

## A New High Quality EAF Charge

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(Received 2000-05-20)

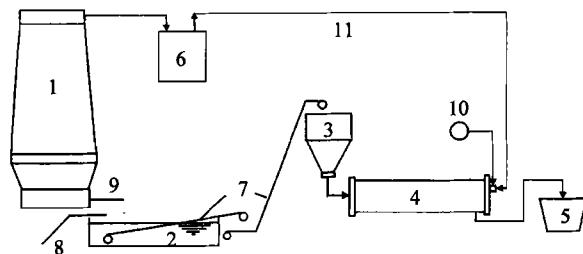
**Abstract:** In order to solve the problem of the shortage of scrap, especially high quality scrap, granular pig iron, a new substitute for scrap or DRI (direct reduction iron) has been developed. The technical process of decarbonized granular pig iron has been evaluated. The result shows that this new process is superior to direct reduction process in product quality, construction investment, operation flexibility, production efficiency etc. Decarbonized granular pig iron (DGPI) not only can be used as conventional scrap but also can be charged into EAF as high purity burden equivalent to heavy scrap.

**Key words:** decarbonized granular pig iron; scrap; DRI

In the past years, with the universal application of continuous casting technique in China, the amount of scrap generated inside steelworks has been reducing continually. On the other hand, the EAF steel proportion is increasing and this makes the obvious change in structure of steel product. At present, the requirement on both scrap quantity and scrap quality is being paid more and more attention. Because of the deficiency in scrap and poor in resource (nature gas and high grade iron ore) for developing direct reduction iron (DRI) in China so that sponge iron can not be produced economically. Instead of part of scrap, some cold pig iron has been charged into EAF. However the high carbon content in pig iron has limited its proportion in EAF metal burden. Because the price of pig iron is lower than that of imported DRI in China, the technique of granular pig iron decarbonization is hopeful to become an effective way to produce substitute for scrap or DRI.

### 1 Technical process of granular pig iron decarbonization

This technical process (figure 1) is composed of two steps: granulation of hot metal and decarbonization in rotary kiln. Firstly, hot metal was broken up into droplets by high pressure water which fall rapidly into a water pool near the blast furnace and were taken out from the water pool by a under water belt conveyor. The granules whose size arranges from 5 mm to 15 mm were more than 90%. The size distribution of granular pig iron could be controlled by changing water pressure and water flow rate. Secondly, the granular pig iron was fed into the rotary kiln continuously and it moved through the rotary kiln in the opposite direction to the



**Figure 1** Technical process of granular pig iron decarbonization, 1—Blast furnace; 2—Water pool; 3—Hopper; 4—Rotary kiln; 5—DGPI Pot; 6—Dust collecting facilities; 7—Belt conveyor; 8—High pressure water; 9—Hot metal; 10—Air blower; 11—BF top gas.

combustion gases from a blast furnace gas burner located in the exit. The decarbonization reaction of pig iron carries out in the oxidation atmosphere formed by the combustion of CO mainly from blast furnace gas and a little from decarbonization reaction. The carbon content of around 4% in pig iron can be decreased to any required level between 0.2% and 2% (mass fraction, so as the follows). The productivity of decarbonized granular iron in rotary kiln as high as 2.0 t/m<sup>3</sup> a day is easy to realize.

This new process was put forward by University of Science and Technology Beijing in 1985 and on the basis of detailed study in lab [1-3], industrial experiments were successfully carried out in  $\phi 0.7\text{ m} \times 12\text{ m}$  in Shanxi province and in  $\phi 2.5\text{ m} \times 50\text{ m}$  in Hebei province respectively. The eligible decarbonized granular iron was produced and it was firstly proved that this process is feasible in technique.

### 2 Characteristics of Decarbonized Granular

## Pig Iron (DGPI) and Its Application

### 2.1 Technical evaluation on DGPI

The chemical constitution of DGPI mainly depends on the quality of iron ore charged into blast furnace,

such as sulfur, phosphorus and other undesirable elements in DGPI are very low. The typical parameters of DGPI basing on the raw material condition in Tianjin Iron Corporation are listed in **table 1**.

**Table 1** Typical parameters of decarbonized granulated pig iron

Chemical composition (mass fraction in %)							Physical properties		
C	Si	S	P	FeO	Cu	As+Sn+Pb+Bi+Zn	Size/mm	Density, $\rho$ / (t·m <sup>-3</sup> )	Oxidation resistance
< 1.5	0.6	< 0.04	< 0.05	< 5	< 0.01	< 0.007	5-15	3.5-4.0	good

DGPI has the following characteristics:

(1) The carbon content in DGPI can be adjusted from 0.2% to 2.0% according to the requirement. Because the usually undesirable elements in steelmaking, such as copper, nickel, tin and frequently chromium, are absent in DGPI, the strong advantage from the purity of DGPI with respect to metallic contaminants has made it superior to steel scrap, so it is especially suitable for being used as the material for making steel with strict requirement on chemical composition.

(2) The quality of DGPI in content of metallic iron and nonferrous oxide are all superior to DRI, so the amount of EAF slag is very little when using more DGPI.

(3) Because DGPI is produced in the oxidation atmosphere, so it has high reoxidation resistance and it can be hot charged into EAF in order to reduce the electricity consumption.

(4) DGPI is high in specific surface so it melts very quickly in EAF. On the other hand, the charging times have been reduced when using DGPI due to the high density. Therefore, the electric power can be obviously saved.

### 2.2 Application of DGPI in EAF

The industrial experiment of using DGPI from 15% to 50% has been carried out in EAF with a capacity of 30t and 150t respectively. The experimental result shows that DGPI is a high quality substitute for scrap or DRI. When being used for EAF production, it has no negative influence on tap time, electrical consumption and finished product quality. A little FeO on the surface of DGPI is favorable of deposphorization during the steelmaking. When adding DGPI in EAF, the charging times have been reduced so that the heat loss and electrical energy consumption will decrease. In order to shorten the melting time, DGPI should be placed at the middle part of EAF in order to avoid the bonding between DGPI and EAF lining.

### 2.3 Technical and economic analysis for granular

### pig iron decarbonization

Since the process of hot metal granulation and self-heating decarbonization consumes little energy, the production cost is very low. The production cost mainly comes from the power of driving rotary kiln, mass loss of DGPI due to the removal of carbon (about 3% to 4%) and equipment depreciation expense. Therefore the price of DGPI mostly depends on the pig iron price and the processing cost accounts for 5% to 7%. At current situation in China, the price of DGPI is lower than that of DRI.

Based on the cost estimation on DGPI cost in China, the price of DGPI will be the 107% of that of pig iron. The main factors which cause the price rising are loss and mass reduction due to the removal of carbon. The processing equipment is very simple in structure, high in productivity and low in construction cost. When the blast furnace is available, the unit investment expenditure for DGPI will be lower than that for DRI.

### 3 Conclusions

(1) The new technical process of granular pig iron decarbonization is superior to direct reduction process in product quality, construction investment, operation flexibility, production efficiency etc when blast furnace existing.

(2) Decarbonized granular pig iron (DGPI) not only can be charged into EAF as a conventional scrap but also can be used as a high purity burden equivalent to heavy scrap or DRI.

### References

- [1] J. Zhang, M. Qin, L. Li: *Journal of University of Science and Technology Beijing*, 15 (1993), No.2. p. 133.
- [2] F. Gu, M. Qi: *Steel Iron*, 24 (1989), No. 2. p. 6.
- [3] X. Li: *The Study on the Decarbonization for Granular Pig Iron*: [Master thesis]. Beijing: University of Science and Technology Beijing, 1988, p. 36.