FREQUENCY-CONTROLLED ELECTRIC DRIVE FOR FAN LOAD

Nikulcha M.V., *nikolaynikulcea2017.77@gmail.com*
Chaikovskyi T.O., *tima.chay14@gmail.com*
Dmytro Motornyi Tavria State Agrotechnological University

Nowadays, it is important to increase the efficiency of the supply of technological machines in the sectors of uninterrupted and high-quality electricity production and to carry out research aimed at creating energy-saving operating regimes. In this respect, particular importance is given to improving the energy efficiency of the production lines and chemical pumping machines with modern electromechanical and semiconductor converters, microprocessing devices for automatic control. Special attention is given to the development of technical means and technologies that ensure energy-saving operating modes of pumping machines by controlled electric drives in chemical industry.

A review and analysis of the operating mode of turbochargers revealed that in order to obtain high technical and economic performance of electric drives for centrifugal pumps and fans, the most efficient way of controlling the speed of rotation of asynchronous engines is the frequency control method, and for turbochargers, the smooth start of high-voltage synchronous engines capable of performing the most economically feasible modes of operation, in both static and dynamic modes, is a highly effective method [1].

The study of known criteria for optimizing a frequency-controlled asynchronous electric drive makes it possible to write down a generalized complex criterion of drive control in static modes:

$$N = c_1 \iota_1 + c_2 \Delta p + c_3 \tau + c_4 \frac{I}{\eta} + c_5 \frac{I}{\cos\varphi} + c_6 \frac{I}{\varphi \cos\varphi} = N_{min} \qquad (1)$$

where $c_1, c_2, ..., c_6$ – weighting factors for individual optimization criteria of the minimum current, loss, heating, maximum efficiency, power ratio and their product respectively.

The special features of defining the energy-efficient modes of turbochargers with maximum performance by transferring asynchronous engines to frequency control are considered. Saving electricity and extending the life of the equipment will be optimal when controlling the speed of rotation down from the nominal speed. Also, the operating costs are reduced and resource saving in the pumping machines is ensured. The calculations made it possible to develop a structure for an energy-efficient pumping station, which is characterized by an acceptable cost of equipment and a minimum energy cost for maintaining the given pressure on the reservoir. The station consists of two groups of pumps of two units. When two pumps are operating simultaneously, the control is always from two units. The increase in the cost of equipment of this station is paid for by additional energy saving, for pumps of 30.0 kW capacity the payback period is 1.2... 1.8 years, for 132.0 kW pumps – 1.0... 1.6 years [2].

The diagram of start-up of high-voltage electric motors of air blowing units with the use of a smooth-start device is presented in figure 1. It shows the timing of the start-up power losses during the smooth start-up of ΔWu.p. for normal mode (curve 1) and in deep throttle mode (curve 2).

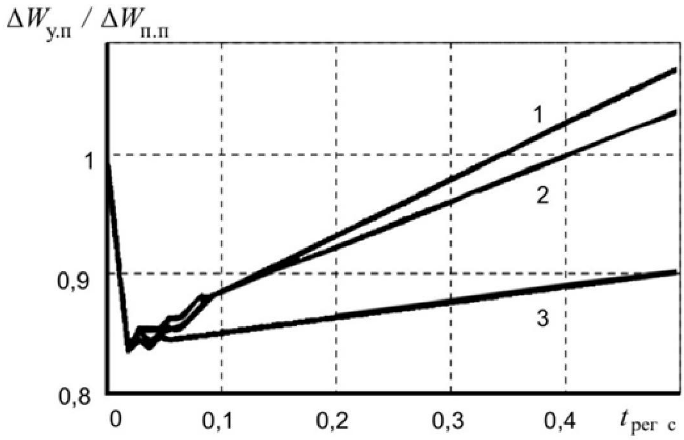

Figure 1. Start-up power loss graphs for a smooth start

The graphs show quite clearly a minimum of the power losses caused by the decrease in the oscillation of processes at a time of 0.02...0.04 seconds (one or two periods of network voltage) of loss is reduced by 15 per cent compared to loss of direct start. Later, the total electrical losses are increased by increasing the operating time of the engine at reduced speeds. In the case of a deep-throttling fluid start (curve 2), the effect of reducing energy losses is greater due to the extension of the time zone during which the energy loss is less than the trigger loss. It is shown that for adjustable electric drives of pumping machines of chemical production with a fan static characteristic, one of important quality criteria for energy and reliability reasons is a loss of power [2].

The optimum correlations between the frequency and voltage of the inverter are determined, which ensure the necessary value of the magnetic flow of the engine and minimize power losses in the electric drive. In a frequency-controlled asynchronous electric drive, the implementation of loss minimization techniques is more complex, as the formation of a flow in an asynchronous machine requires the use of special sensors or complex control algorithms.

It has been established that, in an asynchronous electric drive with fan load, the torque on the engine shaft is an unambiguous function of the speed of rotation, in which case the magnetic flow and, respectively, the engine voltage are determined only by the speed of rotation and the output speed.

By evaluating the results obtained, it can be said that the system of frequency-controlled extreme electric drive, which minimizes the loss of engine power, has good energy saving and dynamic properties. In addition, the greater the efficiency of the electric transmission system, the longer the idling periods of the engine.

References

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