

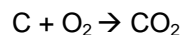
## SECTION 8: REACTOR SYSTEMS

### 8.1 CHEMICAL REACTIONS

A reactor is a *vessel* (a container such as a tank, column or tower) in which substances are brought together to produce different substances through chemical reaction. Many other items of equipment, instruments, controls, and piping are needed to maintain and control a reaction. They provide ways for raw materials to be fed (added) to the reactor and for products and by-products to be removed from the reactor. The reactor and other items needed to maintain and control the reaction are together considered a reactor system.

### 8.2 REACTANTS AND PRODUCTS

A chemical reaction is a process involving two or more substances that change into one or more different chemical substances by combining, breaking down, or interchanging components. For example, carbon (chemical symbol C) reacts with oxygen (chemical symbol O) to form carbon dioxide (CO<sub>2</sub>). The reaction is shown in the following equation:



In this reaction, the raw materials that combine are solid carbon (such as coal) and oxygen gas. Raw materials being consumed in the reaction, forming new substances, are called reactants. So carbon and oxygen are reactants in this example.

The result or product of the reaction shown is carbon dioxide. It is a chemical compound, which means that it is a substance composed of atoms of at least two different chemical elements (carbon and oxygen in this case). The compound CO<sub>2</sub> has a different physical form (it is a gas) than one of the reactants, and very different chemical characteristics from either of the reactants.

The type of reaction by which carbon dioxide is formed from carbon and oxygen is an example of *oxidation*. Oxidation involves the loss of one or more electrons by an atom or ion. The opposite reaction (the gain of at least one electron by an atom or ion) is called reduction. An example of the transfer of electrons by oxidation and reduction is provided by a galvanic cell (e.g., a battery). Oxidation occurs at the anode (the "positive" electrode) of the galvanic cell and reduction occurs at the cathode ("negative" electrode) while an electric current (consisting of electrons) passes through an electrical circuit connected between the two electrodes.

Other types of chemical reactions include cracking, polymerization, hydrolysis, and neutralization.

- Cracking is the thermal/catalytic decomposition (breaking down by heating to high temperature in the presence of a catalyst) of a complex substance, such as the cracking of crude oil to produce gasoline and other products.
- Polymerization is the combination of small units called monomers to produce long chains (polymers) such as polyethylene or polyvinyl chloride (PVC).
- Hydrolysis is the decomposition (breaking down) of a chemical compound by a reaction with water.