petroleum chemistry

Chemical engineering department

Al-Mustaqbal-college

First class

second semester

Lecture one

By

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Lecture one

Petroleum Chemistry: is made of a mixture of different hydrocarbons, The most prolific hydrocarbons found in the chemistry of petroleum are alkanes, these are also sometimes knows as branched or linear hydrocarbons.

What is Organic Chemistry?

Organic chemistry is the branch of chemistry that involves the scientific study of organic compounds (compounds that contain covalently bonded carbon atoms). This branch of chemistry primarily deals with the structure and chemical composition of organic compounds, the physical and chemical properties of organic compounds, and the chemical reactions undergone by these compounds.

Table 1: Comparison of the properties of organic and inorganic compounds

Organic Compounds	Inorganic Compounds
Use mostly covalent bonding	Mostly ionic bonding
Are gases, liquids or solids with low melting points	Are generally solids with high melting points
Mostly insoluble in water	Many are water soluble
Many are soluble in organic solvents such as petroleum, benzene and hexane	Most are not soluble in organic solvents
Solution in water generally do not conduct electricity	When dissolved in water conducts electrical current
Almost all burn	Most not combustible
Slow to react with other chemicals	Often undergo fast chemical reactions

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Q \\ What is the difference between crude oil, petroleum products, and petroleum?

Crude oil is a mixture of hydrocarbons that exists as a liquid in underground geologic formations and remains a liquid when brought to the surface.

Petroleum products are produced from the processing of crude oil and other liquids at petroleum refineries, from the extraction of liquid hydrocarbons at natural gas processing plants, and from the production of finished petroleum products at blending facilities.

Petroleum is a broad category that includes both crude oil and petroleum products. The terms oil and petroleum are sometimes used interchangeably**.**

The primary form of hydrocarbons in the chemistry of petroleum are the alkanes, which are also often named paraffin's. These are termed saturated hydrocarbons and the exhibit either branched or straight molecule chains.

The paraffin's are very pure hydrocarbons and contain only hydrogen and carbon; it is the alkanes which give petroleum chemistry its combustible nature. Depending upon the type of alkanes present in the raw petroleum chemistry it will be suitable for different applications.

Petroleum comes from many different substances, such as oil and natural gas, from which various products are derived, such as: gasoline, kerosene propane, fuel oil, lubricating oil, wax, and asphalt. These substances are mainly compounds of only two elements: carbon (C) and hydrogen (H). They are called, therefore: hydrocarbons.

Why does carbon form so many compounds?

Carbon has the ability to bond with itself to form long chains and ring structures; hence it can form molecules that contain from one to an infinite number of C atoms.

Additionally C atoms may:

- be bonded by multiple bonds (i.e. double and triple) as well as single
- contain branches of other carbon chains
- need additional atoms attached to them to make them stable. The most common of these is H, but, N, O, X, P and S also commonly occurs attached to C and may even be attached in several different ways.

Note X is the symbol for any of the halides – F, Cl, Br or I

The Rules for Drawing Organic Molecules

1. C always has four bonds. This may consist of:

    1. 4 single
    2. 1 double and 2 single
    3. 1 triple and 1 single
    4. 2 double

2. H always has one bond.

3. O always has two bonds. This may consist of:

    1. 2 single
    2. 1 double

4. X always has one bond. X = F, Cl, Br or I

5. N always has three bonds. This may consist of:

    1. 3 single
    2. 1 single and 1 double
    3. 1 triple

6. S may have 2, 4 or 6 bonds, but for this course it has 2 bonds.

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Functional Groups

The behavior of any molecule in a particular chemical environment is determined by the stability or reactivity of its bonds. Each different type of bond shows different levels of reactivity.

Generally in a molecule there is **a group of bonds that are more reactive than all the others** and this group tends to determine how the whole molecule behaves in a particular chemical environment regardless of the structure of the rest of the molecule.

Chemists call these dominant groups of atoms and bonds **functional groups** and these are used to classify organic compounds into families.

Understanding the types of reactions that functional groups undergo will enable an understanding of how an organic molecule interacts with the environment.

A carbon-carbon double bond is an example of a functional group. Organic compounds that contain a carbon-carbon double bond and no other functional group are called alkenes (a family name used to classify these compounds). All alkenes react with bromine to yield dibromoalkanes**.**

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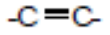
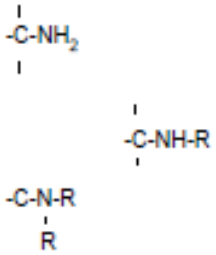
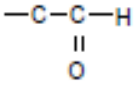
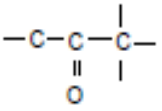
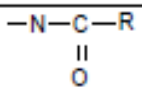
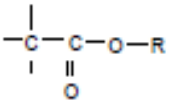
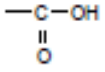
Table 2: contains a list of all the functional groups you are expected to know for this course.

Type of Functional Group	General Formula
Alkane	
Alkene	
Alkyne	
Alkanol (old name alcohol)	
Amine (Primary) Amine (Secondary) Amine (Tertiary)	
Alkanal (old name aldehyde)	
Alkanone (old name ketone)	
Amide	
Ester	
Alkanoic acid (also called carboxylic acid)	

Note 1: R is the symbol for any hydrocarbon chain.

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There are mainly three types of organic reactions:

1. **Substitution reaction :**

In which an atom or group attached to a carbon atom is displaced and replaced by another atom or group.

$CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$

2. **Elimination reaction**

This type of reaction includes a decrease in the number of groups attached to the carbon atoms as the molecule becomes unsaturated (the unsaturated property of the molecule increases).

$CH_3CH_2Br + NaOH \rightarrow CH_2=CH_2 + H_2O + NaBr$

3. **Addition reaction**

Addition reactions: This type of reaction involves increasing the number of groups attached to the carbon atoms as the part becomes saturated.

$CH_2=CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$

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Reagents in Organic Chemistry

Reagents are the chemicals that we add to bring about a specific change to an organic molecule. Any general reaction in organic chemistry can be written as:

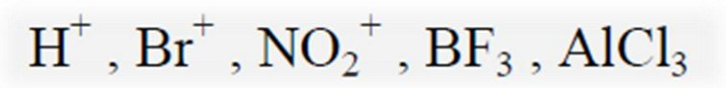
Substrate + Reagent → Product

Where the substrate is an organic molecule to which we add the reagent. Based on the ability to either donate or abstract electrons, the reagents can be classified as:

1. **Electrophiles**
2. **Nucleophiles**

1- Electrophiles

They are reagents that have the ability to accept electrons, that is, they lack electrons (it lacks a negative charge), that is, it is Lewis acid and it can be positive or neutral. It can be generalized that all types that contain a positive charge are electric compounds. For example



2- Nucleophiles

They are electron-rich organic reagents that have the ability to give an electron, that is, it is a Lewis base. It can be generalized that species that have a negative charge are nucleophiles. for example