

# Research and Measures on Reducing Electricity Consumption in Thermal Power Plants

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## Abstract

Energy conservation and consumption reduction have become the top priority for the development of enterprises and even the country in the current and future periods. In order to further adapt to the national energy strategy demands and reduce the plant electricity consumption rate, the turbine workshop of a certain power plant, based on the original four 135 (T) SBII-JA feedwater pumps, has continuously conducted research. By measures such as coordinating with the peak shaving of the units, adjusting the operation mode, reducing start-stop operations, and extending the operation time of high-efficiency pumps, a large amount of plant electricity can be saved, further tapping efficiency and increasing potential, and improving the economic efficiency of operation.

## Keywords

Factory Electricity Consumption; Peak Shaving; Feed Water Pump; Economy.

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## 1. Introduction

Reducing the power consumption of power plants is a complex systematic issue. This paper aims to study the factors affecting the plant power consumption of power plants and, on this basis, propose feasible measures to reduce the plant power consumption.

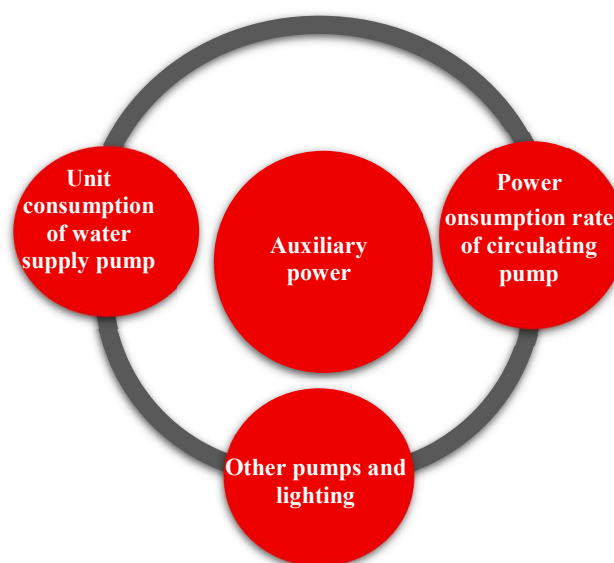


Fig. 1 Shows the main equipment consuming electricity in the factory

Plant power consumption refers to the electricity consumed by the production and operation of plant equipment in power plants, including the electricity consumed by motors, transformers, heating, ventilation and other devices during the production process [1]. In terms of power plants, the main consumption of plant electricity is on the pumps and auxiliary machines of boilers and turbine systems. For turbine workshops, it refers to equipment such as electric feed water pumps, circulating water pumps, lubricating oil pumps, and drainage pumps. According to statistics, the electricity consumed by high-pressure auxiliary equipment such as water pumps accounts for approximately 70% to 75% of the factory's total electricity consumption[2]. Reducing the electricity consumption of high-voltage auxiliary equipment is the key to lowering the factory's electricity consumption.

As can be seen from Figure 1, the main equipment and facilities consuming electricity in the current factory can be divided into three points. First: The operation mode of the feed water pump and the configuration of the number of feed water pumps in operation; Parameter control, pump outlet pressure, current. Second: Based on the current status of the circulating pumps, the number of circulating pumps in operation should be configured in a timely manner according to the load distribution method of the unit operation. Third: Allocate the operating time reasonably for other pumps, lighting, the start and stop of drainage pumps, and the lighting time in the factory building.

## 2. Operating Mode of Feed Water Pump

During the normal operation of the pump and motor, improper parameter control or timely adjustment can lead to low equipment operation efficiency and waste of plant electricity. For instance, if the setting value of the speed control valve of the speed-regulating pump is too high, the output of the feed water pump will increase and the power consumption will rise [3].

As shown in the following table: #8 and 11 feed water pumps are constant-speed feed water pumps, while #9 and 10 feed water pumps are hydraulic coupling variable-speed feed water pumps. They are the pump groups that consume the most plant electricity and have the greatest energy consumption. During the start-up and shutdown of the pump, the constant-speed pump is driven at a fixed frequency and speed, and its motor capacity remains constant. However, the variable-speed pump can adjust and intervene according to the pressure of the water supply pipe and its operating status, minimizing the pressure of the water supply pipe as much as possible and keeping it within the process card range all the time. Therefore, when a constant-speed pump starts up, it is usually operated in conjunction with a variable-speed pump. This not only significantly reduces the current of the variable-speed pump and maintains a relatively low main pipe pressure, but also, through a lower main pipe pressure, to a certain extent, improves and reduces the current of the constant-speed pump, thereby lowering its operating power consumption and further reducing the plant's electricity consumption.

**Table 1.** Specifications for the Pump Body of the Secondary Station feed water Pump

Serial Numble	Model	Internet traffic /h	Lift m	rotational speed r/min	Efficiency %	shaft power kW	npsH	series
#8	135SBII-JA	506	1750	2985	82.1	3052	6	8
#9	135(T)SBII-JA	506	1750	speed regulation	82.1	3052	6	8
#10	135SBII-JA	506	1750	speed regulation	82.1	3052	6	8
#11	135SBII-JA	506	1750	2985	82.1	3052	6	8

### 2.1 Reduce Throttling Losses in the Water Supply System.

According to the standard parameters of the feed water pump body and in combination with the current operation mode of the motor and pump, as shown in Table 1, in terms of output, with the

increase of the operation years of the pump set, its own efficiency decreases, and there is also throttling loss in the constant and variable speed pump system. To further reduce the unit consumption of the feedwater pump, it is necessary to decrease the throttling loss of the feedwater system.



Fig. 2 Inlet of the feed water pump



Fig. 3 Outlet of the feed water pump

Although throttling regulation is a common flow control method, it will cause certain energy loss. Specifically, the throttling regulation losses mainly include the following aspects:

- ① Valve resistance loss: When the opening degree of the valve decreases, the resistance of the valve will increase, thereby causing energy loss.
- ② Inertial loss: When the flow rate changes, the inertia of the liquid will cause changes in the fluid's velocity and pressure, thereby resulting in additional losses.
- ③ Turbulence loss: Turbulence occurs at small holes or narrow slits, resulting in energy loss of the fluid.

Although throttling regulation will cause certain losses, in practical applications, there are still many occasions where throttling regulation is needed to control the flow rate. To reduce the losses of throttling regulation, the following measures can be taken:

- ① Select valves reasonably: Choose the appropriate type and structure of valves based on specific working conditions to minimize valve resistance as much as possible.
- ② Select an appropriate control strategy: Based on actual needs, choose an appropriate throttling regulation control strategy. Under the premise of ensuring the accuracy of flow control, minimize the loss of throttling regulation as much as possible.
- ③ Optimize the pump design: By optimizing the pump design, the energy loss of the pump can be reduced as much as possible, and to a certain extent, the loss of throttling regulation can be decreased.

## 2.2 Switching and Adjusting the Operation Mode of the Feed Water Pump.

The No. 2 Power Station of the Thermal Power Department has four 135 (T) SBII-JA type feed water pumps. Feed water pumps #8 and 11 are constant-speed feed water pumps, while feed water pumps #9 and 10 are hydraulic-coupler-speed-regulating feed water pumps.

Statistically collect the factory electricity that can be saved and the cost saved by reducing the current through the operation mode of the pump and the control of the feed water pump's rotational speed and current.

- ① Strengthen the quality control of maintenance, ensure the reasonable backup of the feed water pump equipment, and guarantee the tightness of the recirculation door
- ②: Strengthen the speed control of the variable-speed feed water pump and adjust the pressure of the feed water pipe to be within the range indicated on the process card.

After the operation mode is determined, make full use of the energy-saving advantages of the variable-speed pump and carry out refined adjustments. By reducing the rotational speed of the feed

water pump to further decrease the current of the feed water pump, the pressure of the feed water pipe will be controlled from over 15 MPa previously to within the range of 14.7 to 15.0MPa. During the process, the monitoring intensity should be strengthened, and the fluctuation of the boiler load should be closely monitored to make timely adjustments.

H: Head, unit m

Q: Flow rate, unit m<sup>3</sup>/h

P: The power of the shaft, unit KW

$\rho$ : The density of the pumping medium, here  $\rho=1000\text{kg/m}^3$

g: Gravitational acceleration, 9.8 meters/second<sup>2</sup>

$\eta$ : The efficiency of the water pump, Range 0-1

### 3. Optimization Implementation Plan for Drainage Pump

The water in the hydrophobic tank is pumped by the hydrophobic pump to the hydrophobic tubes of the deaerator, and then distributed to the hydrophobic tubes of each deaerator through the hydrophobic tubes[4]. The water recycled by the feed pump enters the feed pump recirculation main pipe and enters the deaerator separately. Previously, the start stop time of the day shift pump was equal to the start stop time of the night shift pump. For the convenience of calculation, we took each twice. Due to the peaking and tiered electricity consumption, the electricity price at night is lower than that during the day. Therefore, if the total start-up and shutdown time of the pump remains unchanged each day, the difference in electricity price between the peak period and the off-peak period can be approximately regarded as the cost saved per hour before and after optimization.

The power of the pump is:

$$P = \sqrt{3}UI\cos\varphi = 1.732 \times 380 \times 100 \times 0.85 = 55943.6\text{W} = 55.9\text{KW}$$

$$\sqrt{3} = 1.732$$

U: It's the working voltage, here it's 380V;

I: It's the working current, we take the average value of 100A;

Cos  $\varphi$ : is the power factor. Here, we select 0.85 based on the power factor of most electrical appliances;

After optimization, the daily cost savings are:

$$P \times T \times \$ = 55.9\text{KW} \times 4\text{h} \times \$ = 223.6\$$$

T: It takes about 2 hours to empty the drainage tank water level on average, and the pump start time for the day shift before optimization is 4 hours;

\$: Electricity price difference

### 4. Next Step of Work

The energy consumed by electric feedwater pumps is the "plant electricity" of the power plant, while the energy consumed by steam driven feedwater pumps is the thermal energy of steam[5]. The latter achieves the cascading utilization of energy and increases the extraction volume. Therefore, new methods can be considered to reduce the power consumption of the plant. In the current system structure, the interlock value of the pressure (head) of the feed water main pipe is relatively high, and reducing the unit consumption of the feed water pump is ultimately achieved by reducing the shaft power of the feed water pump.

Reasonably set the start and stop time of the drainage pump, cooperate with the peak shaving of the unit, and try to start the drainage pump to draw water during the normal and valley periods when the grid electricity price is low, in order to reduce the power consumption of the plant.

## 5. Summary

Reasonably adjust the start and stop of the circulating pump, make corresponding changes in a timely manner based on the operation mode of the boiler, and continue to tackle the conditions for the interlocking of the standby operation of the circulating pump. In summary, the power consumption of the feed water pump directly affects the economic indicators of the entire plant. By reducing the unit consumption of the feed water pump, the power consumption rate of the plant can be lowered, thereby achieving the goal of energy conservation and consumption reduction.

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