

Chapter 12 – Nomenclature

What does the oxidation number denote?

The **oxidation number** is the number of excess or deficient electrons that an atom in a molecule (or an ion in a formula unit) possesses compared to the number of electrons that atom has in its elemental form.

The following rules must be applied to assign the oxidation number:

the atoms of a free (or uncombined) element have an oxidation number of zero;

- the oxidation number of hydrogen in compounds is +1, except in ionic hydrides, where it has an oxidation number of -1;

- the oxidation number of oxygen in compounds is -2, except in peroxides (-1) and in oxygen difluoride (+2);

- in a molecule or in a formula unit, the algebraic sum of the oxidation numbers of its atoms or ions is always zero.

How are binary compounds classified?

Binary compounds are classified as oxides, hydrides or binary salts (hydracids).

Oxides are compounds of oxygen and another element and may be acidic or basic.

Basic oxides are ionic compounds of oxygen combined with a metal.

Acidic oxides or acid anhydride are molecular compounds of oxygen combined with a nonmetal.

Hydrides are compounds of hydrogen combined with an element and may be ionic, covalent or hydracid.

Ionic hydrides are ionic compounds consisting of a metal cation and the hydride ion (H⁻).

Covalent hydrides are molecular compounds of hydrogen and a nonmetal.

Hydracids are molecular compounds of hydrogen and a nonmetal (sulphur or a halogen).

Binary salts may be neutral or acidic. Neutral salts are ionic compounds of a metal and a nonmetal. Acid salts are ionic compounds of a metal and the hydrosulfide ion (HS⁻).

According to the IUPAC nomenclature, the name of a particular oxide or hydride is made up of the term *oxide* or *hydride* preceded by the name of the other element; the number of atoms of each element in the formula of the compound is denoted by the prefixes *mono-*, *di-*, *tri-*, *tetra-*, *penta-*, *hexa-*, *hepta-*.

How are ternary compounds classified?

Ternary compounds may be categorised as hydroxides, oxyacids or oxyacid salts.

Hydroxides or bases are ionic compounds consisting of a metal cation and the hydroxide ion (OH⁻). According to the IUPAC nomenclature, the name consists of the term *hydroxide* (dihydroxide, trihydroxide) preceded by the name of the metal.

Oxyacids are molecular compounds of hydrogen, a nonmetal and oxygen. According to the IUPAC nomenclature, the name consists of the term *acid*, the prefix *monoxo* (*dioxo*, *trioxo*, *tetraoxo*), the root of the nonmetal followed by the suffix *-ic* and the oxidation number of the nonmetal.

Oxyacid salts may be neutral or acidic. *Neutral salts* are ionic compounds that derive from oxyacids. They form when all the hydrogen atoms are replaced by metal cations. The name of the compound consists of the name of the metal, the prefix *monoxo* (*dioxo*, *trioxo*) that denotes the number of oxygen atoms and the root of the nonmetal followed by the suffix *-ate*.

Acid salts are ionic compounds that derive from polyprotic oxyacids. They form when one or more hydrogen atoms are replaced by metal cations. According to the IUPAC nomenclature, the name of an acid salt is the same as a neutral salt, with the prefix *hydrogen*, *dihydrogen* or *trihydrogen* denoting the number of hydrogen atoms in the salt formula (the number of oxygen atoms in the formula does not have to be specified).

Why can chromium and manganese form ionic and molecular solids?

The chemical behaviour (metallic, amphoteric, non-metallic) of chromium and manganese changes according to its oxidation number.

Chromium in compounds may have an oxidation number of +2, +3 or +6. Chromium:

- with the oxidation number +2 acts like a metal;
- with the oxidation number +3 acts like a metal or a nonmetal, or is *amphoteric*;
- with the oxidation number +6 acts like a nonmetal.

Manganese in compounds may have an oxidation number of +2, +3, +4, +6 or +7. Manganese:

- with the oxidation number +2 or +3 acts like a metal;
- with the oxidation number +4 is amphoteric;
- with the oxidation number +6 or +7 acts like a nonmetal.