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Phenomena of information and energy transfer in hydraulic drive systems

Annotation. *The approach of physical aspects of the transfer phenomenon and information-energy transfer is considered. The analysis is based on the concept of the structure of the system and information and energy transfer. The scheme of interaction of the system through the process of transfer and functioning is given.*
Keywords: *transfer phenomenon; information and energy transfer; viscosity; temperature.*

In hydraulic drive systems, special irreversible processes arise, which in physics are called the transfer phenomenon. Recently, much attention has been paid to the transfer processes in hydraulic drive systems since they have a pronounced character of energy balance and are closely related to the transfer of mass, energy and momentum [1-4]. Creation of a new class of hydraulic drive systems requires a rational choice when developing a system [1]. Therefore, the creation of high-energy and efficient systems and devices with high energy efficiency and flexible readjustment of the operating characteristics on demand (by command from a computer) requires careful consideration of work processes and the organization of their management. These tasks include the creation of effective vibration protection systems, energy dissipation-shock-absorbing devices with stable characteristics, technology for the development of hydrogen generators of increased productivity using computer control, technologies of cavitation liquid media. The physical characteristics of a substance in the processes of mass transfer are the transfer coefficients of the kinematic, dynamic viscosity, the substances of internal friction of the moving layers of the medium. The change in the nature of the transfer coefficients and the physical and chemical properties of the working fluid (viscosity, density, thermal conductivity) is manifested by the instability of the operation of individual units and affects the organization of work processes, which leads to a change in the functional and performance characteristics of the hydraulic drive elements and the system as a whole. A special class of problems in hydromechanics, requiring an in-depth study of the relationship between mass transfer and virtual information with the refinement of the transfer coefficients. As you know, the physical state of the body is determined by its energy resource, namely the combination of mechanical, internal, surface, chemical energies, the energy of the electrostatic, electromagnetic field, and the like. Academician L.I. Sedov formulated the postulate [3], according to which - energy is the main characteristic of the state of any physical object in accordance with the law of conservation of energy.

Formation of an approach to information-energy transfer for solving problems of hydrodynamics and mechanotronics

To achieve the goal for the first time, it is proposed to use the synthesis of information and energy transfer of signal and energy, which provides a significant reduction in the calculation and design time compared to existing methods. On the one hand, it makes it possible to organize good energy processes, on the other hand, when we drive the electronic part, the time for the numerical calculation of the structure and verification of the design options is significantly reduced. This is achieved due to the process representation, on the one hand, by taking into account the transfer phenomenon at the calculation stage, on the other hand, the consistency of the computer part due to information and energy transfer. The developed block diagram illustrates the proposed information and energy transfer approach in mechatronic systems when analyzing its behavior, transitions of the information flow into the energy flow of the executive system (signal, action, result) (Fig. 1). At the first stage, the flow of information turns into a flow of pneumatic, hydraulic, electrical energy in the executive units and system elements by transfer coefficients (Fig. 1). The movement of the working body in such a system in some cases can be carried out from hydraulic drives. A three-stage energy conversion takes

place in the hydraulic drive. First, electrical or thermal energy is converted into mechanical energy and then into hydraulic energy. For the initial conversion of energy, electric motors are used, less often internal combustion engines or a manual drive. The conversion of mechanical energy into hydraulic energy is performed by hydraulic pumps and is characterized by the transfer coefficients in the drive system in the working environment. The scale of the change in transfer coefficients determines the correspondence of the performance characteristics to their value in the design of the system. As practice shows, in the changing operating conditions of the system, the energy balance changes. For example, a change in heat transfer in the system affects the work processes and, accordingly, leads to a change in the transfer coefficients and the operating characteristics of the system as a whole, namely, its positioning accuracy, the flow rate of the working fluid and the speed of the working body. Changing the operating characteristic of a drive or system requires constant correction of its characteristic and leads to changes in operating parameters, efficiency. Therefore, the known methods to compensate for changes is the introduction of feedback or systems that allow automatic correction carried out in the devices of the drive systems by changing the values of transfer coefficients and organizing operating modes in the format of a neural network. If we consider a neural network, then the current parameters of the transfer coefficients are one of the defining indicators for correcting the drive system according to a certain law and must be taken into account when developing compensators and feedback. Transport phenomena are generally considered at three hierarchical levels (scales): macroscopic, microscopic, and molecular.

Transport phenomena are described by the following laws: momentum (momentum) transfer, Newton's law of viscosity, mass transfer, Fick's law of diffusion, heat transfer, thermal conductivity, Fourier's law.

Let's find the dependence of the energy resource for the transfer of information, A_i in vector form according to the above laws. The law of information transfer: the amount of information that is transferred through a plane perpendicular to the direction along which the energy gradient is observed is directly proportional to the transfer signal, the area of the plane to the energy gradient [5-8]:

$$A_i = -\nu \, grad \, E, \tag{1}$$

where ν - signal, E - energy ("energy complex").

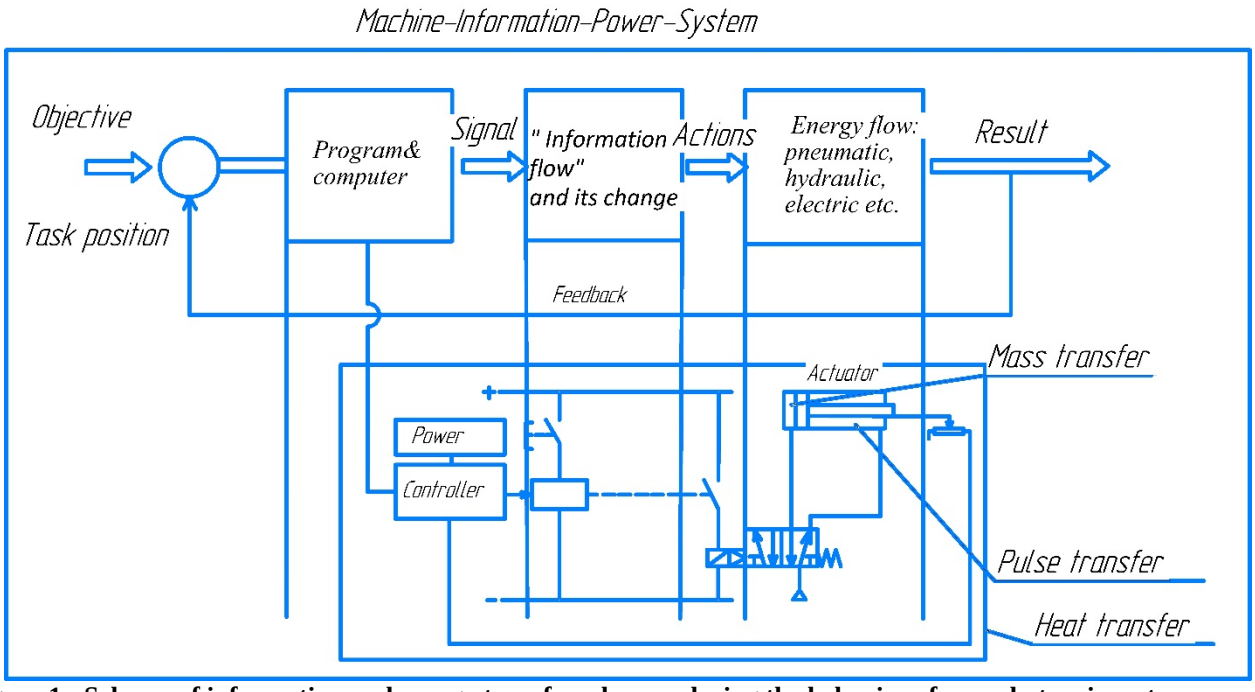

Figure 1 - Scheme of information and energy transfer when analyzing the behavior of a mechatronic system

Thus, energy is the main characteristic of the state of a physical object. Taking into account the processes of transfer and transfer of information makes it possible to evaluate at the stage of research and design the processes occurring in mechanical and hydromechanical systems. The possibility of using information-energy transfer (1) of a signal through an energy gradient is shown. The proposed approaches can be used for a series of tasks for hydraulic drive systems as part of modules of mechatronic systems.

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