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STUDY OF ITMK3 PROCESS

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Abstract

This article presents the study of the ITmk3 process, which is rapid process producing iron nugget from ore fine and coal fine at relatively low temperature. FASTMET, FASTMELT, and ITmk3 are low-cost processes that produce direct reduced iron (DRI) without coke, hot-metal without fired- pellets and iron-nuggets without lump-ore, respectively. The development in the ITmk3 process started in 1996. Kobe steel has constructed the world's first commercial plant in Minnesota, the USA in cooperation with steel dynamic Ins. (SDI). Kobe steel continues its effort in research and development of this new ITmk3 process. This article is a summary of some papers. In this article we will focus on development background, basic research, process flow and comparison between FASTMET, FASTMELT, DRI, and ITmk3 process.

Index Terms: *Fastmelt, DRI, ITmk3, Iron Ore , Coal Etc.*

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1. INTRODUCTION

Demands for reduced iron are increasing in advanced countries including the USA and INDIA as a clean iron source substitute for scrap. The production volume of direct reduced iron increased 60 times from approx. 1400 million tons in 2008 to approx. 1600 million tons in 2015, while the annual increase of total steel production is only a few percent worldwide. Fig. 1 shows annual crude steel production from 2008 to 2015.

Direct reduction process and blast furnace process are the conventional process of reduced iron making. Coal-based direct reduction processes are the alternative ways of iron and steel making. The necessity of the new processes is due to expensive coke, abundant availability of the fine ore and large energy consumption in blast furnace process causing a high burden on the environment.

Blast furnace is the first generation. Second generation would direct reduction iron making process as addressed by MIDREX process. The itmk3 process falls under third generation process category. The concept totally different from BF and DRI. ITMR3 process is faster than BF and DRI process in which series of reaction occur within 10 minutes.

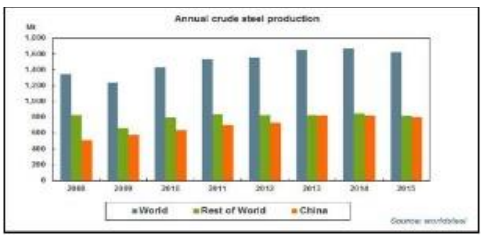

Fig-1: Annual crude steel production

1.1 Development Background

Blast Furnace is the most popular route to produce molten iron for steel- making. Coke is utilized to reduce iron ore. A preheated air is blasted into the furnace and after a series of reaction, molten pig iron is produced. But blast furnace is feasible only when capacity is more than 10,000 tonnes/day. It required pre-treatment such as producing coke from coking coal and preparing sinter from iron ore.

Direct reduction processes have been developed to specifically overcome the difficulties of conventional blast furnaces. DRI is successfully manufactured in various parts of the world. The initial investment and operating costs of direct reduction plants are low compared to integrated steel plants. In DRI process the natural gas is used , so plant has been built only in area where natural gas production is at low cost.

So the industry has concentrated on new processes that uses the abundant reserves of fine ore and fuel coal. In the 1980s, the FASTMET process were developed. In 1995, when developing the FASTMET process, the companies found that metallic iron can be separated from slag within ten minutes of heating. And this new principal is called ITmk3 process. Both FASTMET and ITmk3 use an RHF (rotary hearth furnace) to reduce pellets or briquettes made from iron oxide fines and coal. One revolution of the rotary hearth furnace takes approximately ten minutes. In FASTMET®, the product is direct reduced iron, but in ITmk3®, the pellets are melted in the last zone of the hearth to produce a premium quality pig iron product with a slag by-product.

1.2 Basic Research

Kobe Steel began to study a new iron making process in 1996. Using a tube furnace installed at the Iron & Steel Research Centre (Kakogawa Works, Kobe Steel), the company found that metallic iron grows rapidly, being separated from slag, at a relatively low temperature.

The reaction between iron ore and coal remains the same as that for general iron making and is expressed as follows: Fe xOy + yCO = xFe + yCO2 ……..… (1)

CO 2 + C = 2CO …… (2)

C(s) = C (carburized) ……..…… (3)

Fe(s) = Fe (l) (melt) ……..…… (4)

Reactions (1) and (2) occur in the FASTMET process. The additional reactions (3) and (4) include in ITmk3 process. Which separate metallic iron from slag

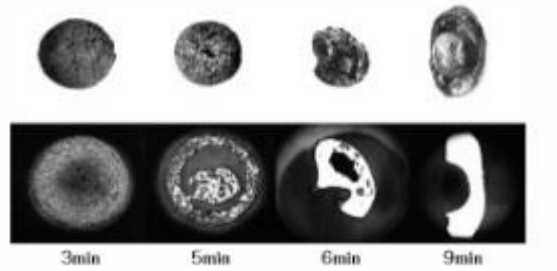

Fig-2: ITmk3 reaction mechanism

According to Kobe steel, study involved investigating the cross sections of agglomerates in the stages of reducing, melting and slag-separating, respectively. **Fig. 2** shows sample results of the cross-sectional study. During the first 3 minutes, the agglomerate, consisting of fine ore and coal, did not exhibit any significant change in appearance. In about five minutes, the metallic iron and slag started to partially melt and became separated. After six minutes, the entire agglomerate started to melt rapidly, with metallic iron being separated from the slag. After nine minutes, they had separated completely.

2. PROCESS FLOW

The ITmk3 Process is based on a totally different concept from conventional processes. The practical operation of the process proceeds as follows, and the process flow is shown in Fig. 3.

1. Iron ore fines and pulverized coal are agglomerated into composite pellets.

2. Pellets are charged into an RHF, heated to 1,350-1,450° C, reduced, melted, and separated into iron and slag.

3. Molten iron is solidified into nuggets in the furnace, discharged after cooling, and separated from the slag

ITmk3 produces slag free Iron nuggets which have similar chemical and physical properties to those of pig iron. It has a metallic iron content of 96 – 97%, C content of 2.0-2.5 %. Sulphur levels in the nuggets are around 0.07-0.11%. The density of iron nuggets is in the range of 6.5-7.0 gm/CC. Iron nuggets have better melt ability than blast furnace pig iron since it has a low melting point and higher thermal conductivity.

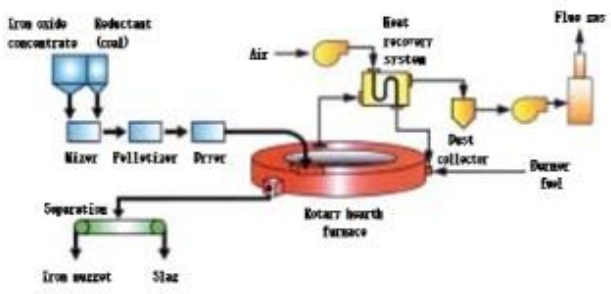

Fig-3: ITmk3® Process flow

3. ITmk3 in India

The Steel Authority of India (SAIL), in a JV with a Japanese firm Kobe Steel, has planned to invest Rs 1500 cr in a 0.5 MTPA iron making plant, SAIL-Kobe Iron India, in Durgapur, West Bengal. The plant is expected to be operational by 2014. This is a significant leap in iron-making technology and is part of SAIL's plan to forge closer ties with leading steel makers. The 2 companies had earlier signed an MoU in Mar 2010, and have been jointly working on a preliminary study to utilise the ITmk3 process.

4. ADVANTAGES

The process is simple and consumes approximately 30% less energy than BF. It allows direct reduction of iron ore fines with non coking coals. The iron nuggets are slag free and are also free from re-oxidation. It does not generate fines and is easy to transport. Operation and adjustment of the process is simple. The process also facilitates the production adjustment by starting and stopping. ITmk3/EAF steel making produces lesser pollutants relative to Coke/BF/ BOF route.

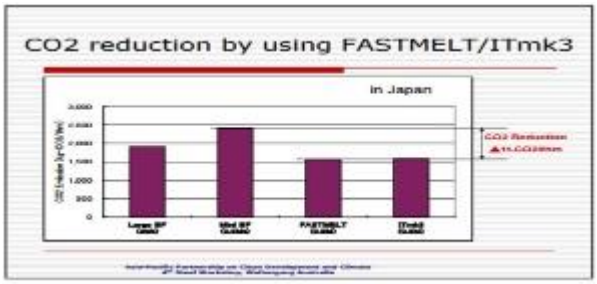

Fig-4: CO_2 reduction by using FASTMELT/ITmk3

5. CONCLUSION

ITmk3® is an ideal way for iron ore mining companies to process either magnetite or hematite and supply a premium quality pig iron product to the steelmaking industry. Moreover, the ITmk3 Process can use cheaper low- grade iron ore and coal, which are difficult to use in blast furnace iron making, to keep raw material costs down for steel and mining companies.

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