

I | What is Iron and Steel Slag?

1

Types of Slag:

Slag Derived from Metal Production Processes and Slag Derived from Waste Heat Melting Processes

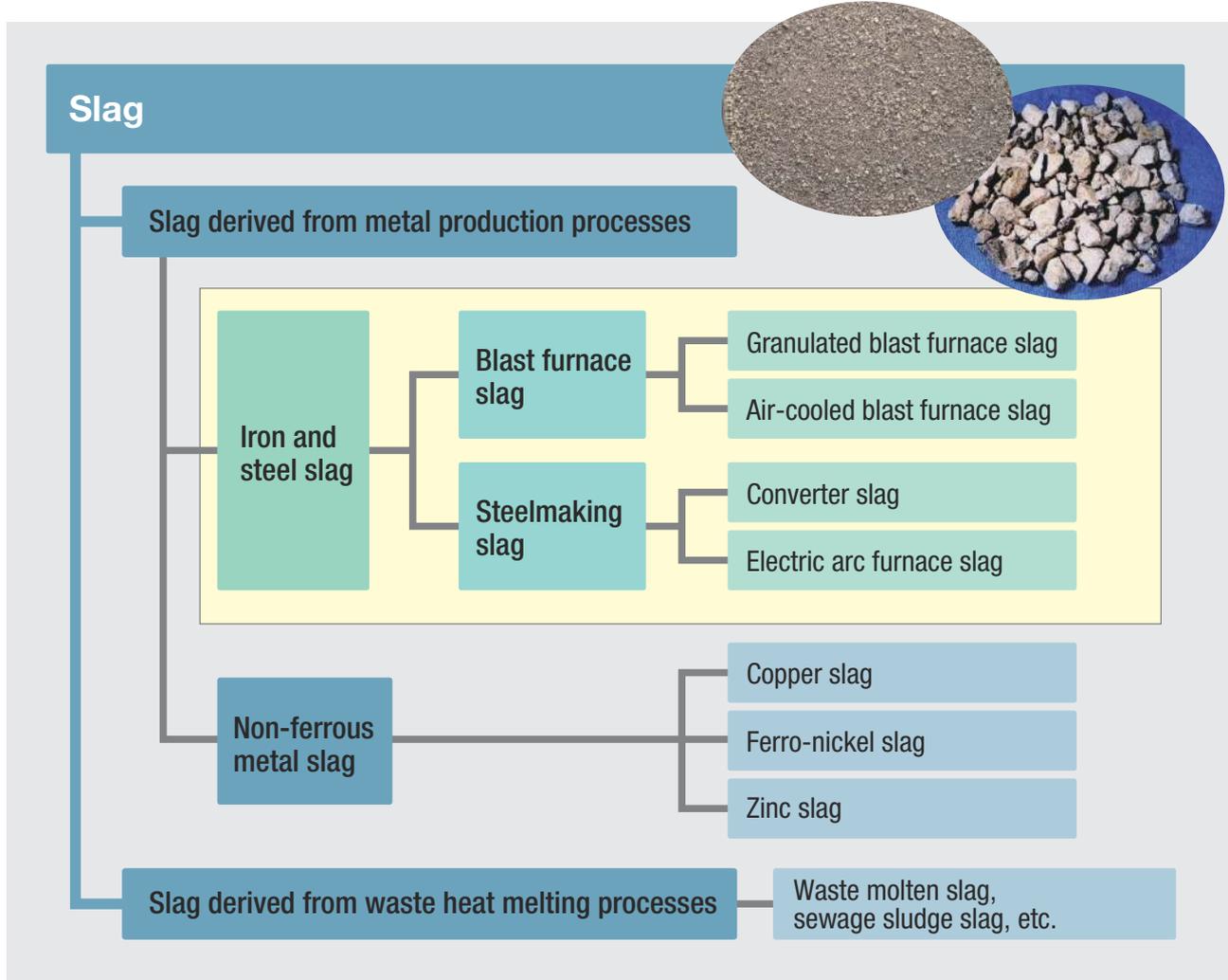
Slag is produced when specific components are melted and separated during the reduction and refining of metal from ores.

Slag originally refers to substances derived from metal production processes. However, in recent years, substances generated from waste incineration facilities through waste heat melting processes are also referred to as slag. Furthermore, slag from metal production processes is classified into iron and steel slag and non-ferrous metal slag. Iron and steelmaking slag specifically

refers to slag produced during the production of steel products.

Iron and steel slag is a by-product formed when components other than iron, such as silica (SiO_2), melt and combine with lime (CaO) during the reduction and refining stages of steel production from iron ores. Iron and steel slag is utilized as an “earth-friendly material” capable of achieving energy and resource conservation, as well as CO_2 reduction.

Types of Slag



2

Processes Involved in the Production of Iron and Steel Slag

Limestone, an auxiliary raw material in steelmaking, as the origin of iron and steel slag

Although limestone may initially seem unrelated to steelmaking, it is an essential auxiliary raw material in the steelmaking process.

The limestone traditionally used by the Japanese steel industry has been mined domestically. Coral reefs and limestone on the oceanic plate in the Pacific were incorporated into the ground of the Japanese archipelago as one plate moved under another along the archipelago. Japan still boasts a rich limestone reserve to this day. Japanese limestone, formed in the vast ocean with few impurities, is even exported overseas due to its high quality.

Limestone is added during the reduction of iron ore to remove impurities such as silica and alumina (Al_2O_3) present in the ore. As it combines with these impurities, limestone forms a molten substance with a low melting point, which facilitates the separation and collection of these impurities from the iron. The collected material becomes iron and steel slag.

Limestone



Processes of Iron and Steel Slag Formation

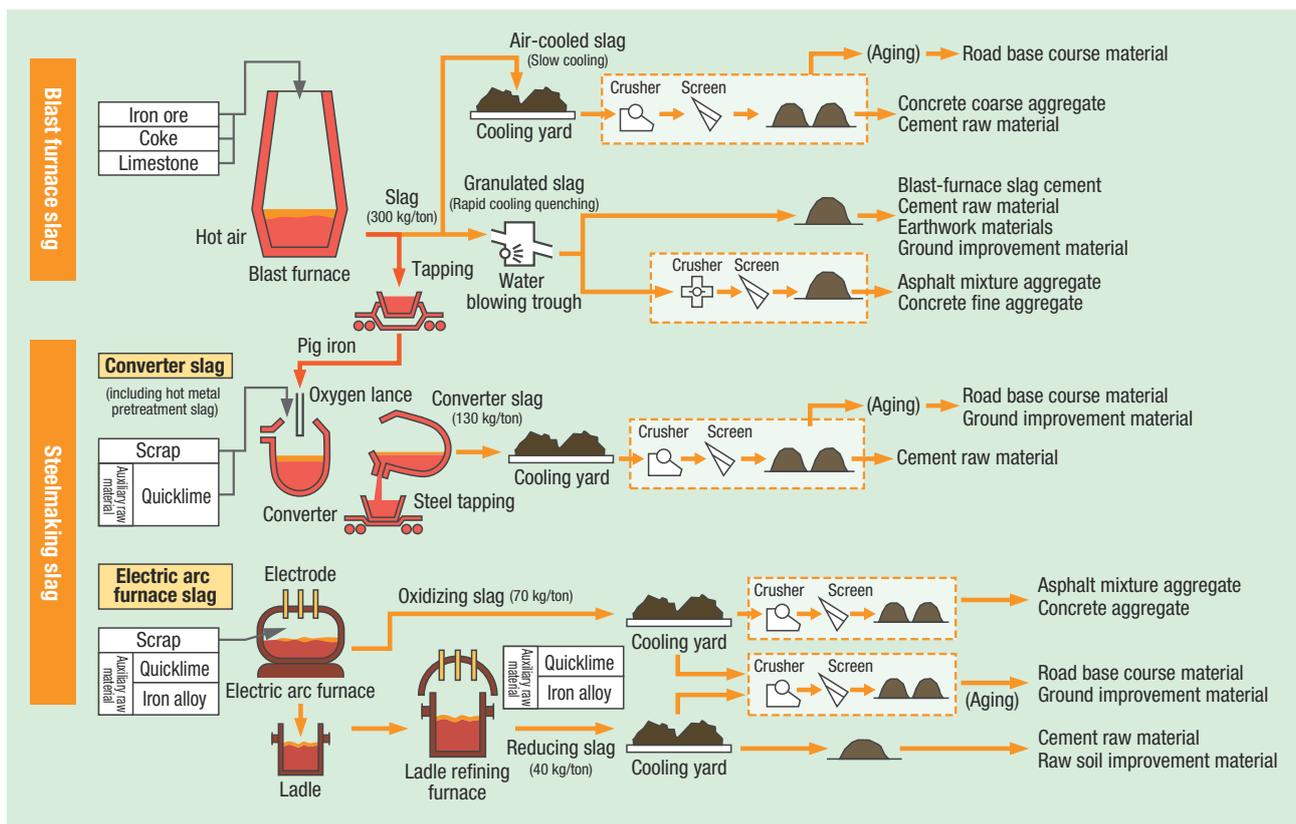
Iron and steel slag can be broadly classified into blast furnace slag, which is produced during the melting and reduction of iron ores in blast furnaces, and steelmaking slag, which is produced during the refining stage of iron. Blast furnace slag is produced when components other than iron in iron ores, such as silica, and the ash content of coke used as a reduction material combine with limestone. In its molten state, blast furnace slag floats on the surface of pig iron, making it easy to separate and collect. Approximately 300 kg of blast furnace slag is produced per ton of pig iron. The slag extracted from the blast furnace is in a molten state at approximately 1,500°C and forms different types of slag with varying characteristics depending on the cooling method (see p.10 for details). Steelmaking slag is produced in the steelmaking process,

which converts pig iron generated in blast furnaces into steel, which is known for its high toughness and machinability. Steelmaking slag is classified into converter steelmaking slag, which is produced during the refining process of pig iron by blowing oxygen and adding auxiliary raw materials such as lime to remove impurities like carbon, phosphorus, and sulfur, and electric arc furnace slag, which is produced when melting and refining iron scrap (see p.11 for details). Approximately 120 kg of steelmaking slag is produced per ton of crude steel.

Chemical Composition of Iron and Steel Slag

Iron and steel slag primarily consists of lime (CaO) and silica (SiO₂). Other components include alumina (Al₂O₃), magnesia (MgO), and a small amount of sulfur (S) in blast furnace slag, and iron oxide (FeO) and magnesia

Iron and Steel Slag Products Production Flow



(Note) In blast furnaces producing pig iron and blast furnace slag, recycled resources such as waste plastic are effectively utilized as auxiliary raw materials.



(MgO) in steelmaking slag.

In the case of steelmaking slag, many metal elements are incorporated into the slag in the form of oxides. Because of the short refining time and high lime content, some of the limestone in the auxiliary raw materials may remain undissolved as free lime (free-CaO).

These components naturally exist in the Earth's crust, natural rocks, minerals and the chemical composition is similar to that of ordinary Portland cement. The shape and physical characteristics of iron and steel slag are similar to those of crushed stone or sand. However, a wide variety of unique characteristics can be given to slag by using different chemical components and cooling processes. For example, some types of slag have a hardening characteristic when stimulated by alkalinity. In this way, various applications have been developed that take advantage of the physical and chemical characteristics of slag and they have been used in a wide range of fields.

Example Compositions of Iron and Steel Slag

(Unit: mass %)

Component	Type	Blast furnace slag	Converter slag	Electric arc furnace slag		Andesite	Ordinary Portland cement
				Oxidizing slag	Reducing slag		
CaO		41.7	45.8	22.8	55.1	5.8	64.2
SiO ₂		33.8	11.0	12.1	18.8	59.6	22.0
T-Fe		0.4	17.4	29.5	0.3	3.1	3.0
MgO		7.4	6.5	4.8	7.3	2.8	1.5
Al ₂ O ₃		13.4	1.9	6.8	16.5	17.3	5.5
S		0.8	0.06	0.2	0.4	—	2.0
P ₂ O ₅		<0.1	1.7	0.3	0.1	—	—
MnO		0.3	5.3	7.9	1.0	0.2	—