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ENERGY EFFICIENT ADAPTIVE SUPPLY SYSTEM OF HYDRAULIC SPINDLE BEARINGS

Improving energy efficiency is the actual problem of the industrial sector of the Ukrainian economy. The problem improving of energy efficiency is directly related to the preservation of the environment, reduction of harmful emissions and reduction of fossil resource consumption. Introduction of energy saving technologies contributes to energy independence of Ukraine.

One of the most important indexes of the efficiency of the machining processes – accuracy, productivity, production cost are provided basically by the form-shaping machine tools knots. Improving the technical level of existing machine tools and the successful introduction a new generation of machine tools consists in possibility to provide high indexes of quality and efficiency of their exploitation.

In work [1] is noted, that a significant influence on the energy consumption during processing have a drive of main motion of machine tool (about 30%) and the auxiliary knots of machine tool (up to 60% of the total electric power consumption).

Application adaptive hydraulic bearings as supports of spindle knots is an effective direction improving the accuracy of machine tools [2]. Reduced operating costs due to regulation the geometric, operating parameters of hydraulic bearings depending on the character of the technological load is their significant advantage. The existing systems supply of hydraulic bearings [3] have a sufficiently low indexes of energy efficiency. Therefore, in this article to

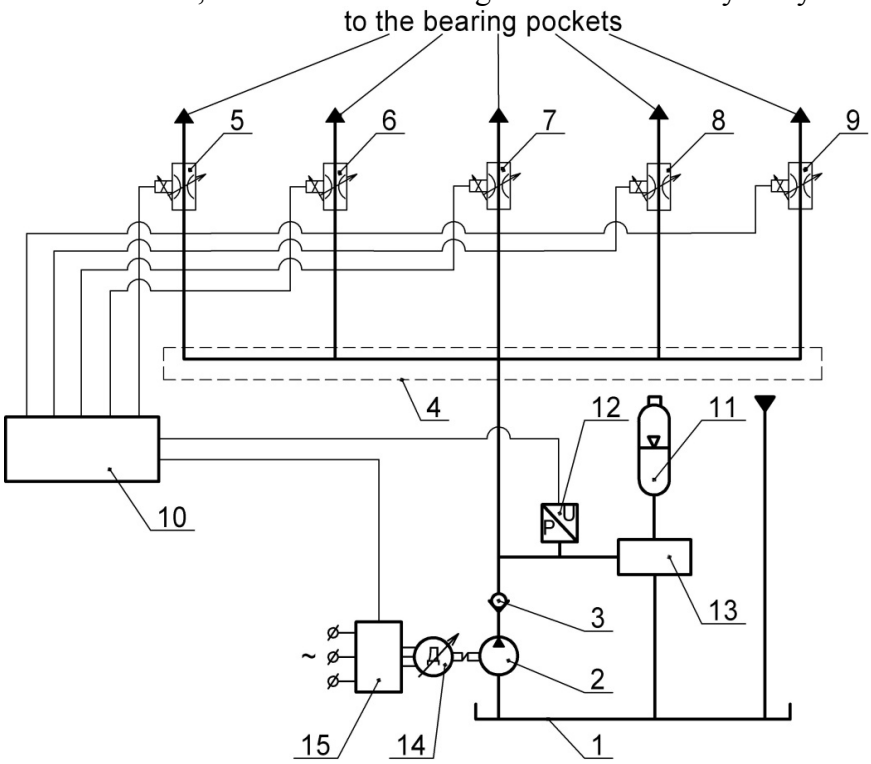
researching and improving energy efficiency of systems supply of hydraulic bearings of rotating knots of technological equipment basic attention is given.

In article [4] is shown that the regulation of supply modes and use the frequency-variable drive of pump are the perspective ways improving energy efficiency of systems supply of hydraulic bearings of rotating knots of technological equipment.

Adaptive supply system of hydraulic supports of spindle knot (Fig. 1) with use the adjustable valves of flow rate, hydraulic accumulator and the frequency-variable drive of the pump is proposed in this work. For reduction of power losses at the viscous friction at high speeds of rotation of the spindle designs of regulated hydrostatical – hydrodynamic bearings with pockets ellipsoidal shape and a smooth change of the flowing section [5 6] is used. This allows to reduce power losses caused by a jumplike change of the flowing section of the segment.

Supply of hydraulic spindle bearings is via the adjustable valves of flow rate 5 - 9. Throughput ability of valves is infinitely adjustable by the microprocessor 10 depending on the spindle speed and lubrication modes of bearings. In the hydrodynamic lubrication mode and at idle speed of equipment the bearings are supplied by hydraulic accumulator 11. Pumping unit in this case disabled. When the pressure of the working fluid in the supply system is reduced below preliminarily determined value, the pressure sensor 12 sends a signal to the microprocessor 10, that controls the frequency converter 15. Frequency converter 15 starts to gradually increase the frequency of the input current of asynchronous electric motor 14 drive of hydraulic pump 2, thereby ensuring a smooth switching-on pumping unit for simultaneous supply of bearing and filling capacity hydraulic accumulator 11 to the required value of pressure.

When the spindle speed exceeds a certain limit value, which is set by the adaptive regulator, microprocessor 10 stops the supply of working fluid to a certain number n of the bearing pockets, which are specified by program. This is done by overlapping the respective proportional flow rate valves. Thus, lubrication of bearing is carried in the hydrodynamic mode.



1 – tank, 2 - pump 3 – return valve, 4 – fluid flow distributor, 5 - 9 – proportional flow rate valve, 10 – microprocessor control unit, 11 – hydraulic accumulator, 12 – pressure sensor 13 – unloading unit, 14 – electric motor, 15 – frequency converter

Fig. 1 – Adaptive supply system of hydraulic spindle bearings

With the purpose of cooling the bearing, during work at high speeds, a working fluid is supplied to the (k-n) bearing pockets.

When the spindle speed decreases below a certain limit value, microprocessor 10 is resuming the supply of working fluid in the all bearing pockets. This is done by adjusting the throughput ability of respective proportional valves of flow rate 5-9. The system switches to the hydrostatic lubrication mode.

During the work of technological equipment to idle, supply of the working fluid to the bearing pockets is reduced to a minimum. This is ensured by adjusting a throughput ability of proportional valves of flow rate by microprocessor control unit.

Experimental researches of the electrical consumption by pump drive motor of supply system of hydraulic spindle bearings at different pressure adjusting schemes were carried out. By results of experimental researches the dependences of electric power, consumed by pump drive motor of supply system of hydraulic spindle bearings from the pressure in the bearings were established. Results of experimental researches (Fig. 2) show the efficiency of the frequency-variable drive pump in the supply system of hydrostatic bearing of spindle knot of precision turning machine.

The proposed scheme of the adaptive hydraulic supply system of spindle bearings with software adjusting a feed mode of working fluid can be used to improving the energy efficiency of wide nomenclature of hydraulic drives of technological equipment with variable exploitation modes.

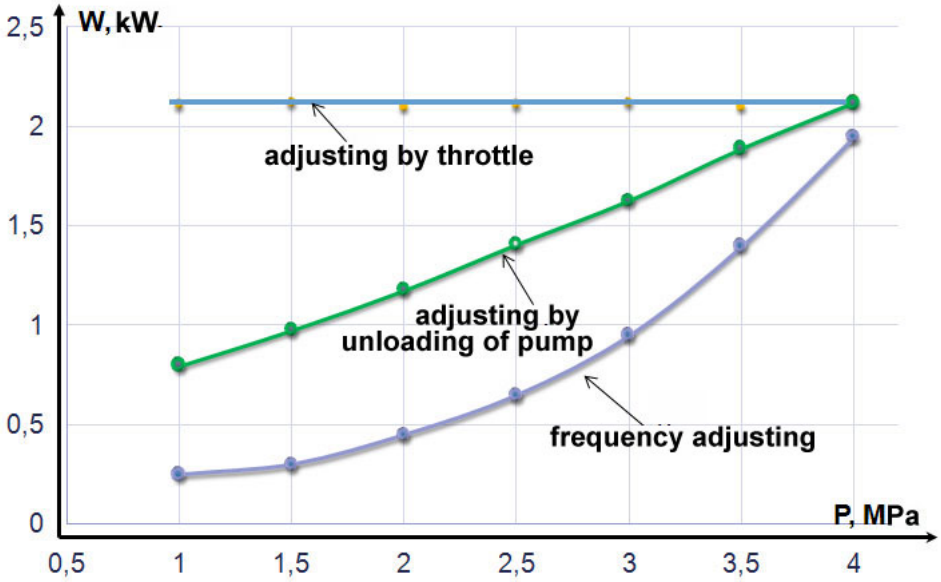


Fig. 2 – The electrical consumption by pump drive motor of supply system of hydraulic spindle bearings depending on pressure in the bearings for different pressure adjusting schemes

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EFFECTIVE MONITORING AND FORECASTING METHODS OF GPU TECHNICAL CONDITION ACCORDING TO THE BASIC TECHNOLOGICAL PARAMETERS

The appointment of a gas transportation system (GTS) of Ukraine is to ensure reliable and uninterrupted transit of natural gas from suppliers to importers and to supply domestic consumers with gas. The principle elements of the GTS are the main gas pipelines, gas distribution, gas metering stations, underground storage facilities and compressor stations with a set of main and auxiliary equipment.

Now Ukraine has a large number of different GPA types. The most common are GPA with a gas turbine driven compressor unit with a free power turbine and a centrifugal supercharger. In the operation of the pipeline the pressure is changing significantly and the temperature at the inlet to the supercharger, gas flow, the number of parallel working GPA, causing corresponding changes of operational parameters at the outlet of the compressor station. The supercharger mode changes constantly in the mode of operation. This is due to the changes in gas flow, gas composition, ambient conditions and changing of GPA technical condition overall. The main parameters of GPA is the gas pressure at the inlet (PBX) and output ofsupercharger (Rvyh), the revolutions of its rotor, the gas temperature at the inlet and outlet of the blower, the temperature of combustion products before the turbine of high pressure (TBT).

The reliability of GPA affects the operation of the pipeline which causes the uninterrupted supply of gas to consumers, as well as transportation through the territory of Ukraine. Modern development of supply technology and processing of information brings new requirements to existing control and diagnosing systems: the implementation of modern diagnostic automated complex compressor plant (SAC) KC in the system of automatic control of compressor shop (ACR) KC with given functions of remote control parameters, the condition of the equipment, and the management of a basic technological equipment from the upper level - systems engineer's workstation (AWS), that affects significantly the reliability and dependability of Ukraine's GTS. The efficiency and reliability of equipment operation is largely determined by a perfect service system, which depends both on the system performing repairs and the skill level of maintenance personnel, and on the appropriate level of operating control system performance and maintainability of the equipment.

To ensure the proper level of operation it is necessary technical diagnostics, which aims at detecting failures and faults in the early stages of their development. Technical diagnostics is the science of recognizing the state of the technical system. The structure of technical diagnostics involves two interrelated areas: the recognition theory and the theory of control suitability. Control suitability is the product property, characterizing its adaptability to the given means of control [1, 2].

The theory of recognition is used to build models of diagnostic objects and for developing recognition algorithms and decision making rules. The theory of control suitability includes