

§14. Development of Pig Ironmaking by Microwave Heating

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1. Introduction

In order to produce 1 ton of pig iron by blast furnace in Japan. As 500kg of the coke is consumed, 1.8 tons of CO₂ gas is emitted. About 275 kg of 500kg coke are burned to make hot gas. The hot gas heats the resources such as iron ore and coke and gives the reduction energy of iron oxides. In the present study, the energy of hot gas is replaced to the energy of microwave and the CO₂ gas emission from the ironmaking processes. From our previous researches, it is realized that microwave is successfully absorbed to the powder of magnetite ore and carbon. The powder generates heat and the reduction of iron ore and the melting of pig iron are taking place during about 10min. In this year, the continuous process of pig ironmaking by microwave heating has been developed.

2. Development of the continuous process of pig ironmaking by microwave heating

The microwave-heating furnace with the power of 12.5kW and the frequency of 2.45GHz in hybrid mode was employed. The mixture powder of magnetite iron ore and 18 mass% of graphite was heated in N₂ gas by microwave. A magnesia crucible was used and an exit hole was opened at the wall near the bottom of crucible. A graphite crucible was set under the hole in order to collect pig iron. A stainless tube was set from the ceiling of the furnace chamber and the mixture was supplied from the tube. At first, 200g of the mixture were set in the magnesia crucible. After the temperature of the mixture increased up to 1400°C and liquid pig iron poured out to the graphite crucible, 50g of the mixture were supplied every 5 min from the stainless tube. The mixture reacted to produce pig iron during 10s. When the mixture was supplied to the crucible, the temperature sharply decreased by about 150°C and gradually recovered to 1400°C during 5 min, as shown in Fig.1. 300g of pig iron were produced from 1000kg of the mixture.

3. Construction of 20kW microwave furnace with the concentrated energy

In order to increase the efficiency of absorption of microwave energy to the mixture, it is effective to concentrate the energy into the center of the chamber of the furnace, as shown in the left picture of Fig.2. The microwave furnace with 20kW was constructed. 8 microwave generators of 2.5kW power were installed on the spherical chamber of 1 m of the diameter. Each generator

has the helical type antenna to radiate microwave one way.

4. Construction of 20kW rotary-kiln-type microwave furnace

In order to improve the efficiency of absorption of microwave energy into the mixture, the mixed powder effectively contacts with microwave using the rotary-kiln type furnace, as shown in the right picture in Fig.2. The rotary part has 1 m in diameter and 2m in length. 4 microwave generators of 2.5kW were installed in both sides of the furnace. Total power of the furnace was.

5) Planning of the construction of 180kW microwave furnace

The microwave furnace with the capacity of the production of 1 ton per day has been planning. 6 microwave generators of 30kW in klystron type will be installed. Total power is 180kW.

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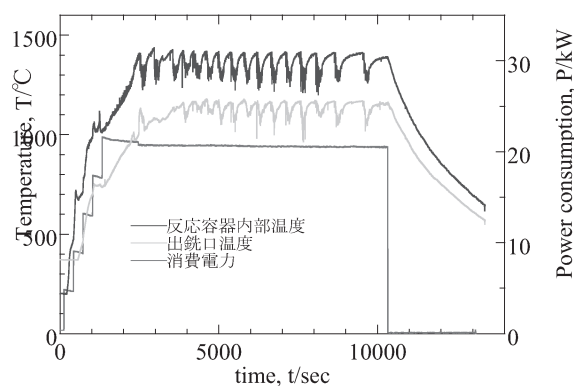


Fig.1 Temperatures in the magnesia crucible of the pig ironmaking furnace.

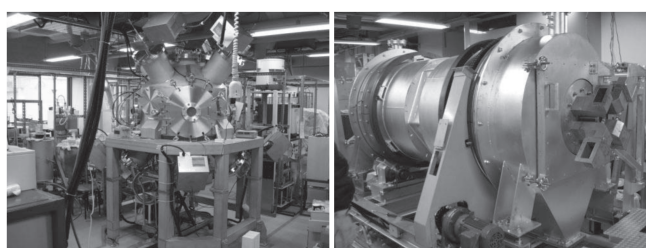


Fig.2 2 types of microwave furnaces with 20kW