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ENERGY RESOURCE-SAVING IN A THERMAL POWER PLANT AUXILIARY

Abstract: The paper presents the main reasons of electric drives wasteful modes in the system of Thermal Power Plant auxiliaries. As example, the way for improvement of the modes of work of electrical drives on the Takhiatash Thermal Power Plant in Uzbekistan, the use of frequency-controlled drive for feeding electric pump with the power of 4000 kW is suggested.

Keywords: Thermal Power Plant, auxiliaries, electric motor, operating mode, frequency regulated electric drive, power block.

Introduction

The growth of electricity consumption in all countries of the world, as well as in the Republic of Uzbekistan over the past decade, significantly exceeded the rate of commissioning of generating capacity, which led to the formation of a deficit of free capacity reserve.

The problem of power shortage can be solved in two ways: either by increasing the pace of construction and commissioning of generating capacity, or by rational consumption of energy produced and the introduction of the latest energy-saving technologies. It must be borne in mind that the cost of creating 1 kW of generating capacity amounts to a huge amount of investment, while the cost of introducing modern energy-saving technologies is no more than 10 percent of the invested amount, respectively. In addition, the construction and commissioning periods of thermal power plants range from 3 to 5 years and require significant investments, while the results of energy savings in the implementation of energy-saving technologies can be obtained in the next one to two years [1–5].

One of the largest consumers of electricity are blade pumping units, fans, compressors, which are used in industry, agriculture, and also in the ON system of a thermal power plant.

The system of own needs (ON) of a power plant is a complex of auxiliary electrical equipment of a power plant, ensuring the uninterrupted operation of its main units (steam boilers, turbine generators). The power plant's own needs include: power and lighting power stations, battery systems, emergency power sources, electric motors of all mechanisms – pumps (water, oil, oil, etc.), fans, smoke exhausters and the most common in thermal power plants – unloading

mechanisms railway cars, fuel supply, coal preparation and dust preparation.

Energy saving in the ON system is considered on the example of a 4000 kW feed pump at the Takhiatash thermal power plant of the Republic of Uzbekistan. Asynchronous electric motors with a squirrel-cage rotor are installed on electric motors in the own needs system of the Takhiatash Thermal Power Plant (TPP), the electric motors are powered from 6 and 0.4 kV. Monthly electricity generation is 281875975 kW · h, and electricity consumption for own needs is 29033225.4 kW · h [according to the data of the technical and technical equipment of the Takhiatash TPP]. The quality of energy-saving technology of the pumping unit uses a variable frequency drive.

Experimental Part

Today, the consumption of electricity for own needs exceeds 10%, although it should not exceed 5–7% of the total generated electricity.

The main reason for the uneconomical modes of operation of the mechanisms of their own needs and the loss of fuel and electricity are variable loads of thermal power plants. Due to the variable modes of most of the power units, the operational reliability and efficiency of both the main heating and mechanical equipment and the mechanisms of the system's own needs – numerous pump and fan installations and their drive asynchronous motors – are deteriorating. Frequent start-ups and shutdowns of power units, changes in their loads are accompanied by losses due to non-optimal operating modes of the main equipment and mechanisms of the own needs system, due to the need for throttling of heat carriers (steam, water, air, gases).

Frequency-controlled electric drive is one of the most effective tools for improving energy consumption and reducing costs in the production and distribution of electrical and thermal energy, and to increase the reliability of operation.

The composition of the frequency – controlled electric drive includes a standard or special asynchronous or synchronous electric motor, a transistor or thyristor frequency converter, a matching transformer or reactor, a starting control and switching equipment [2].

Consider the case when the motor with a constant moment of resistance on the shaft is powered at rated voltage from the mains with a frequency less than nominal. Reducing the frequency will cause an increase in magnetic flux and an increase in torque. Since the moment of resistance remains constant, the slip will be reduced to such an extent that the

balance between the engine torque at a reduced frequency and the moment of resistance is maintained.

Due to an increase in the magnetic flux, the rotor current decreases, and the no-load current increases. The stator current may increase or decrease, as well as for the case of increasing voltage.

Thus, lowering the frequency is almost equivalent to increasing the voltage. Therefore, if, as the frequency decreases, the voltage decreases accordingly, the magnetic flux, and hence the no-load current, rotor current, and stator current, will remain the same as during normal operation. In this case, there will be some change in the losses in the steel and, consequently, the active component of the no-load current. These changes will practically not affect the magnitude of the stator current [1–2].

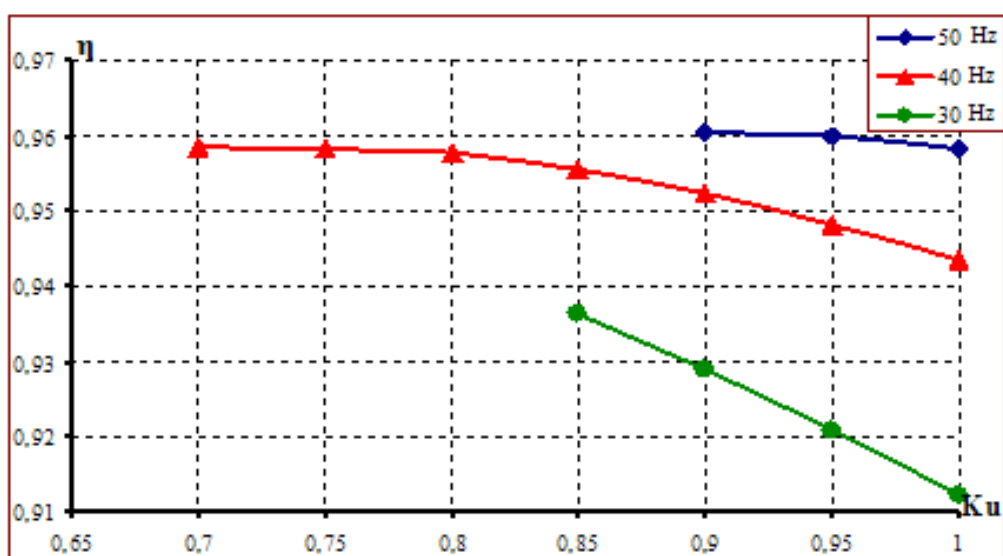


Figure 1. Efficiency change with frequency and voltage Ms = 0.87

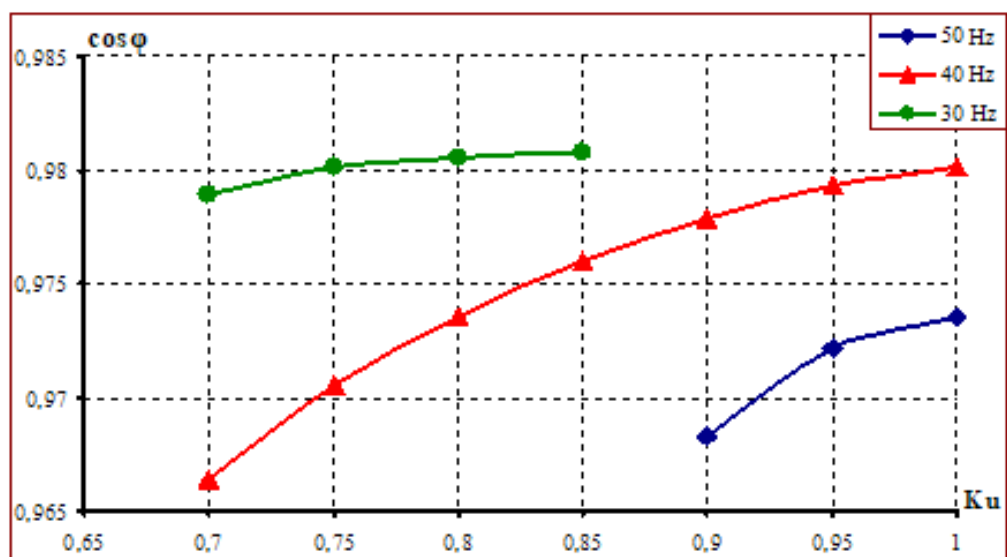


Figure 2. Power factor change with frequency and voltage Ms = 0.87

Based on the foregoing, the calculation of the frequency-controlled electric drive of the feeding electric pump was made. Technical parameters of the electric motor: nominal power 4000 kW (working power 3500 kW), voltage 6 kV, moment of resistance $M_s = 0.87$, nominal stator current 400 A, power factor $\cos\varphi = 0.89$, electric motor efficiency – 97.3%. The results of the calculation are shown below in graphical form (Fig. 1. and Fig. 2). The working efficiency of the pump unit at a load of $M_s = 0.87$, $\eta = 0.947$. And the total engine loss was 196 kW. After changing the frequency and voltage, the engine efficiency reaches $\eta = 0.96$ with the same load. And the total loss of the engine is 146 kW. It should be noted that the use of a frequency – controlled electric drive makes it possible

to save energy by reducing the loss of electric motors in the ON TPP system.

Conclusions

Calculations have shown that when using a frequency – controlled electric drive, it is possible to reduce engine losses, increase efficiency, and also improve the quality of process control.

In addition, the use of a frequency – controlled electric drive leads to the following possibilities:

- high quality regulation;
- large range of regulation;
- high profitability;
- ease of use;
- ease of operation and maintenance.

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