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The influence of the design parameters of the rotors of the planetary hydraulic motor on the change in the output characteristics of the mechatronic system

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Introduction

Actuators of hydraulic drives of mechatronic systems of self-propelled machinery are most often equipped with gerotor, orbital and planetary hydraulic motors. One of the advantages of these hydraulic motors is the possibility of installing directly in the drive mechanisms of the active working bodies of self-propelled equipment, which greatly simplifies the kinematic scheme of the self-propelled machine, improving its weight characteristics. The main structural feature of the hydraulic machines under consideration, in particular planetary ones, is the rotor system (external and internal) that forms the working chambers necessary for filling and displacing the working fluid. The external rotor together with the internal one is a gear pair with internal gearing, which simultaneously performs two functions. The first function is the running-in of the internal rotor inside the external, and the second is the sealing of the working chambers of the planetary hydraulic motor. The working chambers are sealed with a hypocycloidal gear profile of the external and internal rotors of the planetary hydraulic motor with a minimum clearance between the rotors.

The output characteristics of the mechatronic system of self-propelled equipment is determined by the parameters of the hydraulic motors used in the output links of the mechatronic devices. Therefore, this work is devoted to research aimed at increasing the output parameters of planetary hydraulic motors by improving the design of their rotors in order to improve the output characteristics of mechatronic systems of self-propelled vehicles.

Research methodology

To conduct studies determining the effects of improving the design of rotors of a planetary hydraulic motor on changing its output parameters in order to improve the output characteristics of mechatronic systems of self-propelled vehicles, it is necessary:

- develop a methodology for conducting experimental studies of the influence of design parameters of rotor systems of serial and modernized hydraulic motors on their output characteristics;
- to develop a basic hydraulic circuit of an experimental bench for comparative bench tests of high-torque low-speed hydraulic motors;
- to study the change in the output characteristics of the mechatronic system with serial and upgraded planetary hydraulic motors, taking into account the design features of their rotor system.

Results

One of the main stages of research related to increasing the efficiency of planetary hydraulic motors operating as part of the mechatronic systems of self-propelled vehicles is the experimental research of real samples. Experimental studies of the influence of design features of the rotor system of serial and modernized hydraulic motors on the output characteristics of mechatronic systems were carried out by means of comparative bench tests. A technique has been developed for conducting comparative bench studies of planetary hydraulic motors. A test bench scheme is proposed (fig. 1) for testing a family of unified series of high-torque, low-speed planetary-type hydraulic motors.

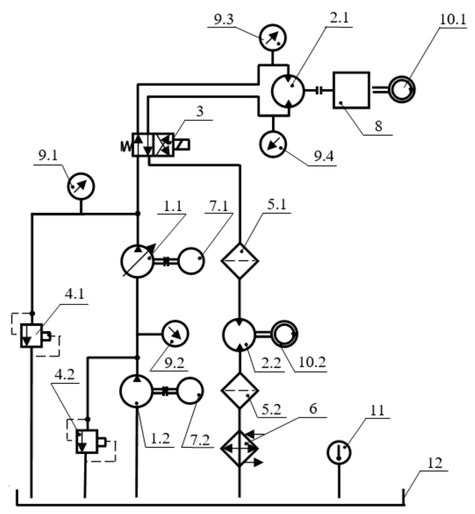

Figure 1. Schematic diagram of the hydraulic experimental setup for testing a family of unified high-torque hydraulic motors: 1.1 – adjustable axial piston pump; 1.2 – vane feed pump; 2.1 – test planetary hydraulic motor; 2.2 – calibrated axial piston hydraulic motor; 3 – switch; 4.1 – safety valve; 4.2 – overflow valve; 5.1, 5.2 – fine filters; 6 – heat exchanger; 7.1, 7.2 – drive electric motors; 8 – powder brake; 9.1–9.4 – pressure gauges; 10.1, 10.2 – tachometers; 11 – thermometer; 12 – tank

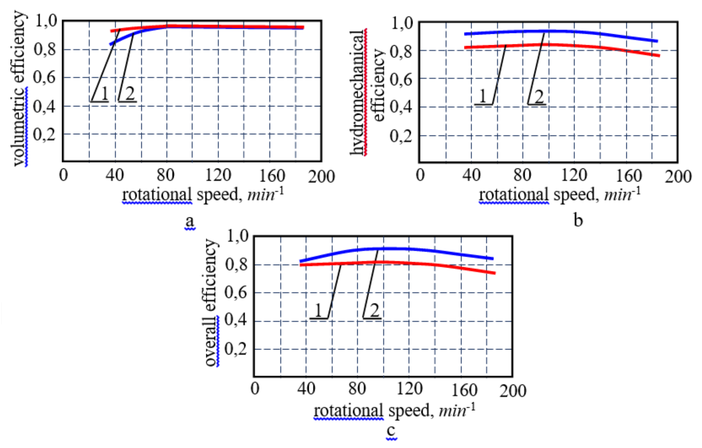

Figure 2. The dependence of the efficiency on the frequency of rotation of the output shaft of the hydraulic motor with a pressure drop Δp = 20 *MPa*: a – volumetric; b – hydromechanical; c – overall; 1 – serial hydraulic motor; 2 – modernized hydraulic motor

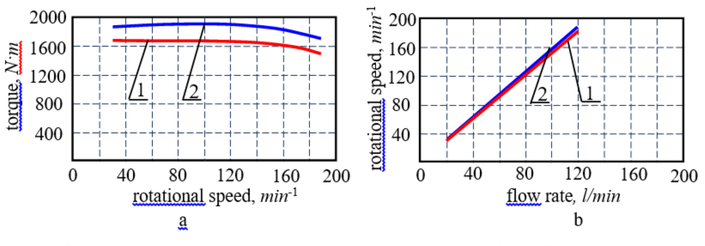

Figure 3. Changing the output characteristics of a planetary hydraulic motor operating as part of a mechatronic system: a – dependence of torque on the frequency of rotation of the output shaft of the hydraulic motor; b – dependence of the rotational speed of the output shaft of the hydraulic motor on the flow rate of the working fluid; 1 – serial hydraulic motor; 2 – modernized hydraulic motor

Results

The main factors determining the change in the output characteristics of the planetary hydraulic motor are: pressure drop, flow rate of the working fluid and the error the manufacturing form of the gear profile of its rotors. Tests of planetary hydraulic motors with a serial and modernized rotor systems were carried out. The modernization of the rotor system was carried out by changing the design of the external and internal rotors in order to reduce the shape error of their gear profile. As a result of experimental studies, it was found (fig. 2, 3) that eliminating the error the manufacturing form of the rotors of the modernized hydraulic motor can significantly improve its output characteristics - increase the torque at specified rotation speeds, and as a result, increase the hydromechanical and overall efficiency of the mechatronic system as a whole.

Conclusions

To conduct studies determining the effects of improving the design of the rotors of a planetary hydraulic motor on changing its output parameters in order to improve the output characteristics of the mechatronic systems of self-propelled vehicles, a methodology for conducting experimental studies of planetary hydraulic motors has been developed. A basic hydraulic circuit of an experimental bench for comparative bench tests of a family of high-torque low-speed planetary hydraulic motors has been developed.

As a result of the studies, it was found that eliminating the error in the manufacturing form of the rotors can increase the hydromechanical and overall efficiency of the modernized hydraulic motor by 7...10%. As a result of the modernization, it was possible to increase the torque by 16% at the given rotation frequencies, which makes it possible to increase the efficiency of the output links of the mechatronic systems of self-propelled vehicles.

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