Basic Characteristic Analysis of Self-provided Power Plant in Iron and Steel Industry

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Abstract. Self-provided power plants are set up in order to maintain normal operation in some high energy-consuming industries in the era of power shortage in China. In a specific historical period, it effectively alleviated the problems of insufficient power supply and low reliability of the power grid, and promoted the rapid development of the national economy. The construction of self-provided power plants in the steel industry is to save electricity costs and improve the operational reliability of important units. This paper analyzes the basic production electrical characteristics and equipment load characteristics of the self-provided power plant in iron and steel industry, and summarizes the adjustment ability of the equipment from two aspects of power generation side and load side.

1. Introduction

China's self-provided power plants are produced in a specific historical period and under corresponding policies. Generally, large energy-consuming enterprises such as electrolytic aluminum, calcium carbide, steel, and cement invest in the establishment of self-provided power plants to provide self-balanced power supply systems within the enterprise, while providing relatively stable and low-cost power supply for end users[1].

Another purpose of the iron and steel industry to spend a lot of money to build its own power plant is to avoid the irreversible damage to the important units of the enterprise caused by the sudden power outage when the power off-grid accident occurs. More steel plant equipment, electricity load is more concentrated and the density is large, most of the electrical equipment is high voltage, high power, electrical equipment contains most of the high precision, continuous production load, so the continuity of power supply requirements higher[2]. Entering the 21st century, China's steel industry energy consumption accounted for one-tenth of the total energy consumption, electricity consumption is about ten percent of the total electricity.

For a long time, self-owned power plants have played an active role in comprehensive utilization of resources, alleviating the contradiction between power supply and demand, and improving the economic benefits of enterprises. However, some problems such as disorderly expansion, environmental protection supervision and safe operation have gradually been exposed in the development and operation. Therefore, it is urgent to carry out orderly rectification[2]. It is beneficial to improve the safety and reliability of the operation of the self-contained power plant and the power grid to carry out the interactive strategy of the self-contained power plant participating in the power grid[5]. Mastering the basic characteristics of the industry self-contained power plant is the premise of formulating a clear and reasonable and reliable interactive strategy of the self-contained power plant participating in the power grid.

2. Electrical characteristics of power plant basic production

Steel industry generally adopts twenty-four hours three shifts continuous working system, the annual load fluctuation is not big, no obvious peaks and troughs. In its process production, there are many continuous production equipment such as coke oven, sintering machine and blast furnace. In addition to the maintenance period, all kinds of equipment are usually running at full load, with high load rate and high requirements for power quality. Therefore, in the process of implementing demand response, fine management of adjustable load resources is needed. Typical daily load characteristic curve of iron and steel industry is shown in Figure 1.

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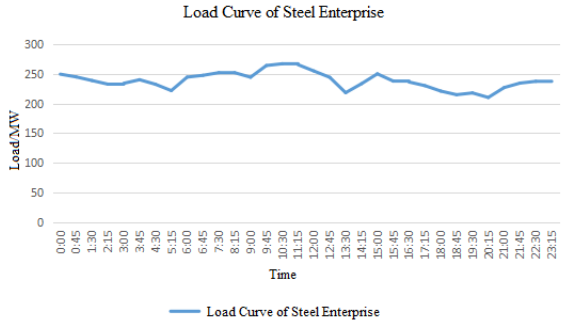

Figure 1. Typical Load Curve of Steel Enterprise.

3. Load Characteristics of Power Plant Equipment

The production load of iron and steel enterprises accounts for more than 70%of the total load, which is mainly composed of blast furnace, converter, continuous casting machine and other equipment. The auxiliary production load accounts for more than 8% of the total load, which is mainly composed of bar, wire fan, electric furnace fan, driving and other equipment. Safety load accounts for about 10% of the total load, which is mainly composed of exhaust gas, dust suction fan, circulating cooling water pump, fire and security equipment ; this kind of load loss may cause injury to personnel and loss of enterprise property.

Non-production load accounts for about 2%-5% of the total load, which is mainly composed of office equipment, central air conditioning and other equipment.

Steel enterprise equipment classification table is shown in Table 1 below.

Table 1. Iron and steel enterprise equipment classification table.

Load Category		Load Ratio	Major Installation
Production Load	Safety Load	10%-15%	dust recovery fan, circulating cooling water pump, Fire control and other equipment
	Main Production Load	55%-60%	electric furnace, refining furnace, oxygen machine, blast furnace, converter, etc
	Auxiliary Production Load	5%-10%	bars, wire fans, electric furnace factory fans, traffic, etc
Non-production load		2%-5%	office lighting, office appliances, central air conditioning, domestic electricity, etc

4. Analysis and Summary of Equipment Adjustment Ability

4.1 Power generation side potential analysis

Iron and steel industry power generation equipment is divided into pure coal-fired units, cogeneration units, waste heat and pressure utilization unit. Pure coal-fired power plant to follow the lack *of grid supply, surplus power grid* design principles, according to the basic power needs of enterprise production unit capacity selection. According to the agreement, the insufficient part of the peak power consumption is supplied by the power grid, and the excess part is transmitted to the power grid. When the load of electrical equipment on the production process becomes smaller, the power generated by the cogeneration unit may be reversed to the external power grid. However, the heat load in the production process of iron and steel enterprises will not change, so the change from the power grid to the power supply is only determined by the change of the load of the electrical equipment. The power generation of the waste heat and pressure unit is related to the characteristic production link in the production link, and the regulation performance is not high.

The power generation resources of the self-owned power plant can participate in the power generation right transaction, and the power generation capacity of the coal-fired unit is traded with the power generation right of the new energy enterprise, which greatly reduces the power generation cost and saves the coal consumption. At the same time, it reduces pollutant emissions and increases the consumption of new energy. The cogeneration unit has good regulation performance and low production cost. It can participate in peak shaving and valley filling, maintain the balance between supply and demand of the power grid, improve the frequency of the power grid, and promote flexible interaction with the power grid.

4.2 Load Side Potential Analysis

Iron and steel industry mainly ironmaking, steelmaking, cast steel, steel rolling four processes. The main equipment used in the process are reclaimer, ball mill, coke oven, sintering machine, blast furnace, converter and electric arc furnace, continuous casting machine, hot rolling mill, cold rolling mill and other auxiliary equipment.

The controllable load of iron and steel industry is mainly divided into productive load and non-productive load. The productive load includes electric furnace, refining furnace, oxygen making machine, steel rolling, bar and wire production line, among which electric furnace load accounts for the largest proportion, about 40%. The non-productive load includes office lighting, split and central air conditioning system and domestic electricity, accounting for a small proportion. The control mode is direct control (flexible), the preparation and recovery time can reach second level, and the response time is 0.5-2h. Adjustable productive load ratio is 19%, non-productive load is about 1%. Based on the analysis of typical user production data, the comprehensive regulation load

accounts for about 20 % of the total production load in the steel industry when the production conditions permit.
Controllable load can participate in the demand side response, participate in the power grid peak shaving interaction. Peak shaving is mainly by electric furnace, refining furnace, oxygen machine and non-productive load participation, reduce the peak load ; the load scheduling production is mainly carried out by the rolling steel, bar and wire production line, and the composite is transferred to the low load period to reduce the production cost. Load control is shown in Table 2 below.

Table 2. Load Control in Steel Industry.

Load Category	Major Installation	Load Ratio	Regulatory Mode	Regulatory Time			Adjustable Load Ratio		
				Setup Time	Response Time	Resumption Operation Time	Individual Effect	Overall Proportion	Total
Main production load	electric furnace	40%	automatic	30min	0.5h	30min	10%		
	finery	3%	automatic	30min	0.5h	30min	1.5%		
	oxygen concentrator	2%	automatic	10min	0.5h-1h	10min	1%		
	rolling production line	15%	direct(rigid)	second grade	0.5h-1h	second grade	5%	19%	20%
	bar production line	5%	direct(rigid)	second grade	0.5h-1h	second grade	2%		
	rod production line	5%	direct(rigid)	second grade	0.5h-1h	second grade	2%		
Non-production load		<1%	direct(rigid)	second grade	0.5h-2h	second grade	<1%	<1%	
		<1%	direct(flexible)	second grade	0.5h-2h	second grade	<1%		
		<1%	direct(flexible)	second grade	0.5h-2h	second grade	<1%		

5. Generalize

To sum up, the self-owned power plant of iron and steel enterprises side coal-fired units and cogeneration regulation potential is excellent, can participate in new energy trading and peak shaving work. Electric furnaces, refining furnaces, steel rolling production and non-productive loads on the demand side have adjustment potential and can respond to electricity price incentives and compensation mechanisms to participate in grid interaction.

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