

Non hydrocarbons components :

The non hydrocarbon components are caused :

- 1- Corrosion.
- 2- Break down in the refinery operation.

the non hydrocarbon components are divided to:

Sulphur Compounds

sulfur is present in crude oil in the form of organic compounds (thiophenes, sulfides, benzothiophenes, and dibenzothiophene), as sulfuric acid and even in its elemental form. Whatever the form, S is considered a problematic in crude oil. It can easily affect acidic properties of the petroleum-derived products and has been found to produce corrosive gases that damage engine parts. On the other hand, S has severe adverse effects on the environment and human health such as acid rain formation, ozone-layer depletion, and respiratory diseases.

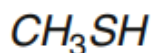
The Sulphur content of crude oils varies from less than 0.05 to more than 10 wt% but generally falls in the range 1–4 wt%.

When the Crude oil with less than 1 wt % sulphur is referred to as low sulphur or sweet, and When the Crude oil with more than 1 wt% sulphur is referred to as high sulphur or sour.

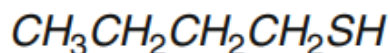
Crude oils contain sulphur heteroatoms in the form of elemental sulphur S, dissolved hydrogen sulphide H_2S , carbonyl sulphide COS, inorganic forms and most importantly organic forms, in which sulphur atoms are positioned within the organic hydrocarbon molecules.

Sulphur containing constituents of crude oils vary from simple mercaptans, also known as thiols, to sulphides and polycyclic sulphides.

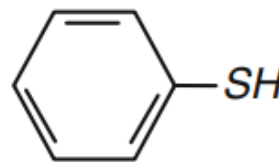
Mercaptans are made of an alkyl chain with –SH group at the end (R–SH). Examples of mercaptans and sulphides are as follows:



methyl mercaptan
(methanethiol)

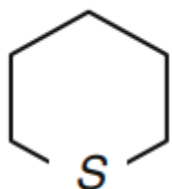


n-butyl mercaptan
(1-butanethiol)

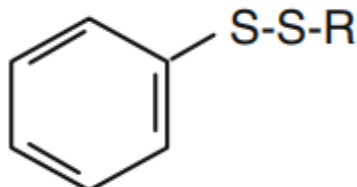
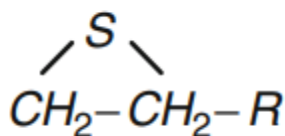


phenyl mercaptan
(thiophenol)

In sulphides and disulphides, the sulphur atom replaces one or two carbon atoms in the chain ($R-S-R'$ or $R-S-S-R'$). These compounds are often present in light fractions. Sulphides and disulphides may also be cyclic or aromatic

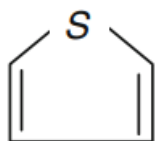


cyclic sulfides

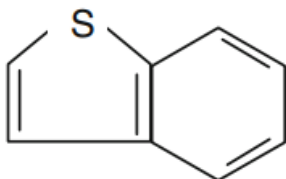


Aromatic disulfide

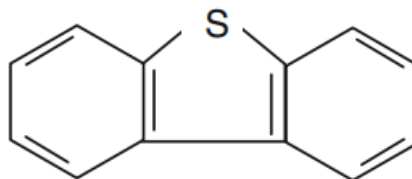
Thiophenes are polyaromatic compounds in which the sulphur atom replaces one or more carbon atoms in the aromatic ring. They are normally present in heavier fractions. Thiophenes present in crude oils may have the following formulas



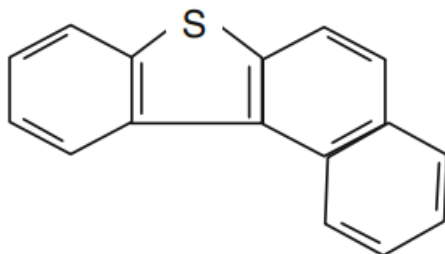
Thiophene



Benzothiophene



Dibenzothiophene



Naphthobenzothiophene

Disadvantages of Sulphur components:

- 1- Corrosion the metal parts of the engine.
- 2- Reduce O.N (octane number).
- 3- Reduce oxidation resistance.
- 4- Solids deposition.

Oxygen Compounds

The oxygen content of crude oil is usually less than 2 wt%.

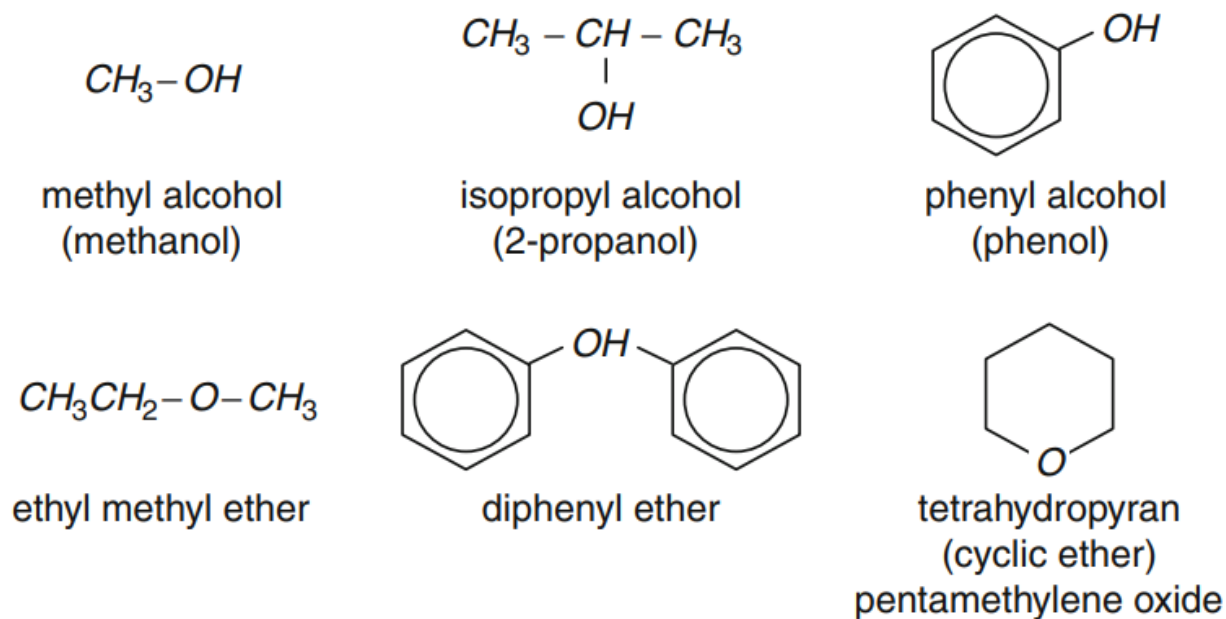
A high oxygen content indicates that the oil has suffered prolonged exposure to the atmosphere. Oxygen in crude oil can occur in a variety of forms.

These include alcohols, ethers, carboxylic acids, phenolic compounds, ketones, esters and anhydrides.

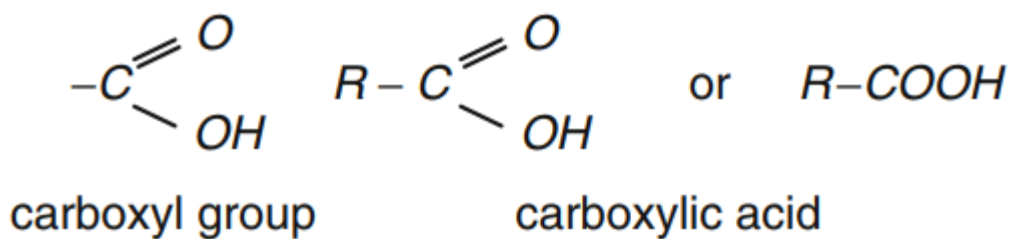
The presence of such compounds causes the crude to be acidic with consequent processing problems such as corrosion.

Alcohols have the general formula $R-OH$ and are structurally similar to water but with one of the hydrogen atoms replaced by an alkyl group. In phenols, one of the hydrogen atoms in the aromatic ring is replaced with a hydroxyl group ($-OH$).

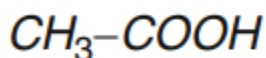
Ethers have two organic groups connected to a single oxygen atom ($R-O-R'$). Examples of alcohols, phenols and ethers are:



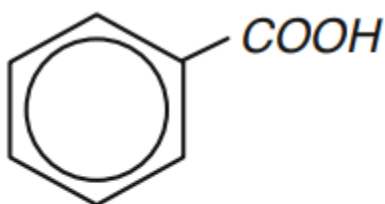
Carboxylic acids have a carboxyl group as their functional group ($-COOH$), and their general formula can be written as:



Examples of aliphatic and aromatic carboxylic acids are:

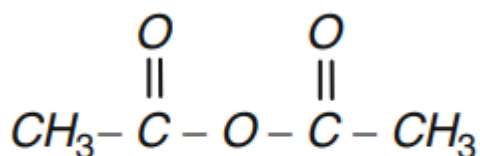


acetic acid
(ethanoic acid)



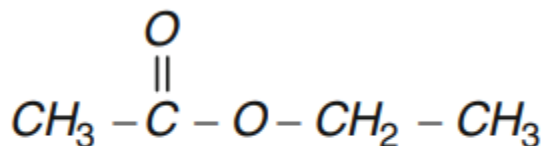
benzoic acid
(benzenecarboxylic acid)

Carboxylic acid anhydrides are formed by removing water from two carboxyl groups and connecting the fragments. The most important aliphatic anhydride is acetic anhydride.

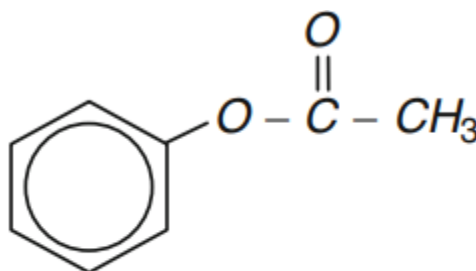


acetic anhydride
(ethanoic anhydride)

Carboxylic acid esters are formed by replacing the --COOH by --COOR group. Examples are:

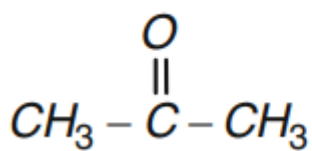


ethyl acetate
(ethyl ethanoate)

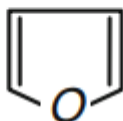


phenyl acetate

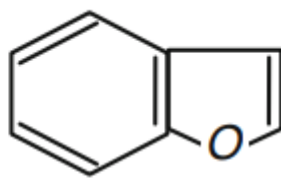
Ketones are compounds with two carbon atoms bounded to the carbon of a carbonyl group $\text{C}=\text{O}$. Furans are heteroaromatic compounds with five member oxygenated rings. Benzofuran is a furan condensed with an aromatic ring. Examples are:



dimethyl ketone
(acetone)



furan



Benzofuran

Nitrogen Compounds

Crude oils contain very low amounts of nitrogen compounds (0.1-0.9 wt% = 1000-9000 ppm).

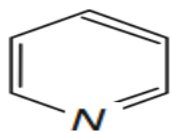
In general, the more asphaltic the oil, the higher its nitrogen content.

Nitrogen compounds are more stable than Sulphur compounds and therefore are harder to remove.

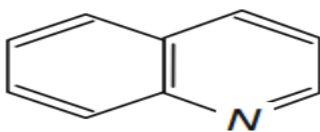
The nitrogen compounds in crude oils may be classified as

- 1- basic
- 2- non-basic.

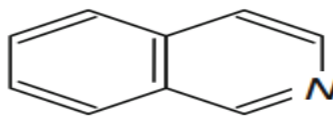
Basic nitrogen compounds consist of pyridines. Pyridines are six-membered heteroaromatic compounds containing one nitrogen atom. When fused with benzene rings, pyridines are converted to the polycyclic heteroaromatic compounds quinolines and isoquinolines.



pyridine
($\text{C}_2\text{H}_5\text{N}$)



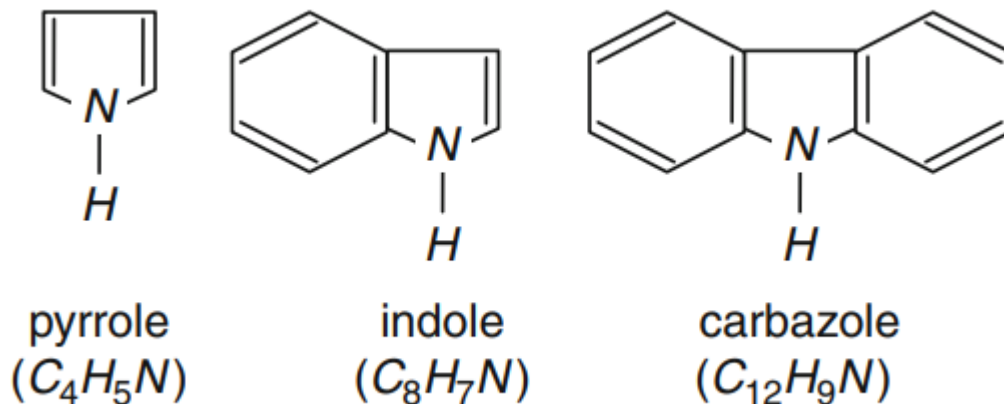
quinoline
($\text{C}_9\text{H}_7\text{N}$)



isoquinoline
($\text{C}_9\text{H}_7\text{N}$)

The greater part of the nitrogen in crude oils is the non-basic nitrogen compounds, which are generally of pyrrole types.

In non-basic nitrogen compounds, pyrroles are five-membered heteroaromatic compounds containing one nitrogen atom. When fused with benzene ring, pyrrole is converted to the polycyclic heteroaromatic compounds indole and carbazole



Disadvantages of Nitrogen components:

- 1- poisoning of a cracking catalyst.
- 2- increases carbon residue
- 3- decreases API
- 4- they also contribute to gum formation in finished products.