EXPERIMENTAL SETUP TO STUDY THE ENERGY INTENSITY OF TECHNOLOGICAL PROCESSES OF ENGINEERING

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Article presents the scheme of experimental installation for research the characteristics of energy capacity of technological processes of shaping in machine-building production

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Processing industries of Republic remain the most power-consuming complex, and retain their demand properties for many decades. Expansion of energy conservation efforts covering the whole country almost had not affected the industry. This is primarily due to the exploitation of the accumulated fleet of technological machines designed in the era of cheap energy and continuing their technological life now. Moreover, new technological lines are also designed based on accepted standards.

Imperfection of many technological processes and machines in terms of energy saving for many years "was not noticed" by domestic designers and technologists. The unshakable confidence of our specialists in the infinity of energy resources did not contribute to the modernization of processes and equipment and survival in strong competition.

Reducing energy costs when processing work-pieces by cutting is urgent problem of modern mechanical engineering. Creation of new and increasing energy efficiency of existing metal-cutting equipment should be based on methods of reducing energy losses along the circuit: currrent network converter of electrical energy into mechanical energy, transmission, cutting zone. Considering the different nature of the phenomena occurring in links of chain, it is advisable to solve the problem of increasing energy efficiency in three successive stages:

- introduction of saving methods of converting electrical energy into mechanical energy;
- introduction of saving methods of transportation of mechanical energy to the cutting zone;
- introduction of saving conditions and parameters for implementation of cutting process.

The third part is of interest for cutting theory. It is the work of cutting that ultimately determines the amount of energy consumed by the motors of the machine from the electrical network, as well as the load losses in the transmission. Therefore, the solution to the problem should begin from final link – from determination of optimal conditions for implementation of cutting process [1].

Cutting is the main technological method in the manufacture of machine parts and mechanisms. Its labor intensity in most branches of mechanical engineering significantly exceeds the labor intensity of foundry, forging and stamping processes taken together.

Calculation of cutting modes and the choice of rational one are the key links in the development of technological processes for the formation of specified configurations of parts, and the quality (and, accordingly, the performance) of the product, labor and money costs for its manufacture largely depend on this.

Cutting conditions are influenced by many factors that should be taken into account in calculation. These include, for example, the micro and macrostructure of the work-piece material, its physical and mechanical properties; condition of the treated surface; material and geometric parameters of the cutting tool; mechanical characteristics of equipment, etc. [2].

A number of experimental studies of the energy intensity of machine-building technological processes were carried out using the example of cutting.

Technological process of lathe machining a shaft-type part on lathe of 16K20 model is taken as object of experimental research. In the course of the experiment, a shaft made of Steel-45 material with tensile strength of 700 MPa was lathed. Measurements are carried out for various process characteristics, which include the processing mode, spindle rotation rate, feed rate and depth of cut. During the experiment, the modes were selected in such a way that the cutting power was constantly increasing.

Various cutting modes are required to obtain the relationship between the cutting force and the characteristics of energy consumption of technological processes of shaping.

During the measurement process, the following energy consumption characteristics are measured:

- The value of consumed current.
- The value of active component of consumed power.
- The value of reactive component of consumed power.
- The value of the total consumed power.
- The value of power coefficient.

Experimental installation was developed to conduct experimental studies of the characteristics of energy consumption of technological processes of shaping, which consists of the following components:

- Screw-cutting lathe model 16K20.
- Three-phase active/reactive electricity meter Mercury 230 AR-01.
- Converter of interfaces Mercury 221.
- Personal computer with installed software “Mercury-Energy account LIGHT”

Lathes make 70 - 80% of the total volume of lathing work. These machines are designed for smoothing and semi-smoothing, as well as for cutting various types of threads and are characterized by high rigidity, sufficient power and wide range of spindle rotation speeds and tool feeds, which allows to machine parts in economical modes using modern progressive tools made of carbide and super-hard materials.

Lathes are equipped with various devices that expand their technological capabilities, facilitate the work of the worker and improve the quality of processing, and have a high level of automation.

Technical characteristics allow to fully using the capabilities of advanced tools when processing various materials. Lathe 16K20 is designed for the needs of enterprises in all industries.

The key point to energy saving is correct energy metering.

Mercury 230 AR meters are designed to account for active and reactive electrical energy, power in one direction in three-phase 3- and 4-wire alternating current networks with a frequency of 50 Hz through measuring current transformers or directly with the possibility of transmitting measurements and accumulated information about energy consumption by digital interface channels [3].

They are operated autonomously or as part of any information and measurement systems for technical and commercial accounting.

Meters provide:

- Account of active and reactive electricity in one tariff mode in total for all phases or account of active energy in each phase separately (optional).
- Also possible multiple tariff account, differentiated by zones of the day when switching tariff zones in the meter with external device via RS-485 or CAN interface (up to four tariffs).
- Measurement of instantaneous values of active (P), reactive (Q) and total (S) power for each phase and for the sum of phases. Determination of the direction of the full power vector;
- Measurement by phase: current (I), voltage (U), frequency (F), $cosf_i$, angles between phase voltages;
- Possible to control external devices for switching off/on the load of consumer through programmable pulse output;
- Transfer of measurement results via 220/380V power network (only consumed energy), CAN, RS-485 interfaces (all available data);
- Programming of meters in the phase summation mode “on module” to prevent theft of electricity in case of violation of the phasing of connection of current circuits of the meter.

The control, measurement and indication device (hereinafter referred to as CMID) together with the terminal block is installed in the base of the frame

Indication control buttons are installed in frame cover and connected mechanically to the CID. Current transformers are used as current sensors in the meter. Resistive dividers are used as voltage sensors. The signals from the current and voltage sensors are fed to the corresponding inputs of the analog-to-digital converter (ADC) of the microprocessor.

The ADC of the microprocessor converts the signals coming from the current and voltage sensors into digital codes proportional to the current and voltage.

Microprocessor multiplying the digital codes obtains value proportional to the instantaneous active power. Integration of power over time provides information on the amount of active energy. Using the appropriate algorithms, the counter also calculates all the required parameters.

This installation allows carrying out the necessary research of characteristics of energy consumption of technological processes of shaping.

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