

REDOX PROCESSES

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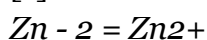
Abstract

Redox reactions, chemical reactions accompanied by a change in the oxidation numbers of atoms. The rate of oxidation does not always correspond to the strength of the oxidizing action. Conjugate oxidation by the formation of intermediate products with a higher oxidation potential in many cases is explained by the fact that an oxidizing substance (actor), acting on an easily oxidized substance (inducer), causes simultaneous oxidation of a third substance (acceptor), which itself is not oxidized or is oxidized with labor under the influence of the actor (associated reactions). This case differs from catalysis in that when the oxidation of the inductor stops, the oxidation of the acceptor stops. In typical coupled reactions it is expressed as a small integer.

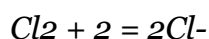
Keywords: Electrons, molecule, ion, oxygenation, simple substances, metal, non-metals, concentration, oxidative equivalent, oxidative power.

Introduction

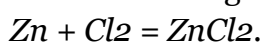
Initially (from the time of the introduction of the oxygen theory of combustion by A. Lavoisier into chemistry, the end of the 18th century), only reactions of a compound with oxygen were called oxidation, while reduction was the removal of oxygen. With the introduction of electronic concepts into chemistry (1920–30), it became possible to broadly generalize the concept of O.-v. and extend it to reactions in which oxygen is not involved. According to electron theory, oxidation is the loss of electrons by an atom, molecule or ion [1]:



Reduction is the addition of electrons by an atom, molecule or ion:

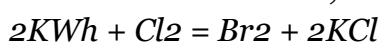
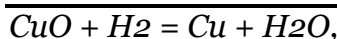


An oxidizing agent is a neutral atom, molecule or ion that accepts electrons (in the second example, a chlorine molecule Cl_2), a reducing agent is a neutral atom, molecule or ion that donates electrons (in the first example, a Zn atom). Oxidation and reduction are interrelated processes that always occur simultaneously. When one substance is oxidized, another is reduced, and vice versa. Thus, the above partial reactions of oxidation and reduction constitute a single process of oxygenation [2]:



Here Zn is oxidized to Zn^{2+} and Cl_2 is reduced to 2Cl^- .

In chemistry, redox reactions are among the most common. For example, the production of simple substances (metals and non-metals) is usually based on them.

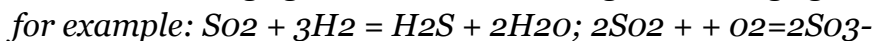


1. Oxidation. Concept and types

Oxidation is a chemical reaction of adding oxygen or removing hydrogen. For ionic processes, a more expanded formulation is generally accepted: oxidation is an increase in the positive valency (charge) or a decrease in the negative valence (charge) of the ion, for example. $\text{Fe}^{3+} \rightarrow \text{Fe}^{2+}$ during the oxidation of ferric oxide salts into oxide salts or $\text{S}^{2-} \rightarrow \text{S}^0$ in the transition from H_2S to free sulfur. Oxidation means the loss of electrons. From the condition of general electrical neutrality, it is necessary that a substance be present in this case adding an electron that increases its negative valency; it is called an oxidizing agent; it itself is reduced. Thus, the processes of oxidation and reduction are closely related and must proceed together. Example: $\text{SnCl}_2 + 2\text{FeCl}_3 = \text{SnCl}_4 + 2\text{FeCl}_2$, or (in ionic form) $\text{Sn}^{2+} + 2\text{Fe}^{3+} = \text{Sn}^{4+} + 2\text{Fe}^{2+}$ [3].

In this reaction, the tin ion is oxidized and the iron ion is reduced; iron ion is an oxidizing agent, tin ion is a reducing agent. Charge balance. It follows that a strict balance between the number of received and released charges must be maintained. This provides a simple way to find the stoichiometric coefficients of reacting molecules if the starting and final products are known. Let us have the oxidation reaction of divalent manganese in the form of $\text{Mn}(\text{NO}_3)_2$ into heptavalent manganese in the form of HMnO_4 via PbO_2 , which is reduced to $\text{Pb}(\text{NO}_3)_2$ in the presence of nitric acid.

Oxidative equivalent. The oxidative equivalent n is the number of negative charges accepted by the oxidizing agent. Oxidation-reduction reactions are used, among other things, in volumetric analysis. In the normal oxidimetric system, the number of grams equal to the molecular weight divided by the oxidative equivalent in 1 liter of solution is taken as a unit of concentration. The oxidative equivalent may vary depending on environmental conditions. Oxidative power. Equal concentrations of oxidizing agents of different chemical natures act differently, being able to oxidize one substance and being insufficient to oxidize another. Further, a substance, being an oxidizing agent for one substance in one reaction, can be a reducing agent for another, stronger oxidizing agent in another reaction [4],



A measure of the strength of the oxidative action is the oxidative potential. If you build an element with a solution of an oxidizing agent at one chemically inert electrode and a reducing agent at the other, connecting the solutions with a liquid conductor and the electrodes with a wire, then current will flow through the wire.

Conjugate oxidation reactions, in addition to the formation of an unstable form, can also be caused by the formation of complex compounds of an inductor with an actor or with an acceptor, generally when one process occurs at the expense of the energy of another, as well as during the formation of complex or insoluble compounds that remove products from the reaction sphere. When phosphorus, turpentine and some other substances are oxidized by oxygen, ozone is formed. Here, the energy released during oxidation is sufficient to carry out the $\text{O}_2 \rightarrow \text{O}_3$ process, which requires energy expenditure.

Of the cases of slow oxidation, the most important is autooxidation (Traube, cf. also Schonbein's "activated oxygen"), the mechanism of which is closely related to the conjugate oxidizer. Autooxidation refers to the oxidation of bodies with gaseous oxygen, which occurs by itself, without any additional influences. According to the now generally accepted theory of Bach and Engler, the oxidation process occurs in 2 stages: in the first, a whole molecule of oxygen is added and peroxide is formed (with a characteristic group A, it has a stronger oxidizing effect than an oxygen molecule), and therefore can oxidize a molecule of some other substance (conjugate reaction) or the same one taken for oxidation [5].

Bearing in mind that all living nature is constantly in contact with such a strong oxidizing agent as free oxygen, one can be surprised at its stability in this regard and the precise regulation of oxidation (respiration). This is explained by the action of powerful resistances, namely the presence of retarding catalysts (antioxygens no Moureu). The use of such moderators is of great practical importance: a 1% addition of alcohol to chloroform is used to protect it from rapid contamination by harmful products; the addition of 0.1% phenol to acrolein made it possible to prepare this unstable substance in large quantities. Many such examples are known, for example: Substance Moderator Na_2SO_3 Benzyl, butyl alcohols, glycerin, benzaldehyde SnCl_2 Mannitol, cresols, aniline Benzoic al-Hydroquinone dehyde Oxalic acid Quinhydrone, resorcinol Adrenaline, al-Sulfurous acid caloids Paraffin Sulfur (new .t°) Fats and oils Phenols, tannin, saligenin, acetylthiourea, etc. Silk Tin salts, rhodanates Rubber Phenols for the retarding action there are the following rules: retardation increases with the concentration of the retarding agent (Fig. 1). Retarders are substances that are themselves capable of oxidation. In some cases, substances from moderators become accelerators: iodine is a moderator for the oxidizing agent benzaldehyde, an accelerator for styrene.

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