

Definition: **metallurgy** from *The Penguin Dictionary of Science*

The study of metals and alloys. It includes the extraction of metals from their ores, and the modification of alloys to produce materials with superior properties. Metallurgy is sometimes divided into ferrous and non-ferrous metallurgy, showing the dominant importance of iron and its alloys.

Summary Article: **metallurgy**

From *The Columbia Encyclopedia*

(mĕt'ĕlŭr'jē), science and technology of metals and their alloys. Modern metallurgical research is concerned with the preparation of radioactive metals, with obtaining metals economically from low-grade ores, with obtaining and refining rare metals hitherto not used, and with the formulation of alloys. Powder metallurgy deals with the manufacture of ferrous and nonferrous parts by compacting elemental metal or alloy powders in a die. The resultant shapes are then heated in a controlled-atmosphere furnace to bond the particles so that the part will retain the shape at normal temperatures and pressures. Welding and soldering (see solder) are techniques for joining metals metallurgically. Extractive metallurgy is the study and practice of separating metals from their ores and refining them to produce a pure metal. This article discusses the extraction of metals in general terms, but methods for the treatment of ores are quite diverse; see also aluminum, copper, gold, iron, lead, nickel, silver, tin, and zinc for special procedures followed.

Concentration of the Ore

When an ore has a low percentage of the desired metal, a method of physical concentration must be used before the extraction process begins. In one such method, the ore is crushed and placed in a machine where, by shaking, the heavier particles containing the metal are separated from the lighter rock particles by gravity. Another method is the flotation process, used commonly for copper sulfide ores. In certain cases (as when gold, silver, or occasionally copper occur "free," i.e., uncombined chemically in sand or rock), mechanical or ore dressing methods alone are sufficient to obtain relatively pure metal. Waste material is washed away or separated by screening and gravity; the concentrated ore is then treated by various chemical processes.

Separation of the Metal

Processes for separating the metal from the impurities it is found with or the other elements with which it is combined depend upon the chemical nature of the ore to be treated and upon the properties of the metal to be extracted. Gold and silver are often removed from the impurities associated with them by treatment with mercury, in which they are soluble. Another method for the separation of gold and silver is the so-called cyanide process. The Parkes process, which is based on silver being soluble in molten zinc while lead is not, is used to free silver from lead ores. Since almost all the metals are found combined with other elements in nature, chemical reactions are required to set them free. These chemical processes are classified as pyrometallurgy, electrometallurgy, and hydrometallurgy.

Pyrometallurgy, or the use of heat for the treatment of an ore, includes smelting and roasting. If the ore is an oxide, it is heated with a reducing agent, such as carbon in the form of coke or coal; the oxygen of

the ore combines with the carbon and is removed in carbon dioxide, a gas (see oxidation and reduction). The waste material in the ore is called gangue; it is removed by means of a substance called a flux which, when heated, combines with it to form a molten mass called slag. Being lighter than the metal, the slag floats on it and can be skimmed or drawn off. The flux used depends upon the chemical nature of the ore; limestone is usually employed with a siliceous gangue. A sulfide ore is commonly roasted, i.e., heated in air. The metal of the ore combines with oxygen of the air to form an oxide, and the sulfur of the ore also combines with oxygen to form sulfur dioxide, which, being a gas, passes off. The metallic oxide is then treated with a reducing agent. When a carbonate ore is heated, the oxide of the metal is formed, and carbon dioxide is given off; the oxide is then reduced.

Electrometallurgy includes the preparation of certain active metals, such as aluminum, calcium, barium, magnesium, potassium, and sodium, by electrolysis: a fused compound of the metal, commonly the chloride, is subjected to an electric current, the metal collecting at the cathode.

Hydrometallurgy, sometimes called leaching, involves the selective dissolution of metals from their ores. For example, certain copper oxide and carbonate ores are treated with dilute sulfuric acid, forming water-soluble copper sulfate. The metal is recovered by electrolysis of the solution. If the metal obtained from the ore still contains impurities, special refining processes are required.

Bibliography

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