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Comparative study of aliphatic and aromatic compounds

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Abstract
Organic Chemistry contains all the compounds made up of carbon and hydrogen, known as hydrocarbons. In this paper, there is a detailed description of aliphatic and aromatic organic compounds. Their physical properties are mentioned significantly. The differences between these two types of compounds are thoroughly discussed. Different areas of uses of these compounds are also highlighted.

Keywords: aliphatic, aromatic compounds

Introduction

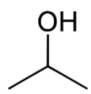
In organic chemistry, compounds are composed of carbon and hydrogen. These compounds are called hydrocarbons. These are divided into two classes: aromatic compounds and aliphatic compounds. Aliphatic compounds are also known as non-aromatic compounds. Aliphatic compound can be cyclic or not, but only aromatic compounds contain a stable ring of atoms, such as benzene. Open-chain compounds are either straight or branched. They contain no rings of any type, and are thus called aliphatic.

Aliphatic compounds can be saturated or unsaturated. Saturated compounds are made up of single bond only while unsaturated compounds are with double bonds (alkenes) or triple bonds (alkynes). Besides hydrogen, other elements can be bound to the carbon chain are oxygen, nitrogen, sulphur, and chlorine.

An aliphatic compound alkane is primarily characterized by the fact that all of the carbon-carbon bonds that make up the skeleton of the molecule are single bonds, i.e. no double or triple carbon-carbon bonds of any kind are allowed. Compounds with double bonds and triple bonds between carbon atoms are alkenes and alkynes respectively. Ring system is also possible in aliphatic compounds, e.g. cyclohexane, but no double bonds in cyclic aliphatic compounds.

Hexane is an example of saturated aliphatic compound since it only contains carbon-carbon single bonds

Aliphatic compounds don't have to be made of only carbon and hydrogen like hexane. They can also contain atoms like oxygen, nitrogen etc. Isopropanol is an example of compound which contains an alcoholic (OH) group bonded to an aliphatic carbon chain.



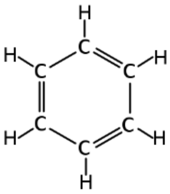
Isopropanol is an example of an aliphatic alcohol

The least complex aliphatic compound is methane (CH_4).

In organic chemistry, aromaticity is used to describe a cyclic (ring-shaped), planar (flat) molecule with a ring of resonance bonds that exhibits more stability than other geometric or connective arrangements with the same set of atoms. Aromatic molecules are very stable, and do not break apart easily to react with other substances.

Organic compounds that are not aromatic are classified as aliphatic compounds—they might be cyclic, but only aromatic rings have special stability (low reactivity).

Aromatic compounds are similar to aliphatic compounds because they both are made of carbon. However, they are also very different from one another in other ways. An aromatic organic compound is characterized by the fact that they contain both a ring structure and a network of alternating double-single-double-single bonds all around the ring. The most common example of an aromatic compound is benzene.



Benzene is an example of an aromatic compound because of its ring and alternating double and single bonds

The most common aromatic compounds are derivatives of benzene (an aromatic hydrocarbon common in petroleum and its distillates), so very first it was considered that the word aromatic means the benzene derivatives. Many non-benzene aromatic compounds also exist. For example, in living organisms, the most common aromatic rings are the double-ringed bases in RNA and DNA. An aromatic functional group or other substituent is called an aryl group.

Properties of Aliphatic Compounds:
Most aliphatic compounds are flammable. They allow the use of hydrocarbons as fuel, such as methane in Bunsen burners and as liquefied natural gas (LNG), and acetylene in welding.

Properties of Aromatic Hydrocarbons:

- The major sources of Aromatic Hydrocarbons are Petroleum and coal. They are well known for their exceptional physical and chemical properties. Poly-aromatic hydrocarbons are defined as aromatic compounds composed of more than one benzene ring. When they include in atmospheric pollution then it is known as carcinogenic in nature.
- Aromatic compounds also include amino acids and precursors to nucleotides. Compounds which are soluble in water they are known as non-polar hydrocarbons. These hydrocarbons cannot form ions or Hydrogen bonds with water molecules. They are usually unreactive because of extra stability and for many organic and inorganic reactions it is widely used as an inert solvent.
- The ratio for carbon-hydrogen is high. They are born with sooty yellow flame because of the presence of high carbon content.
- They go through electrophilic substitution reactions and nucleophile aromatic substitution.
- Hydrocarbons which have multiple bonds are unsaturated in nature like alkenes and alkynes. They tend to give addition reactions due to this unsaturation.
- Due to resonance and give characteristic electrophilic substitution reactions aromatic hydrocarbons are stable. The carbon ring acts as a nucleophile in these reactions and to form a substituted product an electrophile attack on benzene.
- With the coming electrophile, one of the H-atom of a ring is substituted because of this the product also holds its stability and aromatic in nature.
- In the addition reactions, aromatic compound may lose their aromaticity so they do not prefer to give such reactions.

Types: Aromatic compounds are always cyclic as it contains the benzene ring as part of its structure while aliphatic compounds can be linear as well as cyclic. The majority of aromatic compounds are compounds of carbon, but they need not be hydrocarbons.

Difference between aliphatic compounds and aromatic compounds: The difference between aliphatic and aromatic compounds is the arrangement of electrons. Aromatic compounds have a conjugated pi-electron system. Aliphatic compounds do not. Aromatic compounds are not just benzene; they don't have to be composed of only hydrogen and carbon. Tryptophan is aromatic, but its aromaticity is in the indole ring, and the aromaticity includes electrons from the nitrogen. They need to be "flat", and be composed of one or more rings.
Aliphatic compounds are hydrogen and carbon. Other atoms can be attached to an aliphatic molecule, but then only the part with hydrogen and carbon is aliphatic. Aliphatic compounds can be linear, circular, or branched in any number of ways. They can include single, double, or even triple bonds. As long as aliphatic compounds do not induce the pi electrons to delocalize, and become a conjugated system, then it would be an aromatic compound.
Aromatic compounds possess alternating single and double bonds. This is not true, only a depiction that makes it easier to draw. When something like nitrogen atom enters, since nitrogen donates a lone pair to the conjugate system, then this "rule" of every other being a double bond is broken.
Aromatic compounds are ring compounds whereas aliphatic compounds are straight chain. For the same number of carbon atoms, aromatics have lower boiling points than aliphatic compounds, hence they are more volatile.
Aliphatic compounds are more reactive than their (equal carbon) cousins i.e. aromatic compounds.
In case of aromatic compounds, electron pair may get involve (not in all cases, only possible in conjugated systems) in resonance, hence availability of electron over entity get decreased thereby decreases the basicity of compound. On the other hand, in aliphatic compounds, electron pair resides over the atom hence increases the density of electron and therefore increases the basicity. Thus, aliphatic compounds are more basic in nature than aromatic compounds.
Aromatic compounds need special conditions to react while aliphatic compounds react more freely and easily.
Aromatic compounds absorb UV light. Most aliphatic compounds don't, although those with 3 or more conjugated double bonds will absorb UV light.
Assuming the aromatic ring has a H atom attached to it, you will find proton NMR resonance around 7 ppm. Aliphatic compounds won't have a peak in that area.
Uses of Aliphatic and Aromatic Compounds: Aromatic compounds contain a ring of 6 carbon atoms and their carbon-carbon bonding ring is excellent for creating new, more complicated compounds like pharmaceutical drugs, pesticides, herbicides, and on and on.
Aliphatic compounds are just single bonded chain hydrocarbons. These include the simplest, methane, then

ethane, propane, butane and so forth. After butane they become liquids at room temp and usually are used as solvents in other chemistry reactions. On the commercial scale, there are reactions that use metal catalysts and other means to take methane, ethane, and propane make stuff we use in our homes, such as rubbing alcohol, acetylene for cutting steel. This is usually reserved for large scale commercial reactions. Aliphatic compounds are found in chemicals, paint and varnish, textile, rubber, plastics, dyes, dry cleaning and pharmaceuticals. Certain aliphatic compounds can be used in paraffin products and resins. They can also be used as chemical intermediates, fumigants and insecticides.

Conclusion: In organic chemistry, all the compounds are broadly divided into 2 classes: aliphatic and aromatic compounds. Aliphatic compounds are both saturated as well as unsaturated in nature while aromatic compounds are always unsaturated. Different properties of these compounds are discussed. Their differences and uses are also mentioned in this paper.

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