

In the name of God



Technical English Language

for Materials Engineering and Metallurgy

Lesson 4: Extractive Metallurgy

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Fall 2024

1. Introduction to Extractive Metallurgy

Extractive metallurgy is the practice of extracting metal from ore, purifying it, and recycling it. Most metals found in the Earth's crust exist as oxide and sulfide compounds. These mineral compounds must be reduced to liberate the desired metal. The reduction of these compounds can be carried out through either electrolytic or chemical processes, and extraction of some metals employs both methods. Chemical reduction includes reductive smelting and autoclave hydrogen reduction. Electrolytic reduction consists of simply passing a current through a dissolved or molten metal oxide to produce the neutral metal. Before the reduction of the compounds can be undertaken however, it is often necessary to separate the metal compounds from the raw ore. This mineral processing can consist of both physical and chemical treatment of the metal ore.

Extractive metallurgical technologies are divided into three groups: mineral processing, hydrometallurgy and pyrometallurgy. Extractive metallurgical and mineral dressing operations can be divided into two main categories, ferrous metallurgy, which includes reduction of iron ore into iron, and further refinement and alloying with other metals to make steel and non-ferrous metallurgy, which includes all other metals.

The non-ferrous category can be further broken down into extraction of precious metals, or the recovery of gold and silver and the platinum group metals; extraction of base metals which is the recovery of lead, zinc, copper, and nickel and ultimately extraction of light metals includes the recovery of magnesium, aluminum, tin, and titanium. Iron is produced in a blast furnace, schematically shown in the Fig. 1.

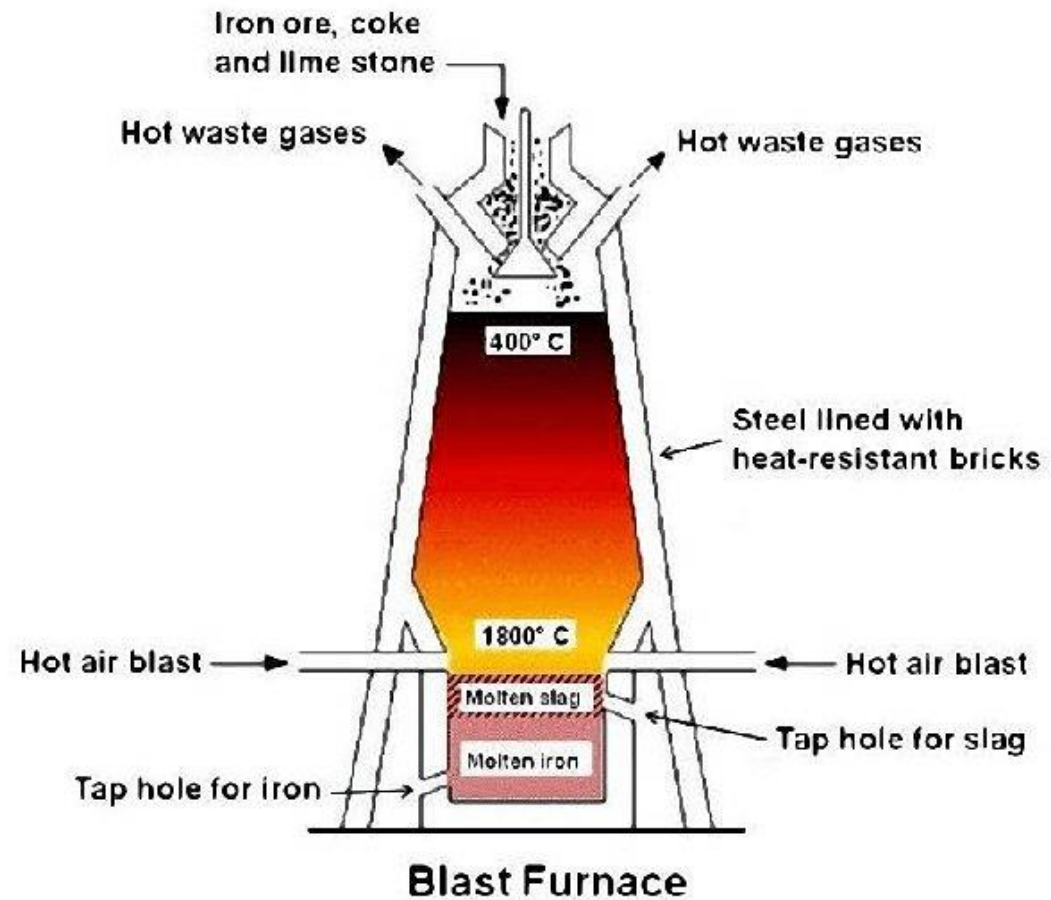


Fig. 1. Producing iron in a blast furnace.

2. Mineral processing

Mineral processing involves the use of physical and chemical processes to manipulate ore particle size, and concentrate valuable minerals using the processes of separation, based on such properties of the ore, as density, chemical composition, electrostatic, magnetic or fluorescence properties. A good example of a separation process is froth flotation. Also of interest to the mineral processor is the separation of mineral solids from water and aqueous solutions by thickening, filtering and drying. Geometallurgy is the combination of geology, geostatistics and mineral processing.

3. Pyrometallurgy

Pyrometallurgy involves the treatment of ores at high temperature to convert ore minerals to raw metals, or intermediate compounds for further refining. Roasting, smelting and converting are the most common pyrometallurgical processes. A roasting process is used to extract metals from sulfide ores: in this process, the ore is heated in the presence of oxygen and the sulfur is oxidized and driven off as sulfur dioxide. Some metals in this process remain in the sulfide form, while other metals are turned into an oxide form. The desired metal may be in either product.

Oxidative smelting and converting are similar to the roasting process, but differ slightly in the way that the processes' temperatures are high enough to promote melting of materials. Some minerals are more resistant to oxidation, so they remain in the sulfide form, while other minerals are completely oxidized and form compounds with additives, often called flux. Molten sulfides and oxide compounds split in two layers because of the different specific weights. The byproducts created in these operations, sulfur dioxide and carbon dioxide, are major pollutants.

4. Hydrometallurgy

Hydrometallurgy includes the use of aqueous solutions to extract metals or compounds from their ores. Some of the hydrometallurgical processes contain leaching, precipitation of insoluble compounds, metal recovery. Biohydrometallurgy is a sub topic of hydrometallurgy; this uses microbes to extract metals or metal compounds from the raw ore. Leaching is a process for chemical dissolution of the desired minerals in aqueous solutions. Due to the difference in the dissolution rates, it is possible to separate the compounds of different metals. Often, some oxidative reagents need to be added to promote leaching.

5. Chemical and Electrolytic Reduction

Chemical reduction can be carried out in a variety of processes, including reductive smelting, the process of heating an ore with reducing agent (often, coke or charcoal) and purifying agents to separate the pure molten metal from the waste products. Some other processes for chemical reduction include autoclave hydrogen reduction and converting.

Electrolytic reduction involves passing a large current through a molten metal oxide or an aqueous solution of the metal's salt. For example, aluminum is electrolyzed from aluminum oxide dissolved in molten cryolite via the Hall-Heroult process.

1. Calcination occurs in two stages with most of the water of being removed in the temperature range 400-600 °C.

- ✓ a) Crystal b) Crystalline c) Crystallization d) Crystallized

2. Aluminum is the most metal in the earth's crust (8%) and only oxygen and silicon are present in larger amounts.

- a) abundantly b) abundancy c) abundance ✓ d) abundant

3. is a heating process used primarily to remove sulfur from the ore.

- ✓ a) Roasting b) Reaching c) Casting d) Agglomeration

4. Until this century, aluminum was a rare metal in a state, even though large of it exist in nature.

- ✓ a) pure, amounts b) perfect, ores c) single phase, pits d) solid, mountains

5. When ores are in water or another the process is known as leaching.

- a) poured, liquid ✓ b) solved, solution c) dissolved, solvent d) boiled, dissolution

6. In steelmaking, desulphurization is the of sulfur from molten iron.

- a) inserting  b) removal c) building up d) accumulating

7. In the blast furnace, iron oxide is by CO and solid carbon.

-  a) reduced b) prepared c) contacted d) converted

8. means the conversion of a substance from a liquid or solid state to a gaseous or vapor state by the application of heat without any chemical reactions.

- a) Decomposition b) Penetration  c) Volatilization d) Ventilation

6. Selected vocabulary

En	Fa	En	Fa
Blast furnace	کوره بلند (دمشی)	Wastewater	پساب
Calcination	تکلیس	Enrichment	غنی سازی
Flotation	شناورسازی	Pollutant	آلوده کننده
Refining	تصفیه کردن	Reagent	واکنشگر
Extraction	استخراج	Aqueous	آبی
Ferrous	آهنی	Mineral	معدنی
Leaching	سنگشویی	Organic	آلی
Ore	سنگ معدن	Additive	افزودنی
Purification	خالص سازی	Charcoal	زغال چوب
Recycling	بازیافت	Direct reduction	احیای مستقیم
Roasting	تشویه	Separation	جدایش
Volatilization	تبخیر	Slag	سرباره
Smelting	گداختن	Precious metals	فلزات با ارزش
Wastage	ضایعات، هدررفت	Sustainability	پایداری