

## 1: Aluminium smelting - Wikipedia

*The present volume is a collection of selected papers dealing with the extractive metallurgy of copper published by the author and his coworkers plus ten new chapters specially written. The book is fully illustrated by many coloured pictures, flowsheets, and diagrams - - should be useful for students, engineers, chemists, geologists, and for.*

An electrolysis cell is made of a steel shell with a series of insulating linings of refractory materials. The cell consists of a brick-lined outer steel shell as a container and support. Inside the shell, cathode blocks are cemented together by ramming paste. The top lining is in contact with the molten metal and acts as the cathode. The molten electrolyte is maintained at high temperature inside the cell. The prebaked anode is also made of carbon in the form of large sintered blocks suspended in the electrolyte. A single Soderberg electrode or a number of prebaked carbon blocks are used as anode, while the principal formulation and the fundamental reactions occurring on their surface are the same. An aluminium smelter consists of a large number of cells pots in which the electrolysis takes place. A typical smelter contains anywhere from to pots, each of which produces about a ton of aluminium a day, though the largest proposed smelters are up to five times that capacity. Smelting is run as a batch process, with the aluminium metal deposited at the bottom of the pots and periodically siphoned off. Particularly in Australia these smelters are used to control electrical network demand, and as a result power is supplied to the smelter at a very low price. However power must not be interrupted for more than hours, since the pots have to be repaired at significant cost if the liquid metal solidifies. The Boudouard reaction may also take place as a side reaction: Formation of CO consumes twice as much carbon as required for CO<sub>2</sub> formation. Carbon consumption shows that the primary anode product is CO<sub>2</sub>. The electrolyte is a molten bath of cryolite Na<sub>3</sub>AlF<sub>6</sub> and dissolved alumina. Cryolite is a good solvent for alumina with low melting point, satisfactory viscosity, low vapour pressure. Its density is also lower than that of liquid aluminium 2 vs 2. Aggregates are mixed with coal-tar pitch, formed, and baked. Carbon purity is not as stringent as for anode, because metal contamination from cathode is not significant. Carbon cathode must have adequate strength, good electrical conductivity and high resistance to wear and sodium penetration. Anthracite cathodes have higher wear resistance [7] and slower creep with lower amplitude [15] than graphitic and graphitized petroleum coke cathodes. Instead, dense cathodes with more graphitic order have higher electrical conductivity, lower energy consumption [14], and lower swelling due to sodium penetration. Anodes are also made of petroleum coke, mixed with coal-tar-pitch, followed by forming and baking at elevated temperatures. The quality of anode affects technological, economical and environmental aspects of aluminium production. Energy efficiency is related to the nature of anode materials, as well as the porosity of baked anodes. Inhomogeneous anode quality due to the variation in raw materials and production parameters also affects its performance and the cell stability. Prebaked anodes are divided into graphitized and coke types. For manufacturing of the graphitized anodes, anthracite and petroleum coke are calcined and classified. They are then mixed with coal-tar pitch and pressed. Coke anodes are made of calcined petroleum coke, recycled anode butts, and coal-tar pitch binder. The anodes are manufactured by mixing aggregates with coal tar pitch to form a paste with a doughy consistency. This material is most often vibro-compacted but in some plants pressed. Higher baking temperatures increase the mechanical properties and thermal conductivity, and decrease the air and CO<sub>2</sub> reactivity. Soderberg Carbon-based materials such as coke and anthracite are crushed, heat-treated, and classified. These aggregates are mixed with pitch or oil as binder, briquetted and loaded into the shell. Temperature increases bottom to the top of the column and in-situ baking takes place as the anode is lowered into the bath. Significant amount of hydrocarbons are emitted during baking which is a disadvantage of this type of electrodes. Most of the modern smelters use prebaked anodes since the process control is easier and a slightly better energy efficiency is achieved, compared to Soderberg anodes. Environmental issues of aluminium smelters[ edit ] The process produces a quantity of fluoride waste: This can be as small as 0. Unless carefully controlled, hydrogen fluorides tend to be very toxic to vegetation around the plants. The perfluorocarbons gases are strong greenhouse gases with a long lifetime. The linings of the pots end up contaminated with cyanide-forming materials; Alcoa has a process for converting spent linings into aluminium

fluoride for reuse and synthetic sand usable for building purposes and inert waste. Energy use[ edit ]  
Aluminium smelting is highly energy intensive, and in some countries is only economical if there are inexpensive sources of electricity.

## 2: Handbook of Aluminum: Volume 2: Alloy Production and Materials Manufacturing - Google Books

*Extract all the metals information you need! A wealth of data on metals and their extraction is revealed in this comprehensive handbook. The aim of this book is to provide a clear description of how a particular metal is extracted industrially from different raw materials, and on what its important compounds are.*

Stainless steel, which contains chromium and sometimes nickel and manganese, is a hard, strong alloy that resists heat and corrosion. Stainless steels are used for such things as jet engines, automobile parts, knives, forks, spoons, and kitchen equipment. Wrought iron is practically pure iron, low in carbon, manganese, sulfur, and phosphorus, but contains an appreciable amount of slag in mechanical admixture. Its desirable properties are due to the fibrous structure of this slag which gives it excellent resistance to shock and vibration, making it particularly suitable for the manufacture of such products as engine bolts, crane hooks, lifting chains and couplings. Wrought iron is readily welded, and the presence of slag makes it self-fluxing. It is readily machinable and cuttings are sharp and clean because the chips crumble and clear the dies instead of forming long spirals. Wrought iron is made from pig iron by melting in a furnace lined with ferrous oxide. Under these conditions, the entire carbon content of the pig iron is oxidized and removed, as well as most of the other impurities while silicon forms slag. As a result, the melting point of the mass increases and a sticky lump is obtained saturated with slag. The form in which carbon is present in the cast iron determines its properties. Produced by melting pig iron, scrap iron, and steel mixture to give the cast iron composition. Both properties make it a useful material for the construction of machinery by casting. It is readily machinable due to graphite flakes and is an economic material since it has a low melting point of about DC. It has, however, poor toughness and limited tensile strength. Produced by melting pig iron and steel scrap. After solidification no carbon is precipitated but remains in combination as iron carbide. It is hard, brittle, and unmachinable. It is used for making grinding balls, dies, car wheels, but mostly used for making malleable cast iron. Prepared from white cast iron by annealing for several days, whereby iron carbide is decomposed into iron and graphite in form of nodules. It is more ductile and more resistant to shock than grey cast iron. It is used in large quantities for such materials as pipes and pipe fittings and the automotive industry requiring higher mechanical properties. It is a high-carbon ferrous product containing graphite in the form of spheroids. The spheroid is a single polycrystalline particle, whereas the nodule is composed of an aggregate of fine flakes. Ductile cast iron has all the advantages of cast iron, e. It is used by the automotive, agricultural instruments and railroad industries, pumps, compressors, valves, and textile machinery. This addition catalyzes the decomposition of carbon into spheroids and not flakes. High-purity iron possesses temporary magnetism, i. Carbon iron alloys on the other hand, show permanent magnetism. For this as well as for other reasons, e. Preparation of pure iron is a tedious process that requires special techniques and numerous operations. This classification is arbitrary since one metal may be placed in two groups, e. The term "rare metals" is sometimes applied to the refractory, scattered, radioactive, and the lanthanides collectively. This terminology is misleading because such metals are not rare; it may be the difficulty in their extraction and uncommon utilization that give the impression that they are rare. From the beginning of the Nineteenth Century, copper, nickel, lead, zinc, and tin and their alloys found use as substitutes for iron in industrial applications that required particular properties in which cast irons and steels were lacking. That is one reason why these metals are known as primary metals. Commercial classification of nonferrous metals and metalloids. Mainly by-products of primary metals but also form their own deposits. Used in almost equal amounts thousand tons annually. Low specific gravity below 4. Do not rust; highly priced. Melting points above DC. Mainly used as alloying elements in steel but also used in the elemental form. Some resist high temperature without oxidation. Do not form minerals of their own. Some of them U, Pu, and Th undergo fission. Plutonium prepared artificially in nuclear reactors. Always occur together, similar chemical properties. Not rare as the name implies. Soft and highly reactive. Higher melting point and less reactive than the alkali metals Handbook of Extractive Metallurgy Table 1. Typical uses of primary metals.

**3: "Handbook of Extractive Metallurgy, Volume 2 " by Fathi Habashi**

*Handbook of Extractive Metallurgy Edited by Fathi Habashi Volume 11 In a Mg A Mg. n a o g Cd co Ni Rb Sr s Ba. Handbook of Extractive Metallurgy, Volume 2.*

The reactions of chalcopyrite with chlorine are also of interest [75]: The recently proposed thermoelectron chlorination process is another variation [76]: Another approach, to avoid converting, proposed the electrolysis copper matte [77]. Around , reverberatory furnaces were constructed in which the ore was processed by roasting reaction, the so-called English or Welsh copper smelting process, originally with ten process steps. The large blast and reverberatory furnaces of the 20th century were derived from these principles. Later, the electric furnace for matte smelting was developed. If only fine concentrates are available, they must first be agglomerated by briquetting, pelletizing, or sintering. Because of this additional step and its overall low efficiency, in the last decades, the blast furnace lost its importance for primary copper production and currently is obsolete and, thus, used in only a few places. Smaller types of blast furnace, however, are used to process such copper-containing materials as intermediate products e. The construction of the furnace is basically related to that of the iron blast furnace, but there are considerable differences in design, especially in size and shape: Recent developments in the steel industry have been adopted, including use of preheated air hot blast , oxygen-enriched air, and injection of liquid fuels. The furnace is charged with alternate additions of mixture copper-containing materials and accessory fluxes such as silica, limestone, and dolomite and coke which serves as both fuel and reducing agent. There are three zones in the furnace: II In the heating zone the uppermost , water evaporates and less stable substances dissociate. II In the reduction zone, heterogeneous reactions between gases and the solid charge take place. II In the smelting zone, liquid phases react The usual mode of operation is reducing smelting, which yields two main products. In contrast, oxide ores are processed directly to impure black copper:: The two ore types can be smelted together to produce matte and a slag with low copper content Another product is top gas, which contains flue dust. Ores that contain high concentrations of arsenic and antimony also form speiss, which is difficult to decompose. Since that time, the number has declined as a result of severe competition from modern autogenous smelting processes. The reverberatory furnace erected in Sar Chesh- Copper meh, Iran, a few years ago was probably the last of its type. In contrast to the reducing operation in a blast The largest units, with hearth areas up to  $m^2$  , are up to 38 m long, 11 m wide, and ca. The construction scheme is shown in Figure 8. The internal furnace walls have a refractory lining ,of basic brick, preferably magnesite brick, for prolonged operating life; in addition, water jackets are provided for protection of sidewalls, and the suspended arch is made with exchangeable bricks. Throughput can attain tid and consists of concentrates with fluxes silica and limestone and copper-rich converter slag. The treatment of sulfide concentrates depends on the sulfur: If the sulfur content is too high, the material must be partially roasted to remove excess sulfur and to obtain an optimum composition for the formation of matte. This process is called a hot-calcine-charged operation. On the other hand, if the S: Cu ratio is in the proper range, no special pretreatment of the concentrate is required and the cold-wet-charged or green-charged operation can be used. A combined action of the two methods has been demonstrated [78]. A special problem with reverberatory furnaces is the formation of high-melting magnetite, which can lead to operational problems and even furnace shutdown. Because of roasting, calcine charging produces more magnetite than does green charging. The charge is passed into the part of the furnace near the burners, either through central or lateral openings in the roof or through the sidewalls, as shown in Figure 8. Fuel pulverized coal heavy fuel oil or natural gas and combustion air are injected at the front; the maximum flame temperature exceeds The front part of the furnace functions as a melting zone, and the back half as. The depth of the molten bath is generally cm for slag and cm for matte. The reverberatory process has the highest energy consumption of all proven pyrometallurgical copper matte smelting methods. A green-charged furnace consumes ca. Schematic longitudinal and cross-section views through a reverberatory furnace [46]. New developments derived from the principle of reverberatory smelting eliminate these disadvantages, chiefly by using oxygen and rebuilding extant furnaces. Some of these developments are the following: Several plants have been built on this

principle: While the conventional reverberatory furnace is primarily a physical melting apparatus, the new variant is an efficient chemical reactor. This operation was a transition stage to the autogenous flash smelting processes and was first employed at the Morenci smelter, New Mexico, United States. The molten bath is intensively agitated by air, which is blown through tuyeres arranged in series. This method is said to have twice the smelting capacity of conventional operations. The Scandinavian countries were the first to do electric matte smelting: Electric furnaces have the rectangular ground plan and the dimensions of larger reverberatory furnaces. Along the centerline, up to six Soderberg continuous self-baking electrodes are used with alternating current Table 8. The largest furnace of this type in the world, at the Inspiration smelter in Arizona, has an electrical power input of 51 kVA [ ]. Two examples of electric matte smelting furnaces.

Company and plant location	Inside dimensions, m	Electrical load, kVA	Length	Width	Height	Electrodes
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**4: Handbook of extractive metallurgy - Fathi Habashi - Google Books**

*Sulfide ores are used to produce a matte (% Cu) and a disposal slag (www.enganche cubano.com of Extractive Metallurgy  $CuFeS_2 + 2Cl_2 \rightarrow 7CuCl + FeCl_3 + 2S$  Electrolysis. and nearly thrice the energy input of the Outokumpu flash smelting furnace.*

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The collection gives a rapid and fully illustrated review of the history and extractive metallurgy of aluminum. A selected collection of papers by the author and his co-workers to which an outline on the recovery of rare earths from different sources has been specially written. The position of rare earths in the Periodic Table is also discussed. *Chalcopyrite. Its Chemistry and Metallurgy* by Fathi Habashi, pages. *History, Chemistry, and Metallurgy* by Fathi Habashi, pages. The book contains articles on the history and structure of asbestos, surface modification of its surface by organic dyes, and the toxicity issue. Published by St. Boyan Kamenov Street, Sofia, Bulgaria. The book is in 8 chapters: Energy Basis of Flotation 3. Basics of Minerals Dissolution and Leaching 5. Beloglazov, and Arnold A Galnbek. Quebec City September 2 - 7, Volume 1, edited by Fathi Habashi. Chemecon Publishing Limited, London, General, Cerium Volume 4, pages - Ferroalloy Metals: Ministry of Metallurgy, Beijing, China and Moscow, Russia

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*handbook volume 1 and volume 2. In this context, a brief overview of the metallurgy of titanium and its alloys is also Habashi F () Handbook of extractive metallurgy, vol 2.*

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