3B2. New Scrap Recycling Process (NSR)

Research and development: Japan Coal Energy Center; Nippon Sanso Corp.; and JFE Steel Corp.
Project type: Coal Production and Utilization Technology Promotion Grant
Period:1992-1997 (6 years)

Technology overview

1. Background

In Japan, approximately 30 million tons of iron scrap are recycled annually, and most is melted in arc furnaces, which consume a significant amount of electric power. The energy efficiency of an arc furnace is as low as approximately 25% (converted to primary energy, taking into account power generation and transmission efficiency). Given this, there is a need for a more energy-efficient melting process. In response, the NSR process employs technology that melts metals such as iron scrap utilizing high-temperature energy from the direct combustion of pulverized coal by oxygen instead of electric power. The NSR process was developed with the objective of significantly increasing the energy efficiency of the melting process relative to that of conventional technology.

2. Development timetable

Development was promoted by a joint team from Japan Coal Energy Center, Nippon Sanso Corp., and NKK Corp. (now JFE Steel Corporation). The main subjects of development were the furnace structure and the burner arrangement to attain high-efficiency melting. The study began with a batch smelter. With the results of the batch smelter, a continuous melting furnace was developed, with the objective of improving the energy efficiency.

Table 1 Development timetable

		1992	1993	1994	1995	1996	1997
Survey							
Batch-furnace	Bench scale (1 t/batch)						
	Pilot plant scale (5 t/batch)						
Continuous furnace (pilot plant scale: 6 t/hr)							

3. Overview of process and results of study

Figure 1 shows the process overview of the continuous melting furnace. The melting furnace consists of three sections: melting, basin, and holding, each of which functions separately. Each section has a pulverized coal oxygen burner. The oxygen supplied to the burner is preheated to temperatures of 400-600°C by an oxygen preheater to combust the pulverized coal. Using the above-described system, even slow-burning pulverized coal can be rapidly combusted, with efficiency similar to that of liquid fuels, such as heavy oil. Raw materials fed from the top of the furnace are directly melted by the burner in a shaft-shaped melting section in the lower part of the furnace. The melted raw material flows through the basin section and enters the holding

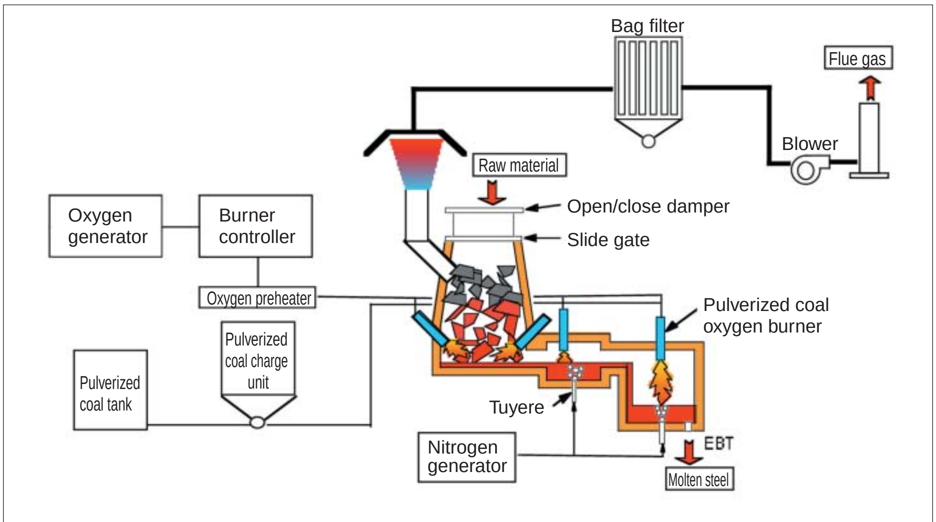

Fig. 1 NSR process flowchart

Fig. 2 Pilot plant (6t/hr)

section. The molten steel is soaked in the basin section. The carbon content of the molten steel in the basin section can be controlled by injecting powder coke into the furnace. The holding section stores the molten steel for a specified period, and rapidly heats the molten steel to approximately 1,600°C, and then taps the molten steel through an EBT system. Molten steel agitation gas is injected from the bottom of the respective furnaces to the basin section and the holding section to accelerate the heat transfer from flame to molten steel, thereby enhancing the slag-metal reaction. All the combustion gas coming from the individual sections passes through the melting section, and is vented from the furnace top after being used to preheat the raw material in the melting section. The raw material is continuously fed from the furnace top and melted in the furnace. Tapping from the holding section is conducted intermittently.

The process effectively utilizes the heat transfer characteristics of oxygen burners, and achieves high-efficiency melting. Figure 3 shows a comparison of melting energy between the NSR process and the arc furnace. Electric power (oxygen is also added because it is produced by electricity) is included in the primary energy and includes power generation and transmission losses. Compared with a standard arc furnace, melting energy was reduced by 40%, dramatically improving energy efficiency. Furthermore, the process achieved highly superior results relative to the conventional process from an environmental perspective, such as a significant suppression of dust (excluding the ash in pulverized coal) and of dioxins, due to the control of the intrafurnace atmosphere.

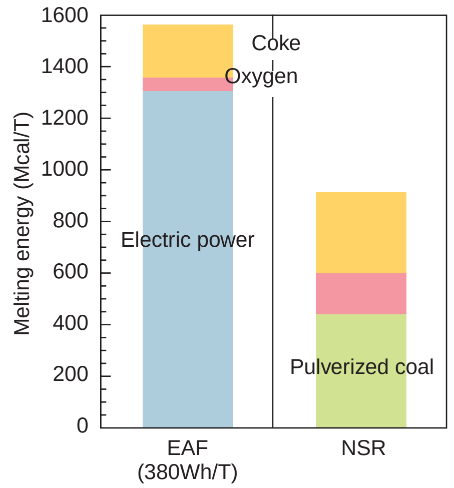

Fig. 3 Comparison of melting energy

4. Toward practical application

The study team completed the design for actual scale facilities. Due to the influence of the current poor economy in the electric furnace industry, however, the process has not been brought into practical application. Nevertheless, since the process is a non-power melting technology, which, even globally, is quite rare, and because of the strong advantage of being unaffected by the electric power infrastructure, the study team continues to make efforts toward commercialization in Japan and abroad.

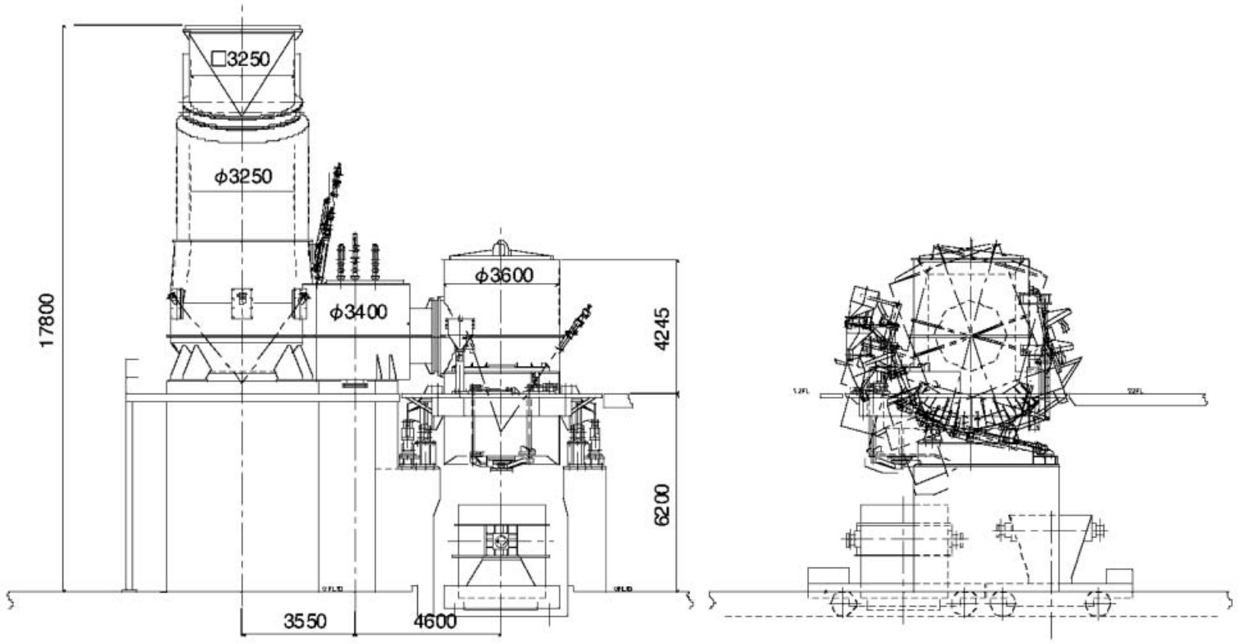

Fig. 4 Schematic for commercial-scale plant (50 t/hr)

References

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