

Power consumption characteristics of cement industry and parameter analysis of self provided power plant

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Abstract. Cement production is an industry that consumes a lot of electric energy. During the period of power shortage in China, the government encouraged multi-channel financing to run electricity to alleviate the power shortage problem of large industrial users. Therefore, many cement enterprises have established their own power plants. This paper analyses the basic electrical characteristics of the cement industry, classifies the loads of enterprises, and studies the regulation characteristics of various types of equipment.

1. Introduction

Self owned power plants are built by our country to alleviate the difficulty of power consumption in the era of power shortage. The first batch of self owned power plants was built by the government for specific industrial enterprises during the expansion of production scale, and the second batch was built at the weak stage of power infrastructure construction in China. In order to alleviate the problem of power shortage for large industrial users, the government encouraged multi-channel financing to run power plants and develop local self owned power plants of small thermal power types[1,2]. High power consumption industries include: electrolytic aluminum, calcium carbide, steel, cement and other enterprises. Among the high energy consumption users in some cities, the cement industry accounts for a large proportion. The survey shows that in 2011, among the 46 high power consumption industries of Jinzhong Power Supply Branch, 17 were cement, accounting for 36.96%[3].

The self owned power plant can provide a self balanced power supply system within the enterprise, and also provide a relatively stable and low-cost power supply for end users[4]. Some large cement plants are far away from the city, and there is no supporting power transmission and distribution system. For example, the 5000 t/d cement production line in Western Asia undertaken by Sinoma Construction Company is 80km away from the city, and there is no large power grid nearby. If the power supply is connected from the power grid, a 57 km power transmission and distribution system is required, and the power grid can only meet the discontinuous 10MW load capacity, and the unit price of industrial power is close to \$1.2, so a self-contained power supply is built, The island operation mode is adopted[5].

2. Electrical characteristics of power plant basic production

The production process of cement industry mainly refers to ore mining, ore crushing, rotary kiln paper burning, clinker grinding, product packaging, and is often referred to as "two grinding and one burning". The cement industry mainly produces in the normal and low periods. The wind bone inversion is obvious, the nighttime load is high and relatively stable, the equipment operation cycle is long, the power load is high, and the power supply reliability requirements are high.

Typical daily load characteristic curve of cement industry is shown in Figure 1.

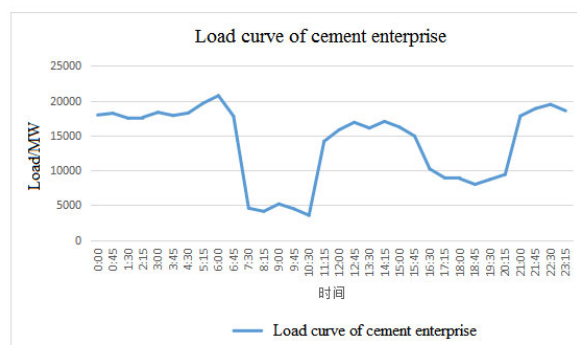


Figure 1. Typical Load Curve of Cement Enterprise.

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3. Equipment load characteristics of cement enterprises

The main production load of the cement industry accounts for 55%-60% of the total load, which is used for raw meal grinding, raw material burning and cement grinding. The main equipment includes raw meal mill, cement mill, ball mill, etc.

The auxiliary production load accounts for 15%-20% of the total load, which is used for the transmission of raw materials, the delivery of finished cement products, the preparation of intermediate products, etc. The main equipment are transmission fans, transmission belt motors, etc.

The safety guarantee load accounts for 8%-15% of the total load, which is used for the cooling of cement production process, lubrication of rotating equipment, etc. The main equipment includes cooling water pump, lubricating oil pump, etc.

Non productive load accounts for 2%-5% of the total load, including office electrical equipment, split and central air-conditioning equipment.

Equipment classification of cement industry is shown in Table 1 below.

Table 1. Classification of Equipment in Cement Industry.

Load Category		Load Ratio	Major Installation
Production Load	Safety Load	8%-15%	cooling water pump, lubricating oil pump, transmission equipment, etc
	Main Production Load	55%-60%	raw meal mill, cement mill, ball mill, rotary kiln, vertical kiln, etc
	Auxiliary Production Load	15%-20%	transmission fan, transmission belt motor, elevator, pulverized coal mill, etc
Non-production load		2%-5%	office lighting, office appliances, split and central air conditioners, blowers, etc

4. Analysis and Summary of Equipment Adjustment Ability

4.1 Potential analysis on power generation side of cement enterprises

In terms of heat and power cogeneration units, the heat and power cogeneration generator units used by cement enterprises generally adopt and are equipped with two types of steam extraction condensing steam turbine generator units and back pressure steam turbine generator units, which can provide heat and power for the process flow of cement enterprises. It can be seen from the production link that the heat load in the production process of the enterprise will not change, so the change of the power supply to the grid is only determined by the change of the load of electrical equipment.

In terms of waste heat and residual pressure utilization unit, there are two sources of high-temperature and high-pressure superheated steam for the generator unit. One is to concentrate the black liquor in the concentrator, and then enter the alkali recovery furnace for combustion, burning the organic components in the black liquor to generate heat energy, which is absorbed by the alkali recovery furnace to generate medium and high-pressure steam for power generation; The other is that the coal is transported to the circulating fluidized bed boiler for combustion, heating the deoxidized soft water in the circulating fluidized bed boiler and generating high-temperature and high-pressure superheated steam. The power generation capacity of this waste heat and residual pressure unit is determined by the waste liquid generated during drying in the production link, which is not flexible.

4.2 Potential analysis of power plant load side in cement enterprises

The continuous production of cement industry is to improve production efficiency, not limited by production process. It has interrupting potential in production process and can participate in power demand response. The main production loads of rotary kiln and vertical kiln account for 45% of the total load and 16% of the total adjustable load.

Load regulation of cement industry is shown in Table 2 below.

Table 2. Load Control in Cement Industry.

Load Category	Major Installation	Load Ratio	Regulatory Mode	Regulatory Time		Adjustable Load Ratio			Total
				Setup Time	Response Time	Resumption Operation Time	Individual Effect	Overall Proportion	
Main production load	rotary kiln	25%	automatic	2h	5h	2h	40%		
	vertical kiln	20%	automatic	2h	5h	2h	30%		
	raw meal mill	5%	automatic	1h	5h	1h	20%	19%	
	cement mill	5%	automatic	1h	5h	1h	20%		24%
	ball mill	5%	automatic	1h	5h	1h	20%		
	conveyor belt motor	6%	direct (flexible)	minutes	5h	minutes	50%		
Auxiliary production load	air compressor	5%	direct (flexible)	minutes	5h	minutes	50%		5%

office lighting <1%
 direct (rigid) 4h
 second grade <1%
 split and central air conditioning system
 No production load
 direct (flexible) 4h
 second grade <1%
 domestic electricity <1%
 direct (rigid) 4h
 second grade <1%

5. Development trend outlook

At present, under the national "double carbon" economic development goal, the government's management policy for self owned power plants is being tightened step by step, gradually stopping the disorderly development of self owned power plants. Due to the characteristics of multi energy cogeneration, self owned power plants generally have the effect of comprehensive utilization of resources. Encouraging self owned power plants to participate in the regulation of power grid supply and demand is of great significance in improving the efficiency of energy comprehensive utilization, improving the balance between supply and demand of regional power grids, and improving the energy consumption and environmental protection level of self owned power plants, which is also the direction of future development of self owned power plants.

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