140 kWh energy saving and emission reduction

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With global warming becoming increasingly serious, governments and industries have attached greater importance to the reduction of greenhouse gas emissions. Modern iron and steel plants focus on "2 high and 2 low" in the production process, that is, high-efficiency process, high value of steel, low emissions of CO2, low dependence on fossil fuels [1, 2]. There are many works to study on energy saving and CO2 emissions reduction for steel mills.

Metallurgical workers have already made a mass of work in the optimization of oxygen and electric supply, improvement of EAF composition control to save energy and reduce CO2 emissions during EAF steelmaking process. Nowadays, with changes in the structure of material in the electric arc furnace, the EAF waste heat increases and EAF waste heat utilization has become the main research object of EAF energy saving and emission reduction [3-7].

Cold scrap is the main raw material of traditional EAF steelmaking. However, more and more hot metal is used during the EAF steelmaking process in recent years. With the increase of hot metal ratio and oxygen supply intensity as well as the application of carbon oxygen lance, the smelting intensity is increased significantly, and the structure of EAF steelmaking changes as well.The smelting efficiency is improved obviously, as the supply of physical and chemical heat is greatly increased to reduce the electric energy supply in EAF steelmaking.

The solid specific heat of pig iron and liquid specific heat of hot metal is 0.745 kJ/kg?C and 0.837 KJ/kg?C, respectively, the latent heat of fusion of the hot metal is 218 kJ/kg. Then the physical heat of 550 kg hot metal is calculated, that is 181 kWh. About 170 kWh in average is supplied by the electric energy during the EAF melting.

Chemical heat of the furnace gas is the energy contained in CO, a constituent of the incomplete combustion furnace gas after decarburization reaction, which is the same as the potential chemical heat (134 kWh).

Physical heat of the furnace gas in EAF is the energy taken away by the high temperature gas. Given the quantity (200-400 Nm3), the temperature (1200?C), and the specific heat (1.137 KJ/kg?C) of the furnace gas, physical heat is obtained and the value is 140 kWh. Similarly, physical heat of the slag and molten steel is calculated, which is 43 and 397 kWh, respectively. The heat taken away by the cooling water and other output heat is about 24 kWh.

Above all, the energy budget in the EAF can be described as the schematic shown in Figure 1. It is easy to find that all of the output energy in EAF except physical heat of the molten steel can be recycled, that is 341 kWh. The chemical and physical heat of furnace gas accounts for a major portion (274 kWh) of the waste-heat

utilization.

High temperature furnace gas contains huge physical and chemical heat that can be recycled. Actual utilization of the EAF gas waste heat is analyzed as the following.

Scrap preheating is the way that raises the temperature of steel scrap by the exchange of heat between the high temperature furnace gas and cold scrap before entering to the electric arc furnace. About 140 kWh of energy can be recycled theoretically during this process.

Statistics suggest that the temperature of the cold scrap can be heated to 400-600? by the high temperature furnace gas. And the electric energy will decrease 15 kWh per 100?C increment of the scrap temperature per ton steel. Thus about 75 kWh of electric energy in average will be saved per ton steel by using the high temperature furnace gas to preheat the steel scrap.

Electricity generation is the way that physical heat of the furnace gas is converted to electric energy by the electricity generation device. 140 kWh of energy can be converted to electric energy in theory.

In fact, about 91 kWh of energy in average per ton steel is saved by generating the electricity in certain EAF steel plant of the country which can produce 57.60 x 106 kWh of electrical energy of two electric arc furnaces with capacity of 150 tons yearly [12].