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Paper Authors:
Urinov Nodir Nasilloevich[1], Saidova Mukhabbat Khamraevna[2]

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ALGORITHM OF AUTOMATED CONTROL OF ENERGY INTENSITY OF MECHANICAL ENGINEERING TECHNOLOGICAL PROCESSES

Urinov Nodir Nasilloevich[1], Saidova Mukhabbat Khamraevna[2]
Doctoral student of "Electrical machines and technologies" department of Bukhara Engineering-Technological Institute[1].
Senior lecturer of "Technology and equipment" department of Bukhara Engineering-Technological Institute[2].
e-mail: urinov1960@mail.ru

Abstract: The work proposes algorithm that allows significantly increasing the energy efficiency of automated control of technological processes of shaping by reducing the reactive component of consumed power, and as a result, increasing the current power factor.

Keywords: energy saving of technological processes of automated control, technological process, energy consumption, compensation current,

Introduction

The most important component of energy saving is the energy intensity of the mechanical engineering technological processes at cutting machining. At present, the energy intensity of technological processes in Uzbekistan significantly exceeds the energy intensity of similar processes in industrialized countries. This is especially important for the reason that the high-energy intensity of technological processes leads to energy consumption during their implementation, reaching up to 70% of the total energy consumption by a mechanical engineering enterprise.

One of the methods for reducing energy consumption in the implementation of mechanical engineering technological processes is the method of compensating for the reactive component of the power consumed during their implementation. It is advisable to implement this method by means of automation, which allows not only taking into account the real parameters of the technological process and equipment, but also increasing the efficiency of compensation and, consequently, reducing the energy intensity of technological processes and increasing the competitiveness of manufactured products.

Main part.

When developing an algorithm for the functioning of automated control system for energy saving of technological processes of shaping, the power factor was chosen as a control parameter as the most objective indicator characterizing energy efficiency of these processes. To determine the values of the power factor, it is necessary to determine the values of the consumed current and voltage in the network, and it is necessary to know the value of the phase angle between these parameters. The latter can be obtained by simple calculations.

To implement the algorithm for the automated control of energy saving of technological processes of shaping, it is necessary to determine the specified power factors:

– required value, at which the implementation of the technological process will take place in the mode of maximum energy efficiency.

– critical value, the value of which the power factor should not exceed.

The latter is necessary to avoid the overcompensation effect, which in turn leads to

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a decrease in the energy efficiency of the process and an increase in losses.

Condensers were chosen as devices that create a compensation current. Based on the nomenclature of these compensators, the range of regulation, the features of the load characteristics of the technological process and the requirements for the speed of the system, and the number of control steps have been set.

The control range is determined by the minimum value of the power factor (at the blank cycle of electric motor of the machine) and by the required value. This range is divided into *n* steps of regulation, each of which is assigned the corresponding capacitance of the condenser [1].

After the input of required values is carried out, the power supply of machine-tool equipment implementing the technological process is checked. Next, the current values of the consumed current and network voltage are read, and the phase angle and power factor are determined. The obtained value of the power factor is compared with the required value and, if it is lower, a condenser is connected. Next, the new values of the power factor are read and, if necessary, additional condensers are connected [2]. In cases where the current value of the power factor is greater than or evenly required, as well as in cases where all condensers are already connected, it is necessary to check for exceeding its critical value. If the critical value is exceeded, it is necessary to disconnect the condenser. This is necessary in order to avoid the overcompensation effect, which leads to a decrease in the energy efficiency of technological process.

With the correct selection of the capacitance of the condensers and the number of control steps, the efficiency of the proposed circuit should tend to 100%, i.e. the power factor of the technological process of shaping should tend to 1.

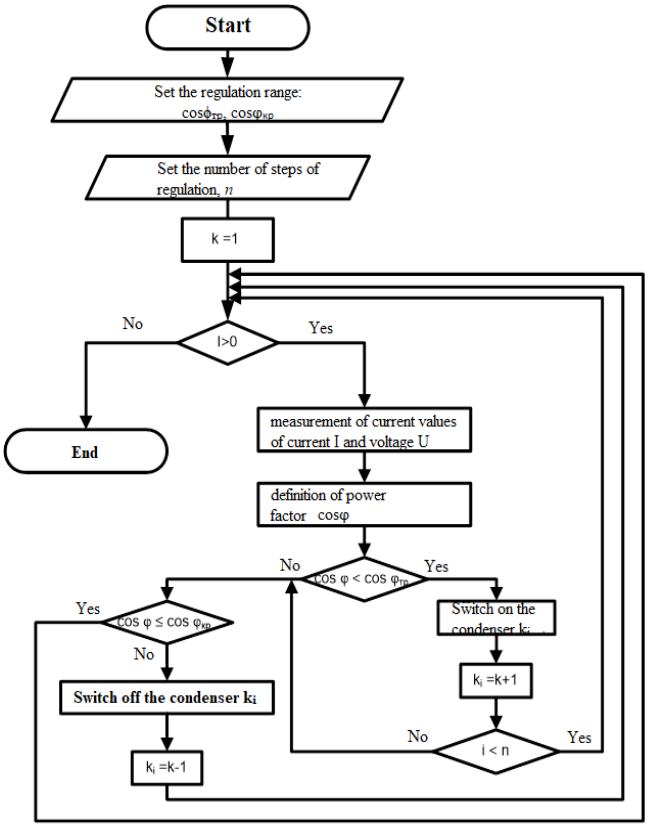

Fig. 1 Algorithm of automated control of energy intensity of mechanical engineering technological processes.

Proposed algorithm allows significantly increasing the energy efficiency of automated control of technological processes of shaping by reducing the reactive component of consumed power and, consequently, increasing the power factor. This algorithm allows taking into account such a feature of technological processes as a wide spread of load characteristics during their implementation and avoiding the effect of overcompensation.

Technological process of turning a part of type the shaft on a turning machine model 16K20 is taken as an object of experimental research. During the experiment, a shaft made of Steel-45 material with a tensile strength of 700 MPa is processed. Measurements are carried out for various process characteristics,

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which include the machining mode, spindle rotation speed, feed rate and depth of cut. In the course of the experiment, the modes were selected in such a way that the cutting power was constantly increasing.

Various cutting modes are necessary to obtain the relationship between cutting force and characteristics of energy consumption of technological processes of shaping [3].

During the measurement, the following energy consumption characteristics have been are measured:

- value of the consumed current;

- value of the active component of the consumed power;

- value of the reactive component of the consumed power;

- value of the total power consumption;

- value of the power coefficient;

The diagram of the experimental installation and its general view are shown in Fig. 2.

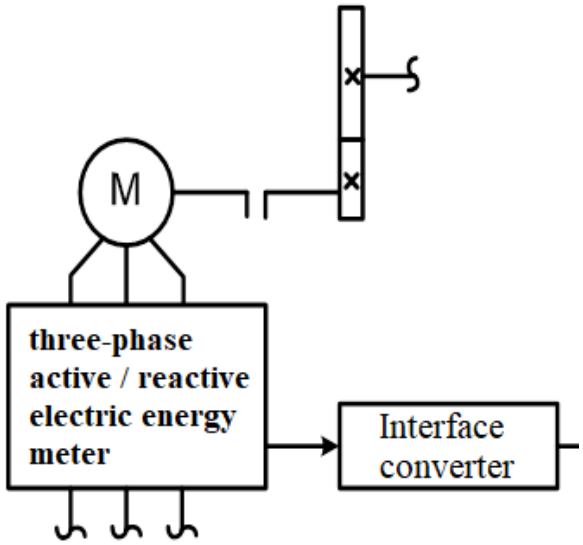

Fig. 2. The diagram of the experimental installation.

To conduct experimental research of characteristics of energy consumption of technological processes of shaping, discussed in the previous chapter, experimental installation has been created, which consists of the following components:

- turning-screw-cutting machine model 16K20;

- three-phase active / reactive electric energy meter Mercury 230 AR-01;

- interface converter Mercury 221

- personal computer with installed software “Mercury-Energy account LITE".

This installation allows carrying out the necessary study of characteristics of energy consumption of technological processes of shaping and establishing the dependences(Fig. 3 and Fig. 4).

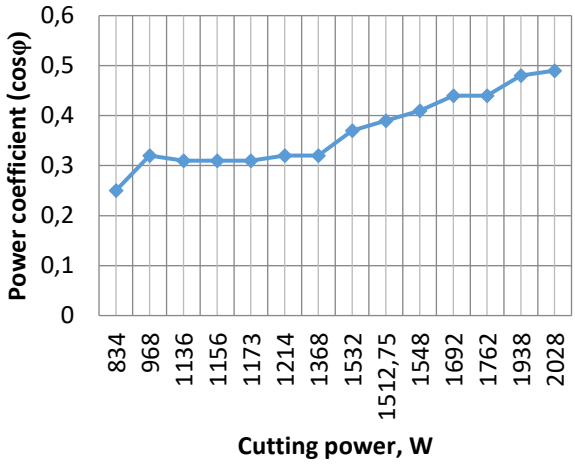

Fig. 3. Dependence of power coefficient from cutting power

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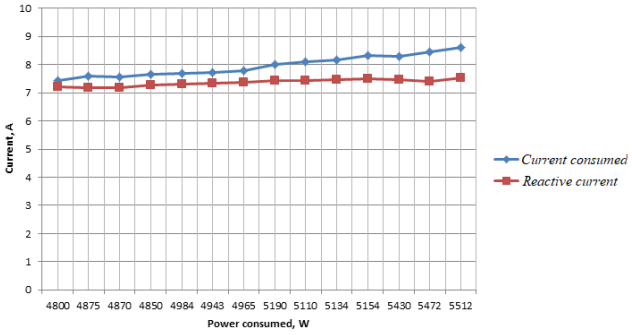

Fig. 4. Dependences of values of consumed currents on consumed power

Conclusions.

This algorithm and installation can be used by local automated energy consumption control systems, i.e. in relation to specific units of machine-tool equipment. This allows controlling energy consumption as accurately and efficiently as possible. In addition, the universality of this algorithm and possibility of its use in relation to a wide range of machine tools should be noted.

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