International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 5 Issue 4, April - 2021, Pages: 111-113

Electromechanical and Mechatronic Systems

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***Abstract* —** *This article analyzes the data on the principle of operation and energy consumption of electromechanical and mechatronic systems.*

Keywords — mechatronic system, technical systems, Electromechanical system.

Introduction

The mechatronic system (MS) is an inseparable set of mechanical, electromechanical and electronic units, in which the transformation and exchange of energy and information is carried out.

In modern mechatronic systems, the transformation of the motion of one or several bodies into the required movements of other bodies is carried out by a system of bodies (parts) called a mechanism. Mechanisms are part of machines - technical systems (TS) and are designed to implement mechanical movements to transform energy flows, force interactions required to perform various work processes. Often, the power base of the MC is an AC or DC electric drive, which forms a controlled electromechanical system for a wide range of purposes. Electromechanical control systems are characterized by a close relationship of the electromechanical part with the power supply channel and the control channel, which determines the expected characteristics of the designed device, often equally by all functional links. Controlled complexes with an electric drive (a system consisting of an engine and associated devices for driving one or more actuators that are part of the MS) are called electromechanical systems (EMC) [1].

Materials and methods

Electromechanical (EMC) and mechatronic (MS) systems represent a well-defined class of technical systems (TS) - an orderly, expedient combination of interconnected and interacting mechanical, electrical, electronic and microprocessor components that form a certain controlled integrity. The most important component of any technical system is the drive used to move some elements of the vehicle relative to others, converting any type of energy into mechanical work. The drive, being an element (subsystem) of the vehicle, in the general case, consists of three main parts: a source of motion (engine), a transmission connecting the engine with a movable element or 'executive body of a machine or equipment, and control devices (control system) [2]. The drive always has two channels - power and information. The first transports the converted energy, the second controls the flow of energy, as well as the collection and processing of information about the state and modes of operation of the drive system as a whole. Various types of energy are used to carry out both the power and control functions of the drive. By the type of energy used, the drives are divided into electric (electric drives), hydraulic, pneumatic and combined, and by the method of connection to the power source - with autonomous and non-autonomous power supply. In the aggregate of conversion and distribution of converted energy, drives usually constitute the main component of all technical systems (TS). In the general case, motor technical subsystems are rather complex controlled power devices of the vehicle, considered as expedient and inseparable sets of power supplies, executive, motors (electric, hydraulic, pneumatic and thermal) and transmission mechanisms of the control object, control equipment [3].

The drive control equipment stabilizes or changes the parameters of movement (displacement, speed, acceleration, force effects) of the actuating (transmission) mechanism of the IM, the working body of the RO EMC, MS, regulating the process of conversion and exchange of energy in the power and information control channels.

The variety and complexity of the functions performed by the drive in EMC, MS systems determines the close relationship of three transformation subsystems: matter, energy, information. At the same time, among the listed subsystems it is impossible to single out the main and the secondary ones, which together represent a single automated control system for a given energy conversion process.

Discussion

In modern EMS, MS, the transformation of the motion of one or several bodies into the required movements of other bodies is carried out by a system of bodies - actuating mechanisms (IM). Mechanisms are part of machines of various technical systems and are designed to implement mechanical movements to transform energy flows, force effects generated by EMC, MS drives and are necessary for the high-quality performance of specified working (technological) processes during the operation of the electric drive.

The creation of a new MS sample is usually accompanied by the use of flexible technological solutions in a variety of options. A variation on this principle is the modular approach. Modules can be easily connected, forming complex technical systems, disconnected, replaced in order to form a vehicle with other components and technical characteristics, if necessary,

modernization, repair. In the general case, the module is characterized by constructive and technological completeness, has strictly fixed parameters (functional characteristics, geometric dimensions) belonging to the predetermined parametric standard-size series [4].

The choice of the type of current and the type of electric drive is advisable to make on the basis of consideration and comparison of the technical and economic indicators of a number of options that meet the technical requirements of this working machine. DC motors are allowed to be used only in cases where AC motors do not provide the required characteristics of the mechanism or are not economical.

Depending on the range and smoothness of speed control, requirements for the quality of transient processes, rheostat speed control systems and systems with individual converters can be used.

For a variable speed drive, the problem of choosing the type of drive is more complicated. Depending on the range and smoothness of speed control, requirements for the quality of transient processes, both rheostat speed control systems and systems with individual converters can be applied [5].

A complete thyristor electric drive includes:

- electric motor;

–Power transformer (or current-limiting reactor);

–Power thyristor converter for motor power supply, consisting of power thyristors with a cooling system, protective fuses, discharge, filtering and protective R, L, C - circuits;

–For a direct current drive - a thyristor converter for supplying the excitation winding with an adjustable magnetic flux of a direct current motor;

–System of pulse-phase control, emergency mode isolation devices, fuse control and overvoltage protection;

- switching and protective equipment in DC and AC circuits;

–Smoothing reactor in the DC circuit (if necessary);

–Dynamic braking device (if necessary);

–High-voltage input cabinet (if necessary);

- electric drive control system;

–Set of devices, instruments and devices providing operational control, condition monitoring and signaling of the electric drive;

- power supply units for the excitation winding of the tachogenerator and the electromechanical brake.

With deep speed control, in most cases the issue is decided in favor of DC drives. However, drives with frequency and frequency-current control are competitive in their properties. The advantages of drives with asynchronous motors are simplicity of design and increased reliability of motors, the possibility of their manufacture in line production. An obstacle to the rapid introduction of variable frequency drives is the complexity of control systems, which leads to inadequate reliability and increased cost. The appearance on the world market of frequency-controlled electric drives with microprocessor control increases their reliability, but their cost does not decrease.

The mechanical part of the electric drive includes the moving masses of the engine, transmission and working machine. Structural diagrams of the mechanical part should take into account elastic connections and the distribution of moments of inertia between the engine and the working machine. Multi-mass elastic systems are most often folded into two-mass systems with the attachment of small flywheels to the links of the mechanical part, which have large flywheels, i.e. to the engine rotor and the driven machine [6.7].

Conclusion

Electrical energy conversion is performed by various devices: thyristor and transistor AC-to-DC converters, frequency converters, pulse-width converters, etc., as well as conventional resistors installed in the motor power circuit. Electric power converters are used as power regulators, providing a given voltage or current to the motor terminals, depending on the requirements for the electric drive, both in steady-state and transient modes.

When the power circuit of the engine is powered from a constant voltage network, additional resistances in the power circuit and relay-contactor control stations are used as a power regulator to turn on or off the steps of these resistances. Appropriate selection of these resistors ensures the correct starting diagram (rheostat torque control) and the required speed of the working element (rheostat speed control).

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