Ferronickel smelting plant – Electric furnace off-gas utilization to save energy

In the past, off-gas generated during smelting and reduction of ferronickel ores in electric furnaces used to be released into the atmosphere. By utilizing this off-gas as a heat source for the rotary dryer, Kawasaki achieved highly efficient heat recovery, reduction of environmental impact and increased productivity.

Preface

Ferronickel is an alloy containing iron and nickel and is used mainly as raw material for producing stainless steel. In recent years, the global stainless steel market has seen growth slow down as the market in China, its major growth driver, has reached maturity. However, demand for ferronickel smelting plants remains high in Indonesia, a major raw ore producer where a recent ban on exports of raw ores has led to many new projects in the country.

This report describes the integrated ferronickel manufacturing and smelting plant delivered to SNNC of South Korea in September 2009, and the capacity expansion plant ordered in November 2012. The report will also explain the utilization of electric furnace off-gas in the rotary dryer.

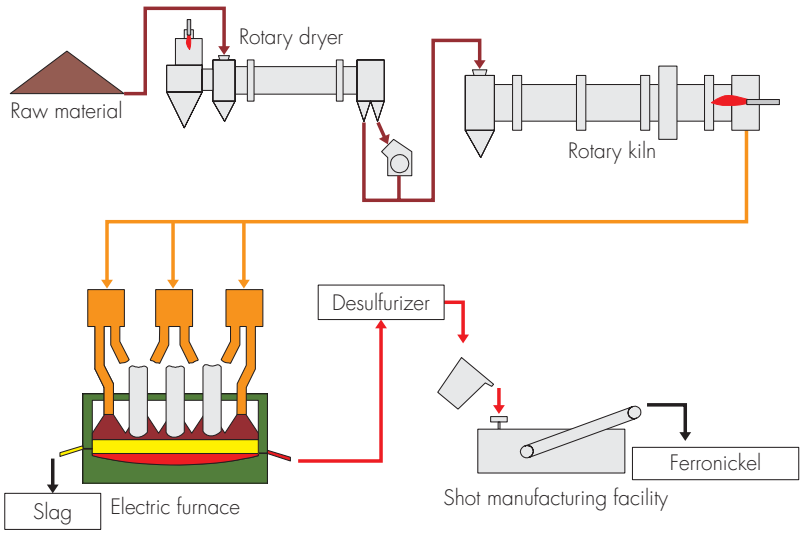

Fig. 1 Flow of ferronickel smelting plant

1 Ferronickel smelting plant and process

Kawasaki's ferronickel smelting plant follows the process shown in Fig. 1. Ferronickel ore with 1.8-2.2% nickel content is first dried in a rotary dryer, then reduced in a rotary kiln. Next, the ore is smelted in an electric furnace and separated into slag and metal (ferronickel) with around 20% nickel content. After the metal is refined in a desulfurizer, it is processed into a product by a shot manufacturing facility. This process makes full use of the technology and experience of Kawasaki, which have been cultivated through years of experience in designing and fabricating cement manufacturing kilns and dryers.

2 Utilizing electric furnace off-gas in the rotary dryer

(1) Material drying facility (rotary dryer)

Ferronickel ore has very high moisture content at 25-30%, making it highly adhesive and difficult to handle. For this reason, the material is dried in a parallel flow type rotary dryer (Fig. 2) to lower the moisture content of the raw material ore to 20-22% and make it easier to handle.

(2) Aim of utilizing electric furnace off-gas in the rotary dryer

In the past, off-gas generated during smelting and reduction of ferronickel ore in electric furnaces used to be released into the atmosphere after complete combustion of the carbon monoxide contained in the off-gas by injecting ambient air.

In the ferronickel plant initially delivered to SNNC, we applied the electric furnace off-gas to the rotary dryer for the following reasons.

(i) Energy saving

By utilizing the electric furnace off-gas as a heat source for the rotary dryer, the amount of fuel consumed by the hot-air generator can be reduced.

(ii) Protection of environment

To minimize environmental impact, dust that used to be dispersed into the atmosphere is collected by a bag filter installed downstream of the dryer.

(iii) Increased productivity

The electric furnace off-gas dust is returned to the process, enabling the nickel contained in the dust to be recovered more efficiently.

(3) Flow of electric furnace off-gas utilization

Electric furnace off-gas undergoes several processes before it can be utilized in the rotary dryer as a heat source. First, it is mixed with ambient air inside water-cooled ducts, and any remaining carbon monoxide is combusted completely. Next, dust is collected in the stabilizer, and the off-gas is mixed with hot air from the hot-air generator in the gas mixing chamber. This mixed gas is used as a heat source in the rotary dryer. After

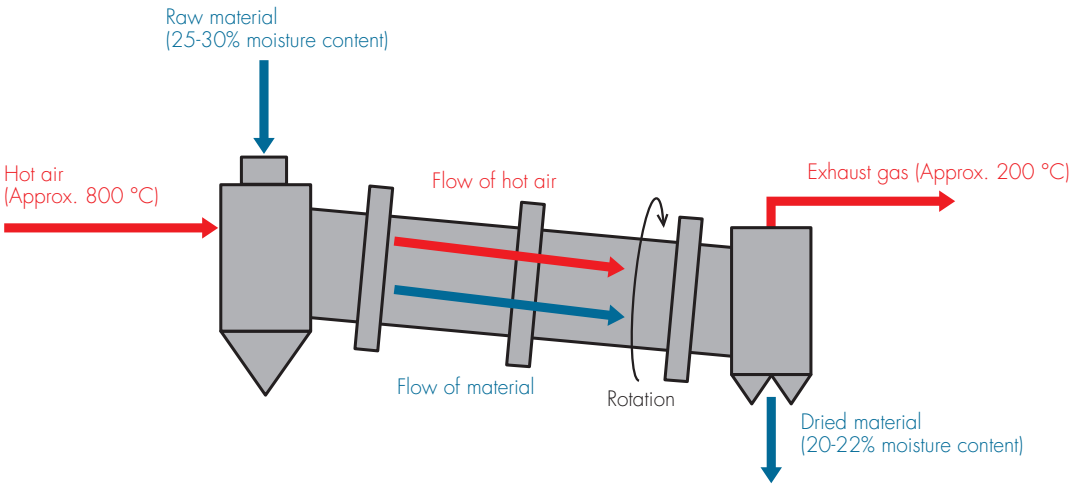

Fig. 2 Parallel flow type rotary dryer

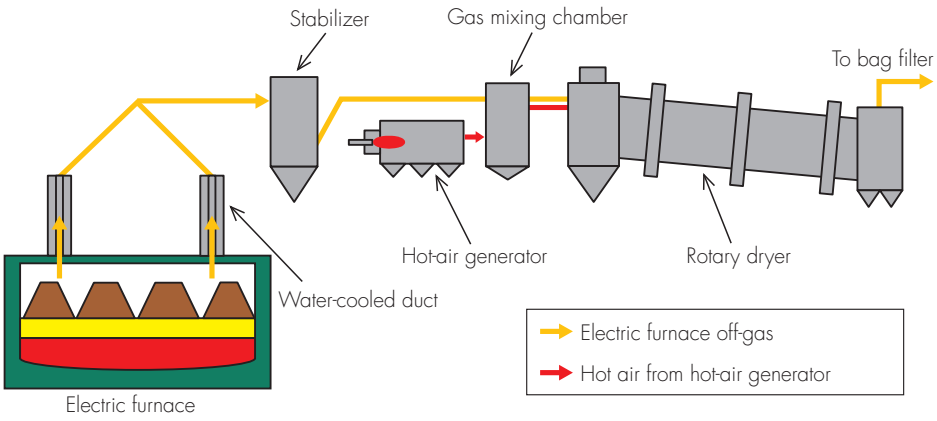

Fig. 3 Flow of electric furnace off-gas utilization

passing through the dryer, the gas goes through a bag filter for dust collection, and then the gas is released into the atmosphere through the chimney (Fig. 3).

(4) Improving fuel efficiency in the dryer by the use of thermohydraulic analysis

In the SNNC capacity expansion project, we did a thermohydraulic analysis (CFD analysis) based on the operational data in the first project to improve the homogeneity of the mixture of the electric furnace off-gas and the hot air from the hot-air generator (Fig. 4).

We applied the optimal arrangement of the hot-air generator, gas mixing chamber, and ducts based on the CFD analysis result. We tried to improve the efficiency of the rotary dryer by making the gas mixture more homogenous. As a result, we achieved approximately 40%

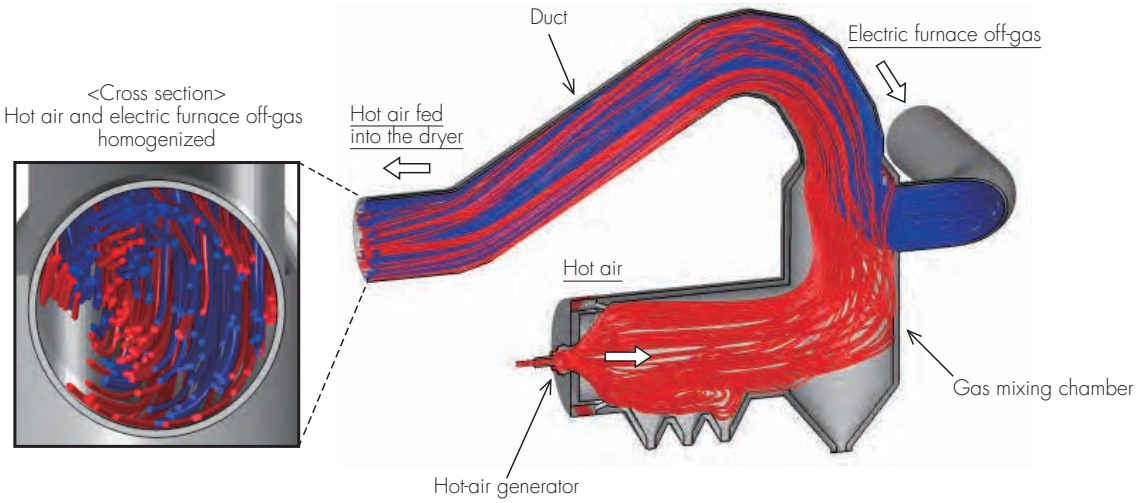

Fig. 4 Mixture of electric furnace off-gas and hot air from hot-air generator (SNNC Capacity Expansion Project)

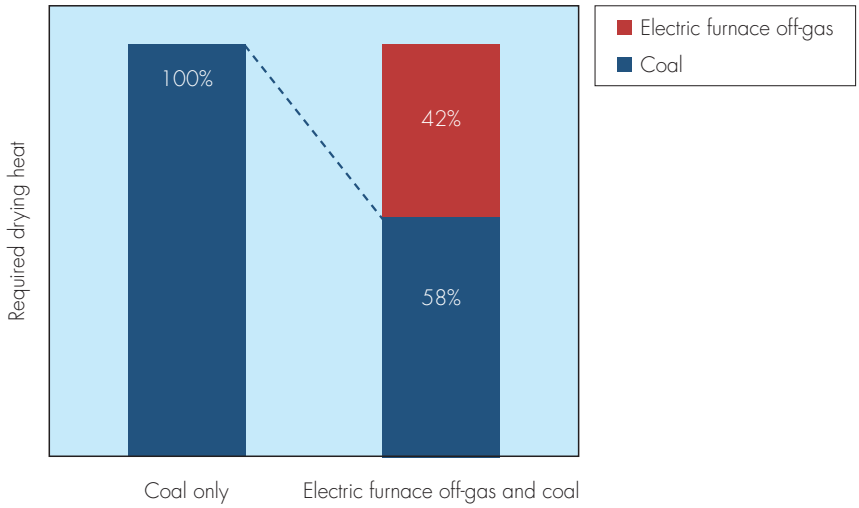

Fig. 5 Reduction of fuel consumption by electric furnace off-gas utilization

reduction of coal consumption on the hot-air generator, compared to without electric furnace off-gas (Fig. 5).

Postscript

In the SNNC project, we achieved a reduction of fuel consumption on the hot-air generator and considerable energy savings by using electric furnace off-gas as a heat source for the rotary dryer.

We will continue to satisfy customer demand for ferronickel smelting plants by making sure our plant design delivers superior performance and efficiency.

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