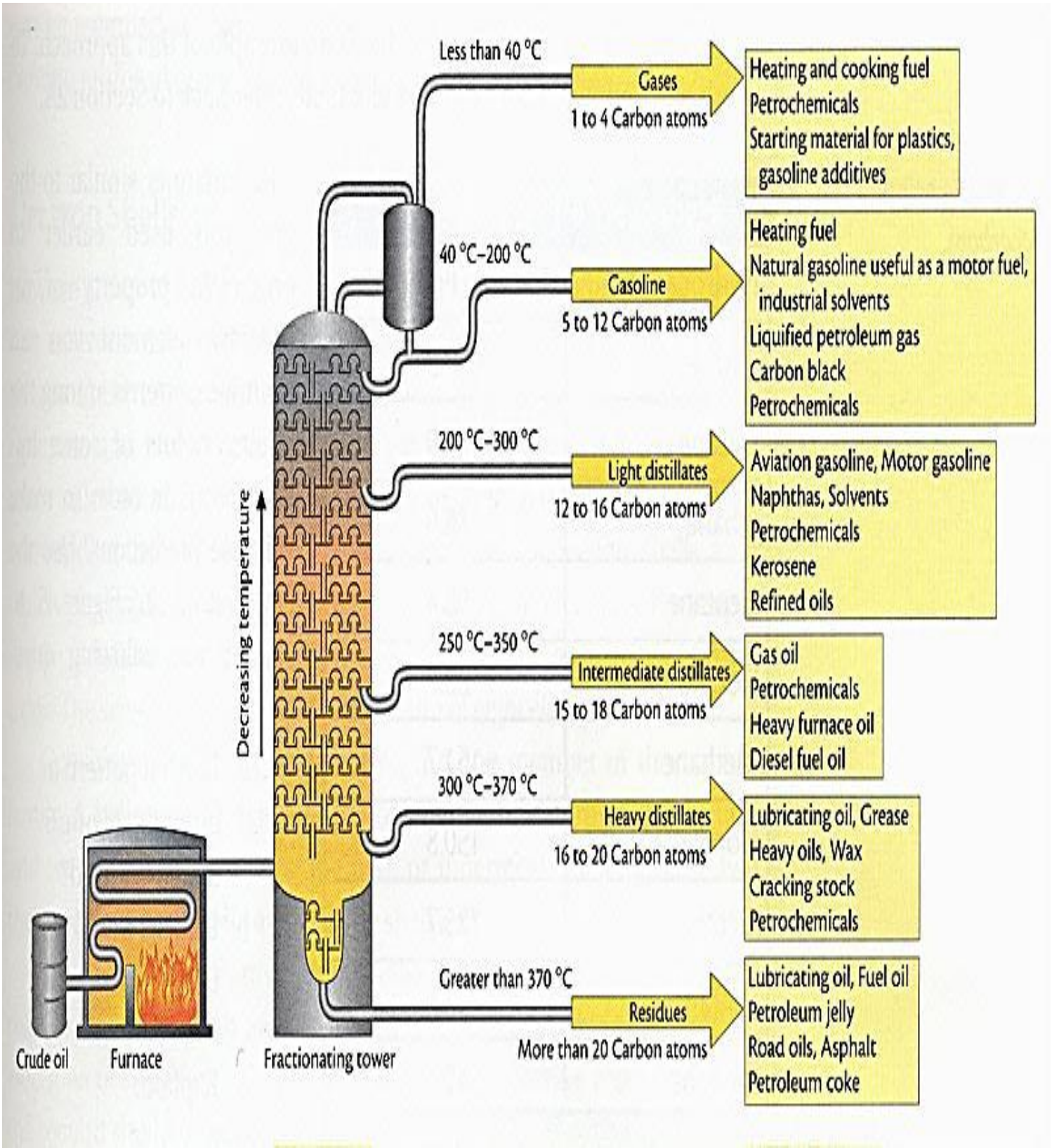
• **Low paraffinic oil** containing less than 1.5% of paraffins. This type of oil can be used for production of jet and winter diesel fuels without deparaffinization.

• **Medium paraffinic oil** containing over 1.5% and fewer than 6% of paraffins. This type of oil can be used for production of jet and summer diesel fuels without deparaffinization.

• **High paraffinic oil** containing over 6% of paraffins. This type of oil can be used for production of diesel and jet fuels only after deparaffinization.

Petroleum fractions from crude distillation unit

Typical petroleum products with their carbon atom and boiling ranges:



Overhead Natural Gases

(C1-C2 methane and traces of ethane)

LPG (C3 - C4)

• Liquefied petroleum gas derived from crude oil refining or natural gas fractionation.

• **LPG** contains: ethane, ethylene, propane, propylene, normal butane, butylene, isobutane and isobutylene.

• For convenience of transportation, these gases are liquefied through pressurizing.

• **LPG** as a **liquid is colorless**, pure LPG has **no smell**, but for safety reasons an odorant agent, usually a mercaptan, is added during manufacture to aid detection at very low concentrations.

• **LPG** has a big advantage over natural gas, which can be liquefied only at a very low temperature and high pressure.

• **LPG** as a **liquid is 250 times denser than LPG as vapor**, so a large quantity can be stored in a relatively small volume.

• **The heating value of LPG** on a volume basis is significantly higher (propane, 95 MJ/m3; butane, 121 MJ/m3) compared with that of natural gas **(38 MJ/m3)**.

• **LPG uses** in central heating, space heating, and hot water supply, as well as in a large number of appliances, such as ovens, stovetops, and refrigerators in homes, hotels, and restaurants.

• The absence of sulfur and very low levels of nitrogen oxides (NOx) and particulate emissions during its combustion make **LPG a most environmentally friendly source of energy.**

• **Automotive LPG**, or auto-gas, refers to the LPG used in automotive applications.

• The disadvantage is that LPG has a lower heating value per unit volume, and thus the vehicle has to refuel more frequently.

• **LPG** used in automobiles is stored in liquid form in an onboard steel cylinder.

• More than 4 million automobiles use LPG worldwide at present.