Oxidizing and Reducing Agents

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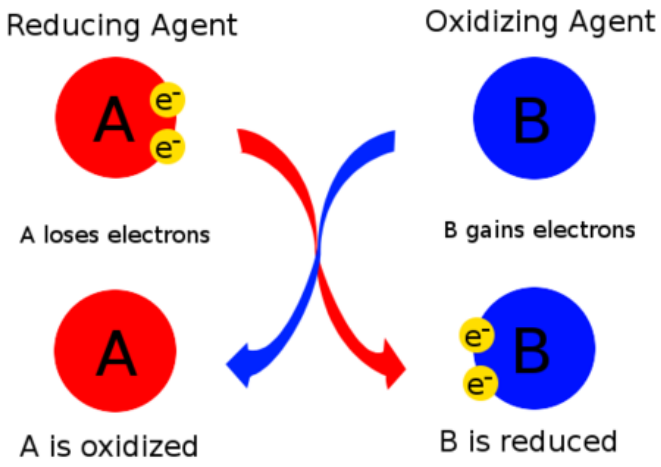
Oxidizing and reducing agents are key terms used in describing the reactants in redox reactionsthat involve transferring electrons between reactants to form products. Here, we will look at what defines an oxidizing and reducing agent, how to determine an oxidizing and reducing agent in a chemical reaction, and the importance of this concept in real world applications.

Oxidizing and Reducing Agents

An **oxidizing agent**, or **oxidant**, *gains* electrons and is reduced in a chemical reaction. Also known as the electron acceptor, the oxidizing agent is normally in one of its higher possible oxidation states because it will gain electrons and be reduced. Examples of oxidizing agents include halogens, potassium nitrate, and nitric acid.

A **reducing agent,** or **reductant**, *loses* electrons and is oxidized in a chemical reaction. A reducing agent typically is in one of its lower possible oxidation states and is known as the electron donor. A reducing agent is oxidized because it loses electrons in the redox reaction. Examples of reducing agents include the earth metals, formic acid, and sulfite compounds.



Definitions

A reducing agent **reduces** other substances and **lose** electrons; therefore, its oxidation state will **increase**.
An oxidizing agent **oxidizes** other substances and **gains** electrons therefore, its oxidation state will **decrease**.

To help eliminate confusion, here is a mnemonic device to help you remember how to determine oxidizing and reducing agents.

OIL RIG:

Oxidation Is Loss and Reduction Is Gain of electrons

Example 1

How to Identify Reducing and Oxidizing Agents

$$Cl_2\ (aq) + 2Br^-\ (aq) \rightarrow 2Cl^-\ (aq) + Br_2\ (aq)$$

Oxidation half reaction

$$2\ Br^-\ (aq) \rightarrow Br_2\ (aq)$$
Oxidation States: -1 0

Reduction Half Reaction

$$Cl_2\ (aq) \rightarrow 2\ Cl^-\ (aq)$$
Oxidation States: 0 -1

Overview

- Br^- loses an electron; it is being oxidized from Br^- to Br_2. Thus Br^- is the *reducing agent*.
- Cl_2 gains one electron; it is being reduced from Cl_2 to 2 Cl^-. Thus Cl_2 is the *oxidizing agent*.

Common oxidizing agents	Common reducing agents
O_2	H_2
O_3	CO
F_2	Fe
Br_2	Zn
H_2SO_4	Li
Halogen metals (halogen metals tend to gain an electron to get to noble gas configuration)	Alkali metals (alkali metals tend to lose an electron to get to noble gas configuration)

Applications

Oxidizing and reducing agents are important in industrial applications. They are used in processes such as purifying water, bleaching fabrics and storing energy (such as in batteries and gasoline). Oxidizing and reducing agents are especially crucial in biological processes such as metabolism and photosynthesis. For example, organisms utilize electron acceptors such as NAD^+ to harvest energy from redox reactions as in the hydrolysis of glucose:

$$C_6H_{12}O_6 + 2ADP + 2P + 2NAD^+ \rightarrow 2CH_3COCO_2H + 2ATP + 2NADH$$

All combustion reactions are also examples of redox reactions. A combustion reaction occurs when a substance reacts with oxygen to create heat. One example is the combustion of octane, the principle component of gasoline:

$$2\ C_8H_{18}\ (l) + 25\ O_2\ (g) \rightarrow 16\ CO_2\ (g) + 18\ H_2O\ (g)$$

Combustion reactions are a major source of energy for modern industry.

Summary

	Oxidizing Agents	Reducing Agents
Oxidation State	Decreases	Increases
# of Electrons	Gained	Lost
Substance is...	Reduced	Oxidized

By looking at each element's oxidation state on the reactant side of a chemical equation in comparison to the same element's oxidation state on the product side, one can determine if the element is being reduced or oxidized. Thus, one is able to conclude the oxidizing and reducing agents of a chemical reaction.

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