Reducing Generation/Discharge of Byproducts at JFE Steel

JFE Holdings				
JFE Steel	JFE Engineering	Kawasaki Microelectronics	JFE Urban Development	JFE R&D

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The steel manufacturing process generates various byproducts, including slag,*1 dust, and sludge.*2 In 1996, the Japan Iron and Steel Federation established a Voluntary Action Plan with a target of reducing landfill disposal in FY2010 by 75% in comparison with FY1990, to a total amount of 500,000 tons.

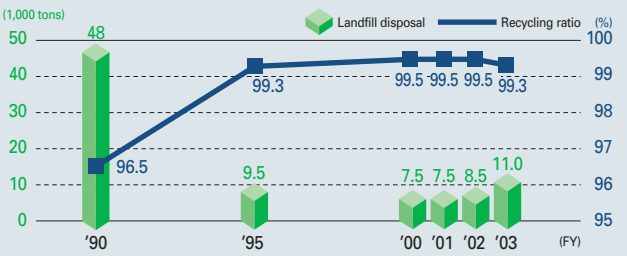
JFE Steel began Zero Waste Activities in advance of the industry, constructing a recycling system which uses generated byproducts in the works as raw materials for steel manufacturing, and now recycles more than 99% of the byproducts generated in its steel manufacturing processes. The company has also made efforts to reduce the amount of byproducts generated, and is helping to reduce landfill disposal by positively developing applications/expanding the market for recycled products made from slag, which accounts for the largest part of steel works byproducts.

Although crude steel production increased by about 2% in comparison with FY2002, in FY2003, total amount of byproducts decreased to approximately 15.6 million tons, 400,000 tons reduction from FY2002, by reducing slag generation. However, higher crude steel production caused an increase in byproducts having low recycling ratios such as dust and sludge. As a result, landfill disposal increased by 25,000 tons from FY2002, reaching 110,000 tons (77% reduction from FY1990). Combining these results, JFE Steel's recycling ratio for FY2003 was 99.3%. In the future, JFE Steel will continue its efforts to reduce landfill disposal.

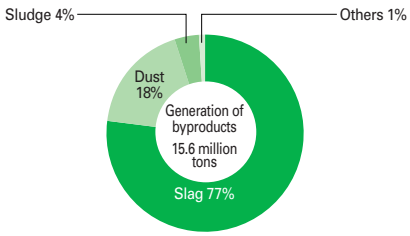
***1) Slag**
Material consisting of non-iron rock components in iron ore, and lime, etc. added to remove impurities such as phosphorus during steel refining. It separates from and floats on the molten metal, enabling deslagging. Slag is processed into fine particles and lumps as material for cement, civil works, fertilizer, etc.

***2) Sludge**
Material remaining after dewatering of the mud-like substance separated and removed by circulating water/waste water treatment equipment. Although sludge consists mainly of iron, in some cases it also contains components which affect blast furnace operation and the quality of steel products and therefore cannot be completely recycled. Technologies for removing harmful components are being developed.

Transition of landfill disposal/recycling ratio



Breakdown of steelworks byproducts in FY2003 (dry base)



Example of Zero Waste Activities (1): Reducing Generation of Byproducts

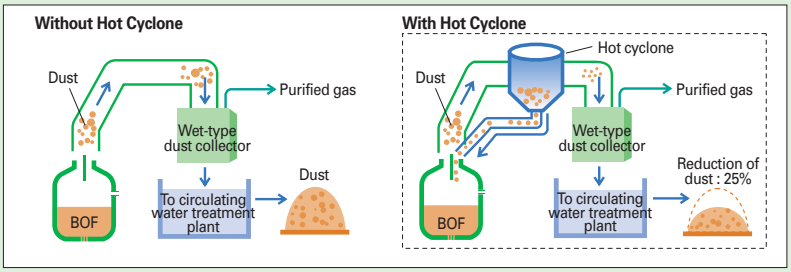
Development/Introduction of Hot Cyclone Equipment for Reducing Dust Generation

JFE Steel is developing technology and equipment to reduce dust generation. In 2001, Hot Cyclone equipment, which reduces steelmaking dust generation by the BOF in the stainless steelmaking process, was developed and installed at East Japan Works (Chiba).

In this advanced stainless steelmaking process, refining is performed by oxygen blowing, using chromium ore, carbon, and molten iron as raw materials, but dust is also generated. Formerly, this dust, together with the gas generated by the BOF, was cooled with water and recovered by dust collection, treated by the circulating water treatment equipment, then dewatered and recycled to the reducing furnace. However, problems remained, as the amount of generated dust was large and the dust was oxidized by contact with the air in the recycling process.

With the Hot Cyclone, relatively coarse dust is captured near the top of the BOF and returned directly to the BOF while still at high temperature, resulting in a final reduction of more than 25% in the dust which must be treated in the water treatment process.

Moreover, because the captured dust does not pass through the water treatment process, dewatering is unnecessary, and oxidation does not occur because the dust is recycled to the BOF without contact with the air, eliminating the need for reduction. These features also contribute to energy saving.



Zero Waste Activities (2): Recycling of Byproducts in Steel Manufacturing Process

Use of Sludge as Hot Metal Pretreatment Material

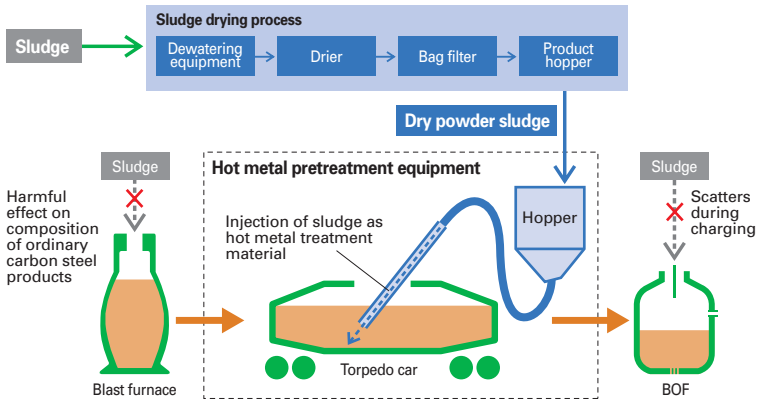
Among the byproducts generated in steel manufacturing processes, sludge is particularly difficult to recycle. JFE Steel has therefore actively conducted research and development on sludge recycling.

For example, if the sludge generated in rolling stainless steel sheets (called "stainless sludge") is used as material in the blast furnace, it may affect the composition of the pig iron in the furnace as a whole, resulting in a composition unsuitable for ordinary carbon steel products. On the other hand, when used as a BOF material, particles of stainless sludge tend to scatter during charging due to their extremely small size.

East Japan Works (Chiba) therefore developed a technology for recycling sludge in the hot metal pretreatment process, which is an intermediate process between the blast furnace and BOF. Stainless sludge is dried and injected in powder form as a hot metal treatment material, solving the problems mentioned above. Drying and use as powder also increase its effectiveness in hot metal treatment.

East Japan Works (Chiba) installed a sludge drying facility with 16,000-ton/year capacity and began full-scale recycling of stainless sludge in hot metal pretreatment in FY2002, thereby increasing sludge recycling.

Flow of sludge recycling in hot metal pretreatment process



Efforts to Reduce Byproduct Discharges: Promoting Byproduct Recycling outside the Company

Development and Expanded Application of Recycled Slag Products

Slag generated by blast furnaces, BOFs, and electric furnaces accounts for about 80% of steel manufacturing byproducts. JFE Steel is developing products using slag and encouraging expanded use by establishing technologies for recycling slag in roadbed material, concrete aggregate, raw material for cement, etc., achieving virtually 100% recycling of the slag generated in steel manufacturing processes, and is also working to expand use through standardization of recycled slag products under JIS.

At present, the slag generated by East Japan and West Japan Works is used in a variety of recycled products and, under Japan's Green Purchasing Law,[*1] is specified as a "Designated Procurement Items."[*2]

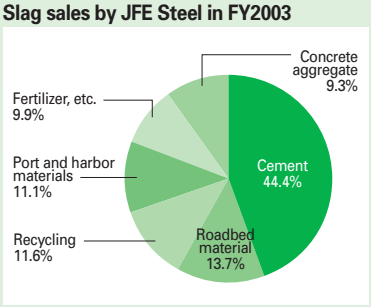
Because blast furnace cement, which is used as a substitute for Portland cement and material for concrete, makes it possible to omit the crushing and calcining processes in cement manufacturing, energy consumption in production is reduced by approximately 43%, while CO_2 emissions are cut by 41%, also contributing to prevention of global warming.

"Steel Slag Carbonated Blocks" and "Steel Slag Hydrated Blocks," which were developed by JFE Steel as concrete substitutes using steel slag, are used to restore shoreline environments and as materials for port and harbor works.

***1) Green Purchasing Law**
Short name of "Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities and Promotion of Demand for Eco-Friendly Goods "

***2) Designated Procurement Items**
Items including 176 products in 15 fields, such as paper, office supplies, OA equipment, etc. selected for priority in purchasing by the states and other entities under the "Basic Policy for the Promotion of Procurement of Eco-Friendly Goods and Services."

Slag sales by JFE Steel in FY2003



Products specified as "Designated Procurement Items" under Green Purchasing Law

- Blast furnace cement
- Blast furnace slag aggregate
- Mixed roadbed material containing steel slag
- Asphalt mixture containing steel slag
- Rock wool using steel slag as material
- Granulated slag for civil works
- Steelmaking slag for ground improvement

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In Focus

Advanced Applications for Slag

To ensure effective use of slag, JFE Steel is working to develop recycled slag products and expand their use. Recycled products developed to date include the following.

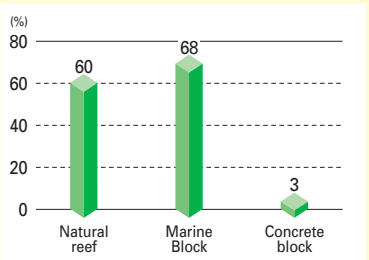
Use in Restoring Shoreline Environments

(1) Artificial reefs for seaweed/coral breeding: "Marine Block" (steel slag carbonated block)

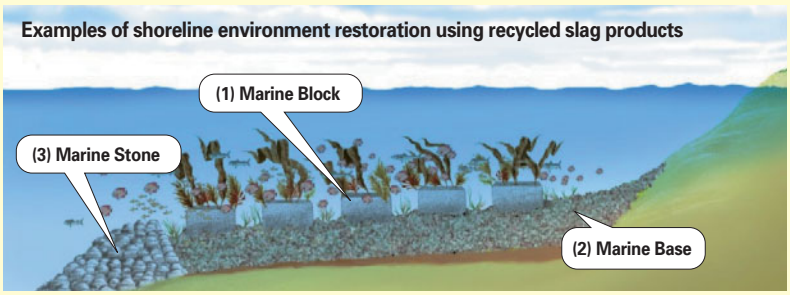
Artificial reef material for seaweed/coral breeding produced by absorbing CO_2 in steelmaking slag. Because the main component is calcium carbonate, same composition as shells and coral, artificial reefs are highly stable in seawater, and make excellent breeding habitats for seaweeds and coral.

Marine Block

Average coverage with large seaweed (after one-half year)



Examples of shoreline environment restoration using recycled slag products



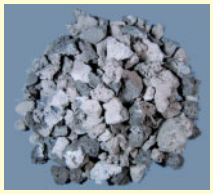
(2) Sand-capping material: "Marine Base"

A sand-capping material which is made from granulated blast furnace slag and composed mainly of calcium oxide and silicon oxide. Covering the sea bottom with organic material (sludge) suppresses elution of orthophosphates and nitrogen compounds, which cause eutrophication, and prevents occurrence of hydrogen sulfide, which causes blue tide. The material size is suitable for bottom-dwelling organism habitats.

Marine Base

(3) Submerged embankment: "Marine Stone"

Submerged embankment/breakwater material using steelmaking slag. Because steelmaking slag provides minor elements necessary for life, Marine Stone habitats are superior to natural stone.



Marine Stone

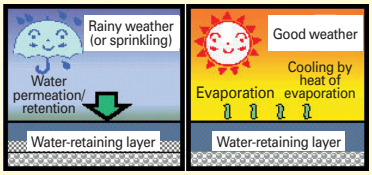
● Concrete substitute: "Ferro-Form" (steel slag hydrated blocks)

Concrete substitute produced by hydration hardening using a mixture of pulverized powder, etc. in steelmaking slag. Progressively adopted as a port and harbor material, for example, in breakwater blocks.

Road Material Application

● Heat island-mitigating paving material

The heat-island effect can be mitigated by using a water-retaining solid composed mainly of fine BF slag in asphalt pavement. The pavement retains water in rainy weather and is cooled by evaporation in good weather, reducing the pavement temperature.



Cooling by same principle as sprinkling
Retains water in structure, maintaining effectiveness
Cooling function of heat island-mitigating pavement

Fertilizer Application

● Slow-release Potassium Silicate Fertilizer

Slag fertilizer is released slowly into soil over long period.

Slow-release Potassium Silicate Fertilizer