Tikrit University

The College of Petroleum Processes Engineering

Petroleum Systems Control Engineering Department

Petroleum Refining Processes

Fourth Class

Lecture 3

By

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Physical and Chemical Properties of Crude Oil and Oil Products

5- Salt Content, lb/1000 bbl

If the salt content of the crude, when expressed as NaCl, is greater than 10 lb/1000 bbl, it is generally necessary to desalt the crude before processing. If the salt is not removed, severe corrosion problems may be encountered. If residua are processed catalytically, desalting is desirable at even lower salt contents of he crude. Although it is not possible to have an accurate conversion unit between lb/1000 bbl and ppm by weight because of the different densities of crude oils, 1 lb/1000 bbl is approximately 3 ppm.

6- Sulfur Content, wt%

Sulfur content and API gravity are two properties which have had the greatest influence on the value of crude oil, although nitrogen and metals contents are increasing in importance. The sulfur content is expressed as percent sulfur by weight and varies from less than 0.1% to greater than 5%. Crudes with greater than 0.5% sulfur generally require more extensive processing than those with lower sulfur content.

7- Flash point

Flash point TF, for a hydrocarbon or a fuel is the minimum temperature at which vapor pressure of the hydrocarbon is sufficient to produce the vapor needed for spontaneous ignition of the hydrocarbon with the air with the presence of an external source, i.e., spark or flame. From this definition, it is clear that hydrocarbons with higher vapor pressures (lighter compounds) have lower flash points. Generally flash point increases with an increase in boiling point. Flash point is an important parameter for safety considerations, especially during storage and transportation of volatile petroleum products (i.e., LPG, light naphtha, gasoline) in a high-temperature environment. The flash point can be estimated using the following equation:

$$T_F = 15.48 + 0.70704\, T_{10}$$

Where T10 is normal boiling point for petroleum fractions at 10 vol% distillation temperature. Both temperatures (T10 and flas point (TF) in Kelvin).

Notes:

- Flash point of petroleum fractions is the minimum temperature at which vapours arising from the oil will ignite, i.e. flash, when exposed to a flame under specified conditions.

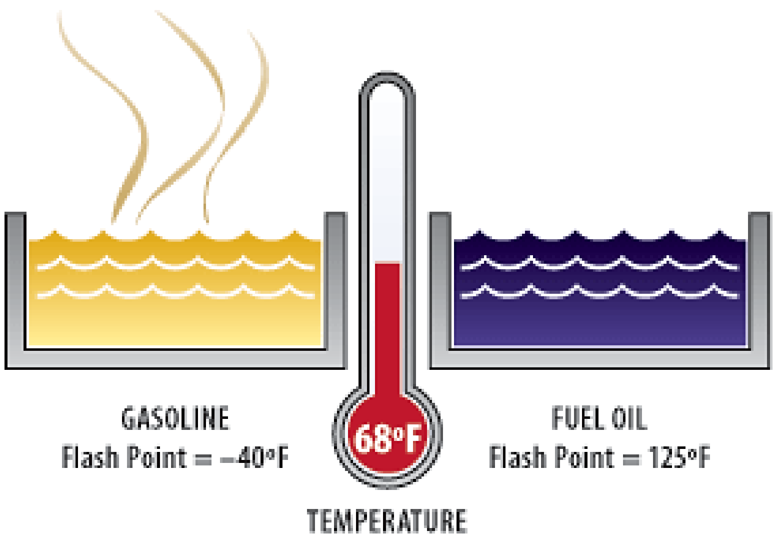
- The flash point indicates the maximum temperature that the fuel can be stored without serious fire hazard.

- Flash point is an important test for light petroleum fractions especially in high temperature environment and is directly related to the safe storage and handling of petroleum products.

- Flash point decreases with increasing volatility of fuel, i.e. the higher vapour pressure the lower is the flash point.

- Generally for crude oils with RVP greater than 0.2 bar the flash point is less than 20°C.

- High flash point means higher temperature is required for the fuel to flash. The fuel therefore does not ignite easily and is safe.



There are several methods of determining flash points of petroleum fractions.

• **The Closed Tag method (Abel) (ASTM D56)** is used for petroleum stocks with flash points below 80°C (175 °F).

• **The Pensky-Martens method (close cup) (ASTM D93)** is used for all petroleum products except waxes, solvents, and asphalts.

• **The Cleveland Open Cup method (ASTM D 92)** is used for petroleum fractions with flash points above 80°C (175°F) excluding fuel oil.

• This method usually gives flash points 3-6°C higher than the above two methods.

The main reason for the requirement of flash point test is to:

➢ Assess the fire hazards of a liquid hydrocarbon with regard to its flammability and then classify the liquid into a group.

➢ This classification is then used to warn of a risk and to enable the correct precautions to be taken when using, storing or transporting the liquid.

➢ The lower the flash point temperature, the greater the risk.

8- Fire Point

Fire point of petroleum fractions is the lowest temperature at which vapors arising from the oil will ignite, i.e. fire, when exposed to a spark or flame under specified conditions. Therefore, the fire point of a fuel indicates the maximum temperature that it must not reach it to prevent the combustion of the petroleum fractions.

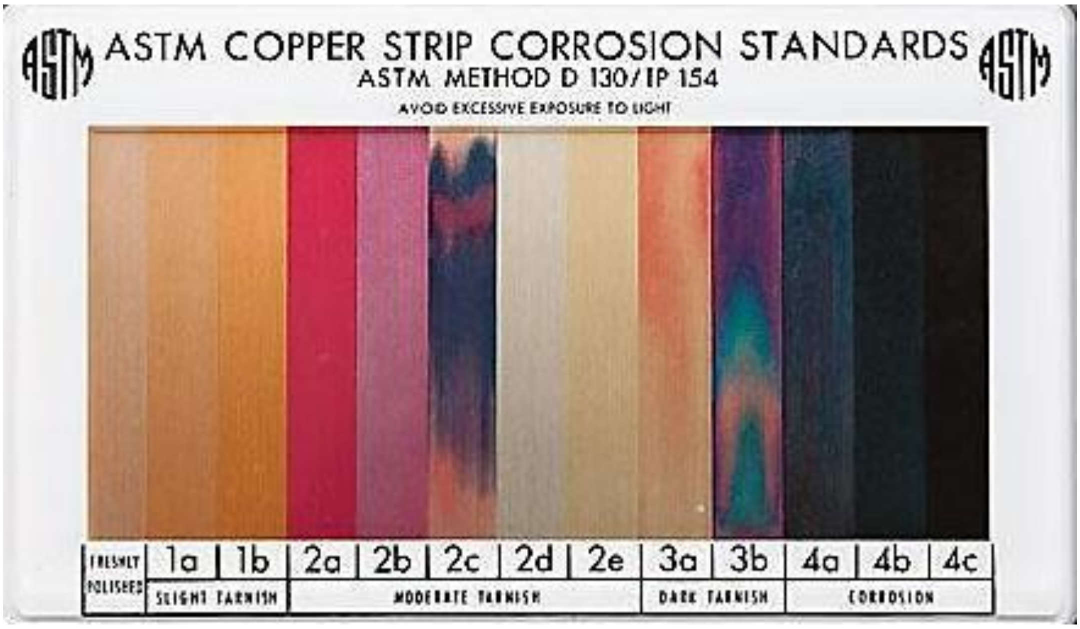
9- Copper strip corrosion test

➢ Measures the corrosivity of light and mid distillates due to presence of sulphur compounds.

➢ ASTM D130 for Petroleum products (gasoline, aviation fuel, kerosene, diesel, fuel oil, natural gasoline).

➢ A polished copper strip is immersed in the sample for three hours at 50°C (122°F). The strip is then removed and tested for discoloration and corrosion of a copper strip under standard test conditions.

➢ Classification number ranges from 1 to 4 after a comparison with the ASTM D130 copper strip corrosion standard is given as below.



class	Designation	Description
1	Slight Tarnish	a) Light orange, almost same as the finely polished strip b) Dark orange
2	Moderate Tarnish	a) Claret red b) Lavender c) Multi colored d) Silvery e) Brassy or gold
3	Dark Tarnish	a) Magenta overcast on brassy strip b) Multi colored with red and green showing no gray
4	Corrosion	a) Transparent black, dark gray, or brown b) Graphite or lusterless black c) Glassy or black

10- Octane number

An octane number is a measure of the knocking tendency of gasoline fuels in spark ignition engines. The ability of a fuel to resist auto-ignition during compression and prior to the spark ignition gives it a high octane number. Two octane tests can be performed for gasoline. The motor octane number (MON) indicates engine performance at high way conditions with high speeds (900 rpm). On the other hand, the research octane number is indicative of low-speed city driving (600 rpm). RON of a fuel may be estimated from the pseudocomponent techniques in the following form:

$$\mathrm{RON} = x_{\mathrm{NP}}(\mathrm{RON})_{\mathrm{NP}} + x_{\mathrm{IP}}(\mathrm{RON})_{\mathrm{IP}} + x_{\mathrm{O}}(\mathrm{RON})_{\mathrm{O}} + x_{\mathrm{N}}(\mathrm{RON})_{\mathrm{N}} + x_{\mathrm{A}}(\mathrm{RON})_{\mathrm{A}}$$

where x is the volume fraction of different hydrocarbon families i.e., n-paraffins (NP), isoparaffins (IP), olefins (O), naphthenes (N), and aromatics (A). RONNp, RONIp, RONo, RONN, and RONA are the values of RON of pseudocomponents from n-paraffin, isoparaffins, olefins, naphthenes, and aromatics families whose boiling points are the same as the mid boiling point or the ASTM D86 temperature at 50% point of the fraction and can be determined from Figure 1:

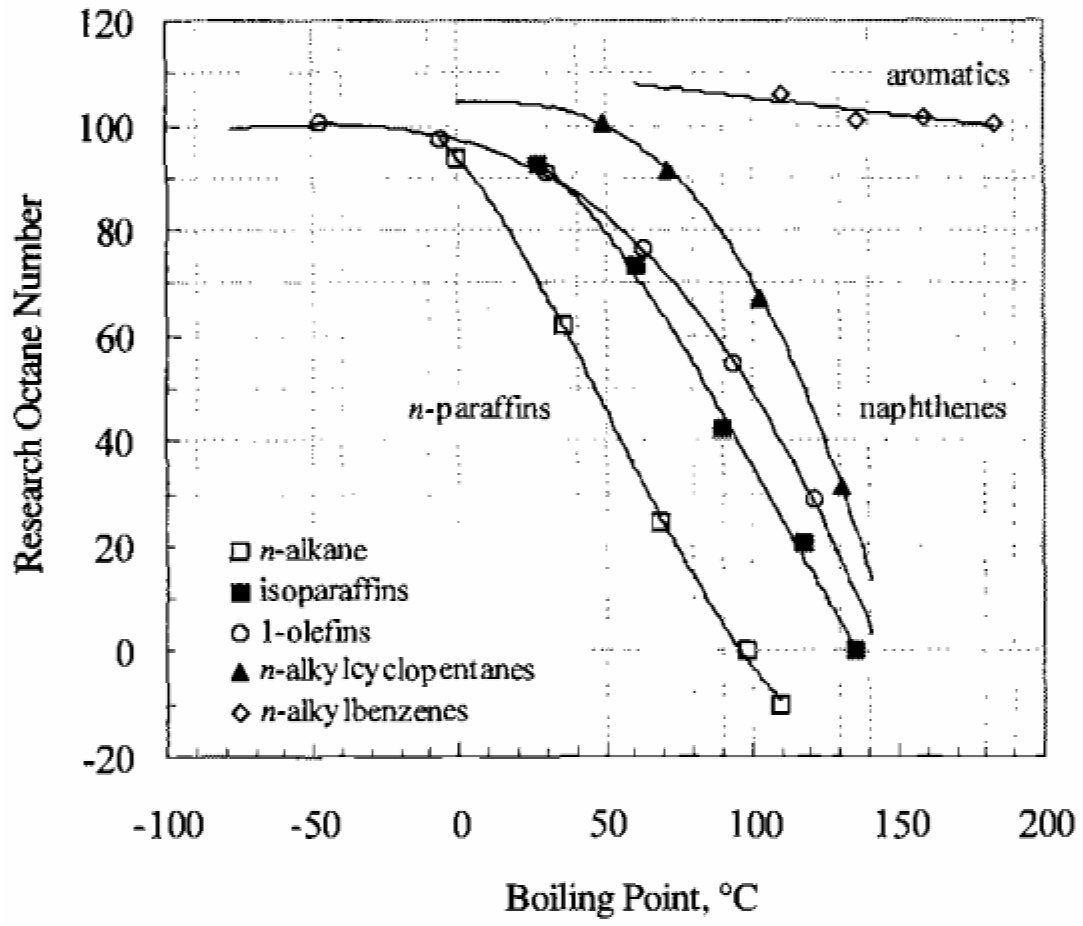


Figure 1: Research octane number of different families of hydrocarbons.

There is another graphical relation for estimation of RON of naphthas in terms of Kw characterization factor or paraffin content (wt%) and mid boiling point as given in Figures 2 & 3below.

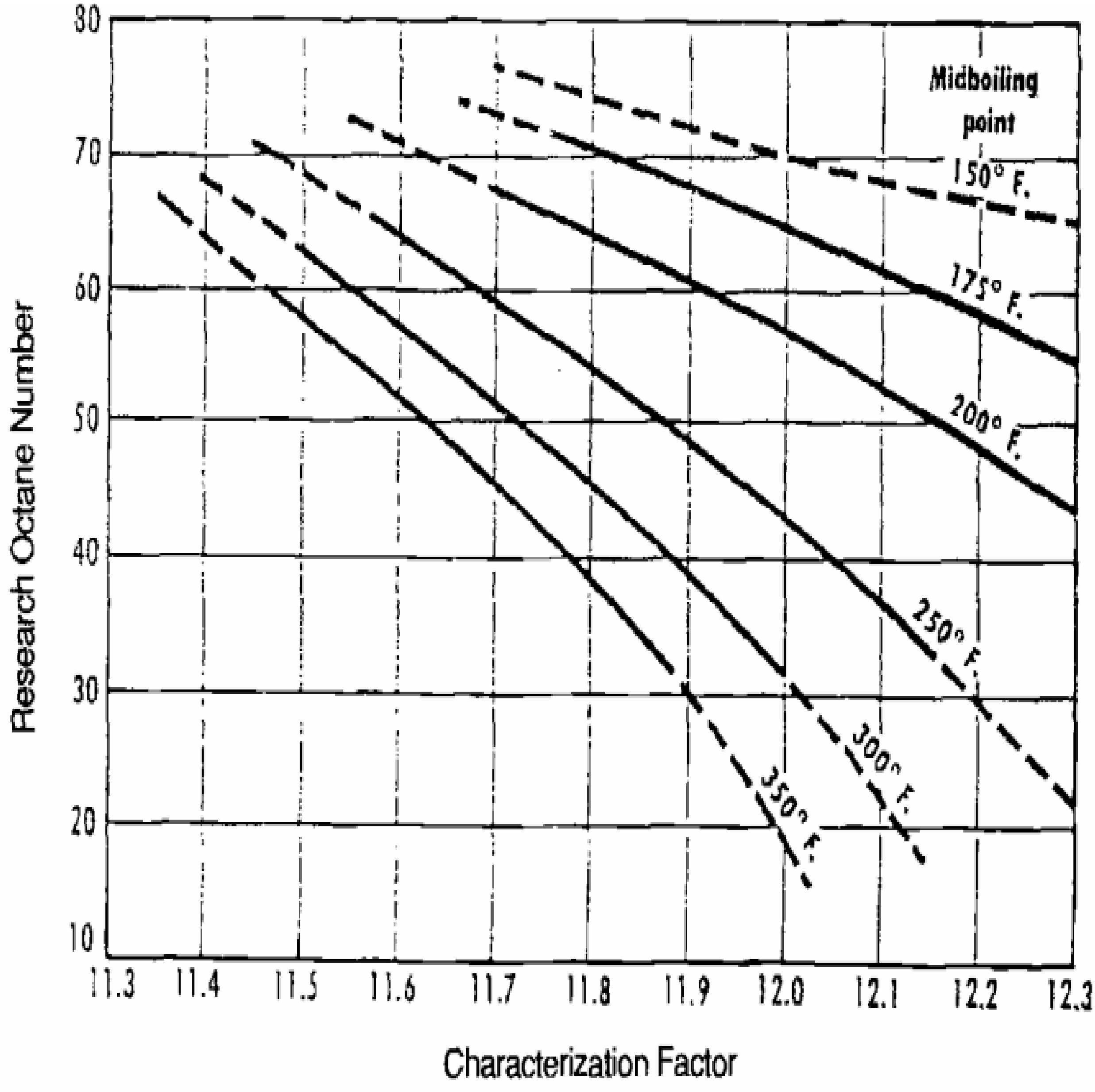


Figure 2: Research octane number of naphtha.

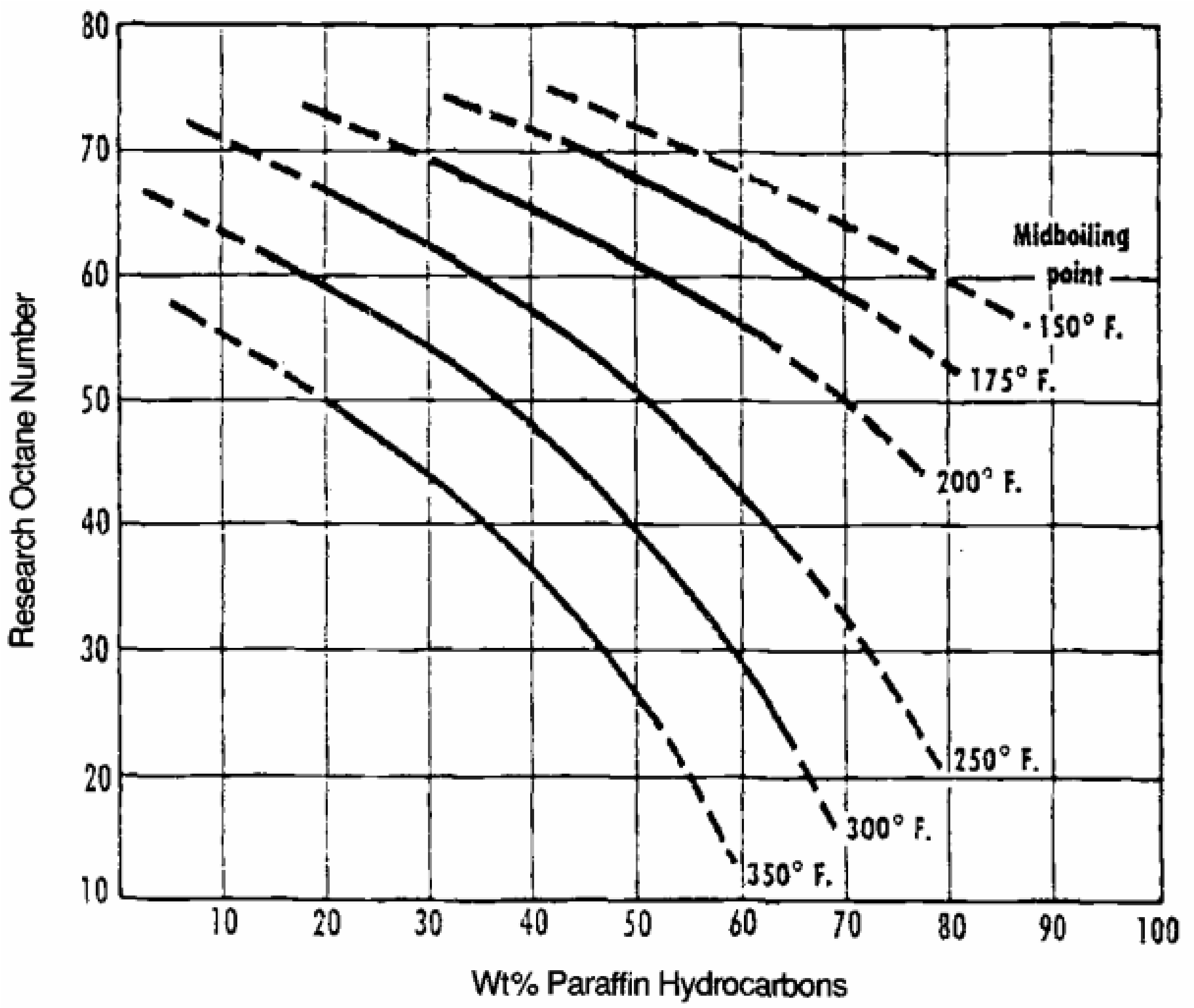


Figure 3: Research octane number versus paraffin content.

RON for these various hydrocarbon groups have been correlated to normal boiling point, Tb in the following form:

$$\mathrm{RON} = a + bT + cT^2 + dT^3 + eT^4$$

Where RON is the clear research octane number and T = (Tb 273.15)/100 in which Tb is the boiling point in kelvin. Based on the data taken from the API-TDB, the coefficients a – e were determined and are given in Table 1 below:

Table 1: Coefficients for estimation of RON

Hydrocarbon family	*a*	*b*	*c*	*d*	*e*
n-Paraffins	92.809	−70.97	−53	20	10
*iso*paraffins					
2-Methyl-pentanes	95.927	−157.53	561	−600	200
3-Methyl-pentanes	92.069	57.63	−65	0	0
2,2-Dimethyl-pentanes	109.38	−38.83	−26	0	0
2,3-Dimethyl-pentanes	97.652	−20.8	58	−200	100
Naphthenes	−77.536	471.59	−418	100	0
Aromatics	145.668	−54.336	16.276	0	0