Saturated Hydrocarbon

Jean Brainard, Ph.D.
Learning Objectives

- Define saturated hydrocarbon.
- Explain how saturated hydrocarbons are named.
- Identify shapes of saturated hydrocarbon molecules.

You can tell that this sponge is saturated with water because when it is squeezed, the water pours out. When something is saturated with water, it already holds as much water as possible. Compounds called hydrocarbons, which contain only carbon and hydrogen, can also be saturated, but not with water.

What Are Saturated Hydrocarbons?

Saturated hydrocarbons are hydrocarbons that contain only single bonds between carbon atoms. They are the simplest class of hydrocarbons. They are called saturated because each carbon atom is bonded to as many hydrogen atoms as possible. In other words, the carbon atoms are saturated with hydrogen. You can see an example of a saturated hydrocarbon in the Figure 1.1. In this compound, named ethane, each carbon atom is bonded to three hydrogen atoms. In the structural formula, each dash (-) represents a single covalent bond, in which two atoms share one pair of valence electrons.

Q: What is the chemical formula for ethane?
A: The chemical formula is C₂H₆.
What’s in a Name?

Saturated hydrocarbons are given the general name of **alkanes**. The name of specific alkanes always ends in -**ane**. The first part of the name indicates how many carbon atoms each molecule of the alkane has. The smallest alkane is methane. It has just one carbon atom. The next largest is ethane with two carbon atoms. The chemical formulas and properties of methane, ethane, and other small alkanes are listed in the Table 1.1. The boiling and melting points of alkanes are determined mainly by the number of carbon atoms they have. Alkanes with more carbon atoms generally boil and melt at higher temperatures.

**Table 1.1**: Small Alkanes and Their Properties

<table>
<thead>
<tr>
<th>Alkane</th>
<th>Chemical Formula</th>
<th>Boiling Point(°C)</th>
<th>Melting Point(°C)</th>
<th>State (at 20 °C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>CH₄</td>
<td>-162</td>
<td>-183</td>
<td>gas</td>
</tr>
<tr>
<td>Ethane</td>
<td>C₂H₆</td>
<td>-89</td>
<td>-172</td>
<td>gas</td>
</tr>
<tr>
<td>Propane</td>
<td>C₃H₈</td>
<td>-42</td>
<td>-188</td>
<td>gas</td>
</tr>
<tr>
<td>Butane</td>
<td>C₄H₁₀</td>
<td>0</td>
<td>-138</td>
<td>gas</td>
</tr>
<tr>
<td>Pentane</td>
<td>C₅H₁₂</td>
<td>36</td>
<td>-130</td>
<td>liquid</td>
</tr>
<tr>
<td>Hexane</td>
<td>C₆H₁₄</td>
<td>69</td>
<td>-95</td>
<td>liquid</td>
</tr>
<tr>
<td>Heptane</td>
<td>C₇H₁₆</td>
<td>98</td>
<td>-91</td>
<td>liquid</td>
</tr>
<tr>
<td>Octane</td>
<td>C₈H₁₈</td>
<td>126</td>
<td>-57</td>
<td>liquid</td>
</tr>
</tbody>
</table>

Q: The **Table 1.1** shows only alkanes that have relatively few carbon atoms. Some alkanes have many more carbon atoms. What properties might larger alkanes have?

A: Alkanes with more carbon atoms have higher boiling and melting points, so some of them are solids at room temperature.

**Shapes of Alkanes**

Structural formulas are often used to represent hydrocarbon compounds because the molecules can have different shapes and a structural formula shows how the atoms are arranged. Hydrocarbons may form straight chains, branched chains, or rings (see **Figure 1.2**). You can read about each type below.
A) In a straight-chain molecule, all the carbon atoms are lined up in a row like cars of a train. The carbon atoms form the “backbone” of the molecule. B) In a branched-chain molecule, at least one of the carbon atoms branches off from the backbone. C) In a cyclic molecule, the chain of carbon atoms is joined at the two ends to form a ring. Each ring usually contains just five or six carbon atoms, but rings can join together to form larger molecules. A cyclic molecule generally has higher boiling and melting points than straight-chain and branched-chain molecules.

References

2. Jodi So. CK-12 Foundation . CC BY-NC 3.0
3. Christopher Auyeung. CK-12 Foundation . CC BY-NC 3.0