RESEARCH OF WATER HYDRAULIC COMPONENTS AND SYSTEMS FROM ASPECTS OF QUALITY OF LIFE

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Abstract:
This article describes the importance of water hydraulic components and systems from the aspect of quality of life. Water hydraulics has become of major interest because it is human friendly and environmentally safe. The continuous introduction of new materials and technologies in the production of components and systems of water hydraulics ensures the increasing application of these systems.The most important component of a water hydraulic system is the pump. Research of piston axial water hydraulic pumps is presented in this paper. A test stand was developed to validate the computational fluid dynamics simulations for the water hydraulic axial piston pump.

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1. INTRODUCTION

Modern water hydraulics is a unique field of science in which mathematical methods of describing processes and phenomena are in line with the results of experimental tests [1-3]. The theory is confirmed and supplemented with experiments in order to create the basis for a more exact and reliable research.

The most important component of the water hydraulic system is the pump [4]. Modern development of water hydraulic pumps sets standards in terms of the ever more stringent modes of operation of the pumps, and in terms of their quality and reliability. Special attention is paid to raising the level of technical performance through improving the overall efficiency and energy savings, reducing the noise level as an important ecological factor, increasing the age of the devices in exploitation, correct structuring of the whole system in which the device works and optimization of the operating mode and management.

Axial Piston pump is one of the most frequently used hydraulic components in recent engineering technique (Fig.1).

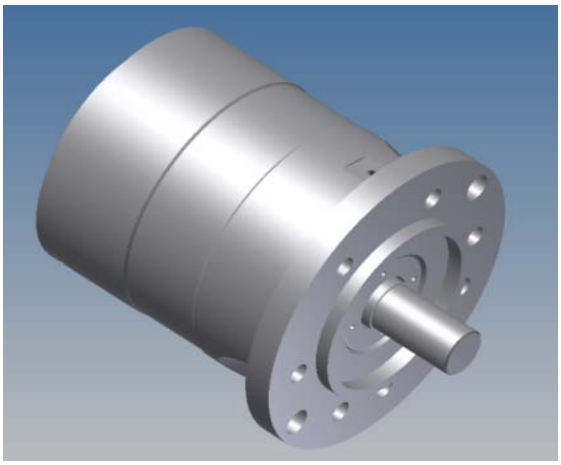

Fig.1. Water hydraulic axial piston pump

The axial piston pump usually contains 7 or 9 pistons in the rotating cylinder block. The pistons execute linear movements into the cylinders [5-7]. During one revolution the pistons execute the full stroke. The pistons are connected to the swashplate with slippers, which allows rotating motion against the swashplate. The swashplate has an inclination angle which defines the stroke of the pistons. The theoretical flow of the pump is worked out with the piston area, stroke of the

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pistons, number of the pistons and the rotation speed of the cylinder block [8-12]. The valve plate realizes the connection of the piston chambers to the suction and pressure ports. The swashplate and the valve plate are fixed and the cylinder block is the rotating part.

Water hydraulic axial piston pumps are pumps of high pressure. High-pressure pumps have versatile applications in the land-based, marine or offshore plants [13]. These pumps are designed for Reverse Osmosis.

2. EXPERIMENTAL RESEARCH OF WATER HYDRAULIC COMPONENTS

The research and development challenges were to find engineering solutions to the specific problems in design and manufacturing of water hydraulic components and industrial systems suitable for using pure tap water as the pressure fluid [14]. Current technological efforts for water hydraulics are far less than those for oil hydraulics. The experience gained from oil hydraulics is very important for future water hydraulics research [15].

The experimental research of water hydraulic piston axial pumps was carried out in the Research and Development Center RDC-PPT NAMENSKA. The tests were carried out on a test facility specially formulated for examination of water hydraulic components. The basic component of the test installation is the test stand BAC 2063 (Fig.2).

2.1. Technical data of test stand are:

1. High pressure circuits:
- pressure selection range 7 ÷150 bar
- flow selection range 0 ÷ 20 l/min

2. Low pressure circuits:
It consists of three low pressure pumps connected in parallel
- flow 500 l/min, pressure 7 bar
- flow 150 l/min, pressure 7 bar
- flow 50 l/min, pressure 7 bar

3. Drive shaft with speed selection:
- power 37 kW at 7000 min^{-1}
- speed selection 100 ÷7000 min^{-1}
- constant torque at the whole speed range
- operating as a motor, for pump testing in both directions

4. Static testing circuit:
- maximal pressure 300 bar
- operating volume 10 cm^3/cycle.

In addition to the test stand, the installation for experimental research is made up of measuring converters. The most important measuring converters are for the pressure, flow and speed of the drive shaft.

3. EXPERIMENTAL RESEARCH RESULTS

The acquisition of the measured values was done for five different physical quantities (Fig.3). The values of the pressure at the inlet and the outlet of the pump, the flow, the number of shaft rotations and the torque of the pump shaft were measured [16]. The measured values of the most important operating parameters of the water hydraulic piston axial pumps enable further research in order to optimize the characteristics of the pump [17-19]. The diagram in Fig.3. shows the mutual relationships of all five measured sizes

Fig. 2. Test stand BAC 2063

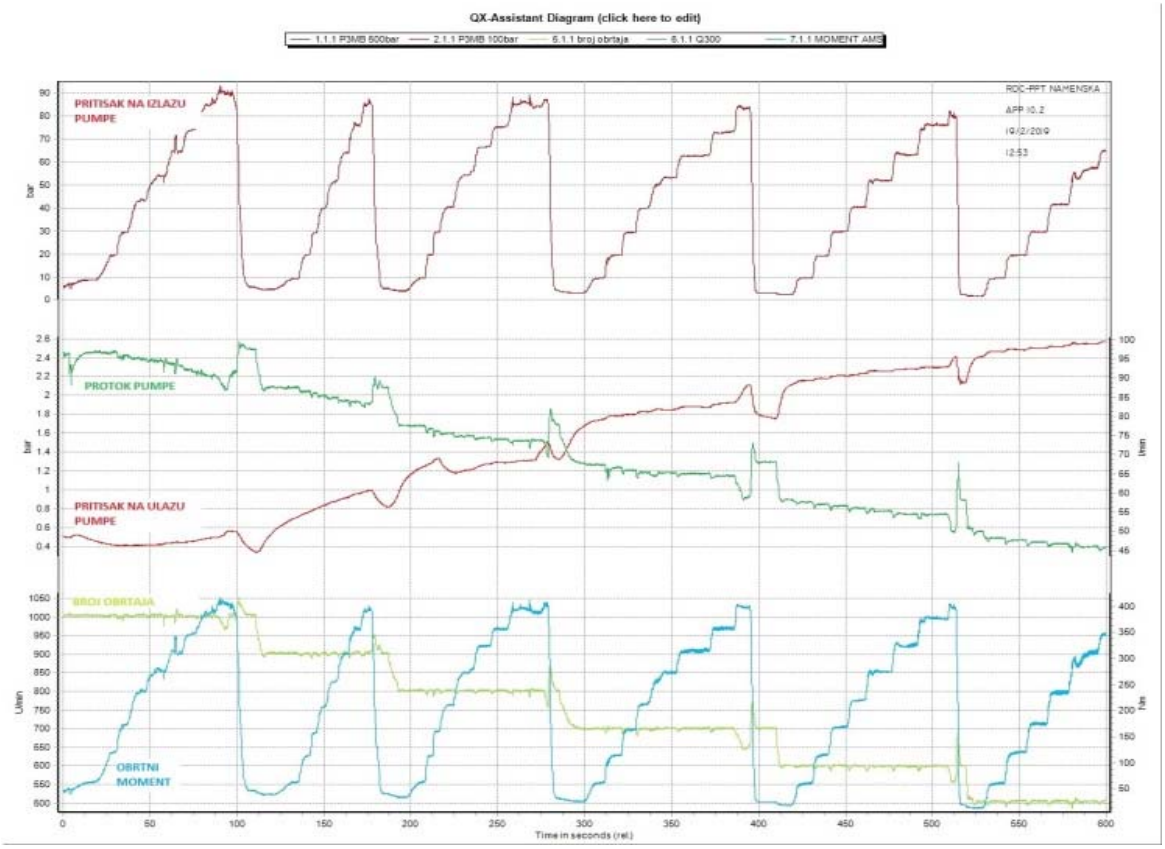

Fig.3. The diagrams of measurements

The diagrams were obtained using data processing software specially developed for this type of research. The measurement of the working parameters were taken in the 600 s interval. The number of shaft rotations was used in the range from 1000 rpm to 500 rpm. A change was made every 100 s during the test. During this period, the value of the number of shaft rotations was unchanged, and during this time the value of the pressure at the outlet of the pump was varied from the minimum setpoint to the maximum setpoint of the pressure at the outlet of the pump. This procedure was repeated for each new value of the number of shaft rotations. During the test, the inlet pressure was in the range from 0.33 bar to 2.56 bar. The diagram shows the dependence of fluid flow in a unit of time. The flow of the fluid through the pump decreases due to a decrease in the speed of the pump drive shaft. The diagram also shows the torque dependence of the drive shaft in a unit of time. The obtained values of this magnitude are directly dependent on the change in the pressure at the pump outlet.

The diagrams obtained in this paper based on the results of the experimental tests show, by behavior, a great similarity to the corresponding diagrams of the experimental tests conducted in [20], noting that our results were obtained as a function of time while in the literature they were obtained as a function of the rotational angle of the pump drive shaft.

4. CONCLUSION

Energy efficiency of components and systems will also be very important aspect in the future. The consumption of energy during the system use has to be minimized. The life cycle of the whole system has to be considered. The situation in water hydraulics is different. Due to material requirements of the components, the system building costs are higher than in oil hydraulics at present. The use of water instead of oil offers benefits, when considering energy consumption.

The modern development of pumps sets standards, both in terms of increasingly stringent modes of operation of the devices themselves, and in terms of their quality and reliability. Attention is paid to:

- ✓ raising the level of technical performance of the pump,

- ✓ improving the overall efficiency and energy savings,
- ✓ reducing noise levels as an important environmental factor,
- ✓ increasing the service life of the device,
- ✓ proper structuring of the whole system in which the device operates and
- ✓ optimization of operating and control modes.

The experiences gained in experimental research will provide good helps for design and development of water hydraulic axial piston pumps. Modern water hydraulic technology is still new and a lot of problems must be solved to make the technique more widely available for power transmission.

The results of the experimental tests presented in this paper can be used to develop new structures or to refine the existing solutions of water hydraulic axial piston pumps.

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