HERVICON + PUMPS

HMS GROUP

September 8-11, 2020, SumSU, Sumy, Ukraine

XVI International Scientific and Engineering Conference
Hermetic Sealing, Vibration Reliability and Ecological Safety of Pump and Compressor Machinery

PROGRAM OF VIRTUAL CONFERENCE

PARTNERS

Sumy State University
Hydraulic Machines and Systems Group
JSC Nasosenergomash Sumy
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INFORMATIONAL SUPPORT

Journal of Compressor and Power Engineering,
Journal of Engineering Sciences,
https://www.worldpumps.com/events/2020-09/,
https://impeller.net/event/herviconpumps-conference-2020/

Dear Colleagues !

The Regular XVI International Scientific and Engineering Conference **Hermetic Sealing, Vibration Reliability and Ecological Safety of Pump and Compressor Machinery – HERVICON+PUMPS-2020** will be held **virtually** in the Sumy State University (Sumy, Ukraine) on **September 8, 2020**.

Sumy City is one of the largest centers of pump and compressor machinery in Eastern Europe. The many leading engineering companies of Ukraine in this area are located in it, such as JSC Nasosenergomash Sumy, JSC VNIIAEN, JSC Sumy NPO, TRIZ Ltd., et al. Therefore, scientists and specialists in the field of pump and compressor machinery, sealing technology, bearings, and vibration reliability of centrifugal machines, as well as representatives of manufacturers and consumers of compressor and pump equipment are invited to participate in the Conference.

The Conference is dedicated to the memory of its founder and permanent Chairman of the Organizing Committee Dr., Prof., Dr.h.c. Volodymyr Martsynkovskyy. He was the well-known scientist in the field of centrifugal pump hydrodynamics and strength, sealing technology and rotordynamics, honored worker of science and technology of Ukraine, distinguished professor of Sumy State University, doctor honoris causa of Kielce University of Technology (Poland). And as well he was the holder of the Order of Merit of the Republic of Poland in the 2017 year from Andrzej Duda, the President of the Republic of Poland. In the 1976 year, Volodymyr Martsynkovskyy founded a Scientific and Technical Meeting on Sealing Technology, which, subsequently, grew into the International Scientific and Engineering **HERVICON+PUMPS** Conference.

Organizing Committee

INFORMATION FOR CONFERENCE PARTICIPANTS

The time limit for a presentation with discussion is **15** minutes.

The presentation must be prepared in the Microsoft Power Point program and sent to the Conference Organizing Committee before **04.09.2020**. Preliminary video recording of the presentation is possible. Posters will be placed in the Poster section and on the Conference website. To prepare your Presentation and Poster, you can use Templates that will be sent by email.

The video stream of the Conference will be held on a separate ***YouTube*** channel: https://youtu.be/eoep3HcETRw.

Please get in touch on ***Skype***: https://join.skype.com/kylBBiKopqkT *with* ***Login name (First name and Surname)*** *5 minutes before the start of your presentation, as well as, if necessary, to ask questions and participate in discussions. Short questions can be asked in the* ***YouTube*** *chat.*

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Tuesday, 08.09.2020

Beginning at 9^{00} (Kyiv Time)

Andriy Zahorulko (Sumy State University), Igor Tverdokhleb (HMS Group)
Introductory speech dedicated to the memory of founder and permanent Chairman of the Conference Organizing Committee, the well-known scientist and teacher, Dr., Prof., Dr.h.c. Volodymyr Martsynkovskyy

Break 5 min.

Section 1
DEVELOPMENT, MODERNIZATION AND IMPROVEMENT OF POWER MACHINES

9^{20} – 10^{35}

Session I Prospective ways of power machines development
Chairman: *Grzegorz Peczkis, Silesian University of Technology*

1.1 O. Kovtun (JSC Nasosenergomash Sumy), I. Tverdokhleb (HMS Group), S. Lugova (JSC Nasosenergomash Sumy), O. Makivskii, O. Lugovii (Sumy State University)
Axial forces in multistage back-to-back pumps
1.2 I. Kovaliov, A. Ratushnyi, T. Dzafarov, A. Mandryka, A. Ignatiev (Sumy State University)
Predictive vision of development paths of pump technical systems
1.3 S. Vaneev, T. Rodymchenko, S. Meleychuk, V. Baga, O. Bolotnikova (Sumy State University)
Influence of the degree of off-design of the traction nozzle of a jet reaction turbine on its efficiency
1.4 O. Kostornoi, P. Tkach, O. Bondariev, N. Podopryhora (JSC VNIIAEN)
Design of impeller blades in the intermediate stage of centrifugal pump to a preset meridional flow pattern
1.5 G. Peczkis, T. Synowiec (Silesian University of Technology), A. Zahorulko (Sumy State University)
New flowing system in cooling system axial-flow pump in a hard coal electric power plant

Break 5 min.

10^{40} – 11^{55}

Session II Modernization and improvement of centrifugal pumps characteristics
Chairman: *Przemyslaw Szulc, Wroclaw University of Science and Technology*

1.6 A. Ratushnyi, A. Sokhan, I. Kovaliov, A. Mandryka, A. Ignatiev (Sumy State University)

Modernization of centrifugal impeller blades
1.7 S. Antonenko, S. Sapozhnikov (Sumy State University)
Creation a universal technique of predicting performance curves for small-sized centrifugal stages of well oil pump units
1.8 V. Kondus, O. Gusak, J. Yevtushenko (Sumy State University)
Investigation of the operating process of a high-pressure centrifugal pump with taking into account of improvement the process of fluid flow in its flowing part
1.9 A. Chernobrova, M. Sotnyk, O. Moloshnyi (Sumy State University) and V. Boiko (National Technical University of Ukraine "Igor Sikorsky Kyiv Politechnic Institute")
Influence of different volute casings theoretical methods design on pump working processes
1.10 O. Moloshnyi (Sumy State University), P. Szulc (Wroclaw University of Science and Technology) and G. Moliński (Pompax Sp. z.o.o.)
The analysis of the performance of a sewage pump in terms of the wear of hydraulic components

Break 5 min.

12^{00} – 12^{45}

Session III Improving the efficiency of the vortex pump workflow
Chairman: *Andrii Rogovyi, Kharkiv National Automobile and Highway University*

1.11 A. Rogovyi, V. Korohodskyi (Kharkiv National Automobile and Highway University), S. Khovanskyi (Sumy State University), I. Hrechka (National Technical University Kharkiv Polytechnic Institute) and Y. Medvediev (Volodymyr Dahl East Ukrainian National University)
Optimal design of vortex chamber pump
1.12 A. Machalski, J. Skrzypacz, P. Szulc, D. Błoński (Wroclaw University of Technology)
Experimental and numerical research on influence of winglets arrangement on vortex pump performance
1.13 P. Szulc, A. Machalski, J. Skrzypacz, D. Blonski (Wroclaw University of Science and Technology)
The numerical simulation of the rope vortex creation and the possibilities of its control

Break 5 min.

12^{50} – 13^{20}

Session IV Improving the performance of labyrinth screw and axial pumps
Chairman: *Andrii Rogovyi, Kharkiv National Automobile and Highway University*

1.14 P. Andrenko (National Technical University Kharkiv Polytechnic Institute), A. Rogovyi (Kharkiv National Automobile and Highway University), I. Hrechka (National

Technical University Kharkiv Polytechnic Institute), S. Khovanskyi (Sumy State University), and M. Svynarenko (Kharkiv National University of Construction and Architecture)
Characteristics improvement of labyrinth screw pump using design modification in screw
1.15 I. Altyntsev, D. Homa (POWEN-Wafapomp Group), G. Peczkis (Silesian University of Technology)
Modifications of propeller pumps design algorithm. Numerical and laboratory tests

Break 5 min.

13^{25} – 13^{55}

Session V The hydraulic systems and rotary machine components analysis
Chairman: *Ievgen Konoplianchenko, Sumy National Agrarian University*

1.16 G. Romanik, J. Rogula, A. Machalski (Wroclaw University of Science and Technology)
Experimental and numerical analysis of the rail with the heat control valves
1.17 V. Melnyk, V. Vlasovets (Kharkiv Petro Vasylenko National Technical University of Agriculture), I. Konoplianchenko, V. Tarelnyk, M. Dumanchuk and Vas. Martsynkovskyy (Sumy National Agrarian University)
Developing a System and Criteria for Directed Choice of Technology to Provide Required Quality of Surfaces of Flexible Coupling Parts for Rotor Machines

Break 5 min.

Section 2
TRIBOLOGY, DYNAMICS AND STRENGTH OF TURBOMACHINERY COMPONENTS

14^{00} – 15^{30}

Session I Mechanical, annular and labyrinth seals
Chairman: *Noel Brunetiere, Institute Pprime of University of Poitiers*

2.1 T. Shihab (Middle Technical University/Engineering Technical College of Baghdad), L. Shlapak, P. Prysyazhnyuk, O. Ivanov and M. Burda (Ivano-Frankivsk National Technical University of Oil and Gas)
Increasing of durability of mechanical seals of oil and gas centrifugal pumps using tungsten-free metal-ceramic composites
2.2 Ryszard Dindorf (Kielce University of Technology)
A Numerical Solution of Temperature Distribution in the Clearance and the Sealing Rings of the Non-Contact Face Seal
2.3 S. Gorovoy, G. Golovchenko, M. Dumanchuk (Sumy National Agrarian University)

Determination of angular stiffness factor of the annular seal experimentally - calculated by.

2.4 O. Pozovniy, A. Zahorulko (Sumy State University), G. Peczkis (Silesian University of Technology), C. Kundera (Kielce University of Technology)

Influence of geometrical parameters of the chamber on the total radial hydrostatic force in a two-annular seal

2.5 Y. Tarasevych (AGH University of Science and Technology), N. Sovenko and I. Savchenko (Sumy State University)

Influence of operational changes of clearances in pump channels on the work of the automatic balancing device

2.6 V. Andrusiak (JSC VNIIAEN), S. Lugova (JSC Nasosenergomash Sumy), S. Medvid, P. Tkach and A. Rudenko (JSC VNIIAEN)

Effect of front impeller seal leakages on centrifugal stage characteristics

Break 5 min.

15^{35} – 16^{20}

Session II Bearings

Chairman: *Jean Bouyer, Institute Pprime of University of Poitiers*

2.7 Vas. Martsynkovskyy, K. Liubchenko, A. Prokopenko (TRIZ LTD), A. Lazarenko (Sumy State University)

Damper thrust bearing with fluid pivot

2.8 L. Ropyak, A. Velychkovych, V. Vytvytskyi, M. Shovkoplias (Ivano-Frankivsk National Technical University of Oil and Gas)

Analytical study of "crosshead – slide rail" wear effect on pump rod stress state

2.9 I. Konoplianchenko, V. Tarelnyk, Vas. Martsynkovskyy (Sumy National Agrarian University), O. Gaponova, A. Lazarenko (Sumy State University), A. Sarzhanov, M. Mikulina (Sumy National Agrarian University), Z. Zhengchuan (Sumy National Agrarian University and Henan Institute of Science and Technology) and V. Pirogov (G.K. Parts Group LCC)

New technology for restoring Babbitt coatings

Break 5 min.

16^{25} – 17^{25}

Session III Rotordynamics, dynamics and strength

Chairman: *Jan Krmela, Alexander Dubček University of Trenčín*

2.10 A. Yashchenko, A. Verbovyi (JSC VNIIAEN), A. Rudenko (JSC Nasosenergomash Sumy)

Computational study of the effect of duty and mounting to foundation compliance on rotor and pump natural frequencies

2.11 M. Tkachuk, A. Grabovskiy, M. Tkachuk, A. Zarubina, A. Lipeyko (National Technical University "Kharkiv Polytechnic Institute")
Analysis of elastic supports and rotor flexibility for dynamics of a cantilever impeller
2.12 A. Zinkovskii and A. Stel'makh (G.S. Pisarenko Institute for Problems of Strength of the National Academy of Sciences of Ukraine)
Prediction of stability against subsonic flutter for axial turbine machine compressor blade assemblies
2.13 A. Dzyuba, Yu. Selivanov (Oles Gonchar Dnipro National University)
Research of strength characteristics and optimization of parameters of hull structures using holographic interferometry

Break 5 min.

17^{30} – 18^{00}

Session IV Power transmission
Chairman: *Ievgen Konoplianchenko, Sumy National Agrarian University*

2.15 V. Tarelnyk, Vas. Martsynkovskyy, D. Hlushkova, M. Dumanchuk, I. Konoplianchenko, N. Tarelnyk, M. Mikulina, G. Smolyarov, O. Semernya, M. Dovzhyk, M. Nahornyi, O. Vasilenko, S. Bondarev (Sumy National Agrarian University), B. Antoszewski, Cz. Kundera (Kielce University of Technology), S. Hudkov (Sumy State University)
Increasing fretting resistance of flexible element pack for rotary machine flexible coupling
2.16 M. Ivanov, O. Pereyaslavskiy, S. Shrhorodskiy, R. Hrechko (Vinnitsa National Agrarian University), V. Mazurenko, Holovko (Hydrosila APM, Private Joint Company)
Vibration resistance of HST 90 hydrostatic transmission

18^{00} – 19^{00}

Poster section 1

Chairman: *Maryna Demianenko, Sumy State University*
P.1 A. Tomaszewski, T. Przybyliński, M. Lackowski (Institute of Fluid-Flow Machinery Polish Academy of Sciences), E. Krzemiński (Zakład Produkcji Doświadczalnej Automatyki Co.), J. Rogula, G. Romanik, D. Błoński (Wrocław University of Science and Technology)
The measuring system for air mass flow rate determination – difficult measuring conditions – case study
P.2 A. Kulikov, A. Ratushnyi, I. Kovaliov, A. Mandryka, A. Ignatiev (Sumy State University)
Numerical study of the centrifugal contra rotating blade system
P.3 M. Sotnyk, V. Moskalenko and O. Strokin (Sumy State University)
Influence of construction and operating pump parameters on pressure pulsations amplitude

P.4 R. Puzik, I. Kovalyov, O. Ratushnyi, T. Dzafarov, S. Petrenko (Sumy State University)
The ways to increase the efficiency of the stage of low specific speed
P.5 D. Błoński, P. Szulc, A. Machalski, J. Rogula (Wroclaw University of Science and Technology)
Numerical simulation and experimental investigation of submersible sewage mixer performance
P.6 P. Szulc (Wroclaw University of Science and Technology), G. Moliński (Pompax Sp. z.o.o.) and O. Moloshnyi (Sumy State University)
The influence of the impeller construction on the performance of one channel pump
P.7 J. Skrzypacz, P. Szulc (Wroclaw University of Science and Technology)
The influence of a pipe impeller external shape on the pump parameters
P.8 S. Sapozhnikov, S. Antonenko (Sumy State University)
Effect of gas content in the pumped liquid on the characteristics of a torque flow pump
P.9 V. Panchenko, V. German, V. Kondus, O. Ivchenko, O. Ryasnaya (Sumy State University)
Combined Operating Process of Torque Flow Pump
P.10 V. Kondus, V. German, V. Panchenko (Sumy State University)
Improving the efficiency of the operating process of high specific speed torque-flow pumps by upgrading the flowing part design
P.11 D. Prokopenko, I. Shatskyi, M. Vorobiov and L. Ropyak (Ivano-Frankivsk National Technical University of Oil and Gas)
Cyclic deformation of separating tape in electromagnetic rolling pump
P.12 O. Gusak (Sumy State University), M. Cherkashenko, O. Potetenko, A. Gasiyk, K. Rezvaya (National Technical University "Kharkiv Polytechnic Institute")
Improving reliability and efficiency of hydraulic turbines
P.13 A. Panchenko, A. Voloshina, O. Titova, I. Panchenko (Dmytro Motornyi Tavria State Agrotechnological University)
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

<u>Poster section 2</u>

Chairman: *Oleksandr Pozovniy, Sumy State University*
P.1 J. Krmela (Alexander Dubček University of Trenčín), A. Artyukhov (Sumy State University), V. Krmelová (Alexander Dubček University of Trenčín) and O. Pozovnyi (Sumy State University)
Determination of Material Parameters of Rubber and Composites for Computational Modeling Based on Experiment Data
P.2 A. Radionov (LLC Ferrohydrodynamica), A. Podoltsev (NASU Institute of Electrodynamics), A. Radionova (LLC Ferrohydrodynamica)
Magnetic field in the core of a magnetic fluid seal taking magnetic structural elements into account

P.3 V. Martsynkovskyy, S. Hudkov, A. Zahorulko (Sumy State University) and Cz. Kundera (Kielce University of Technology)
Dynamics of impulse seals with tubular feeders
P.4 A. Zahorulko, V. Izemenko (Sumy State University), Vas. Martsynkovskyy (TRIZ LTD), Y.-B. Lee (Korea institute of Science and Technology)
CFD analysis of leakage rate and rotordynamic characteristics of labyrinth-scallop seals
P.5 A. Zahorulko, D. Kayota (Sumy State University), Vas. Martsynkovskyy (TRIZ LTD), J. Bouyer, N. Brunetiere (Institute PPrime of University of Poitiers)
Investigation of the effect of oil scrapers on the thermal state and bearing capacity of a tilting pad thrust bearing
P.6 A. Voloshina, A. Panchenko, O. Titova, I. Panchenko (Dmytro Motornyi Tavria State Agrotechnological University)
Changes in the dynamics of the output characteristics of mechatronic systems with planetary hydraulic motors

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XVI International Scientific and Engineering Conference "HERVICON+PUMPS 2020"

Vibration resistance of HST 90 hydrostatic transmission

Sumy State University

Nikolai Ivanov, Alexey Pereyaslavsky, Serhiy Shargorodskiy, Roman Hrechko, Vasyl Mazurenko, Serhiy Holovko

1 Introduction

Typical representatives of hydrostatic drives are hydrostatic transmissions (HST 90), which need research and improvement to meet modern requirements, which are determined by the development of agricultural engineering, construction, road and other areas.

The expansion of the use of hydrostatic transmissions for various occasions, which have been widely practiced recently, can lead to unstable operating modes during which significant vibrations occur, which in some cases lead to significant disruptions in the operation of machines. Solving the problem of ensuring the stable operation of a hydrostatic transmission, which eliminates the occurrence of vibrational modes of its operation, requires a comprehensive review of the features of the hydrostatic transmission, taking into account the expansion of the range of inertial and technological loads.

Current trends in the development of agricultural machinery require the development of fundamentally new and improvement of existing hydraulic drive schemes and designs of hydraulic machines, as well as new approaches to solving the problem of ensuring the reliability and quality of agricultural machinery.

2 Aim and Research Tasks

Aim. Development of measures to increase the level of dynamic characteristics of hydrostatic transmissions such as HST 90 to expand their use in hydraulic drives of various machines.

Research tasks:

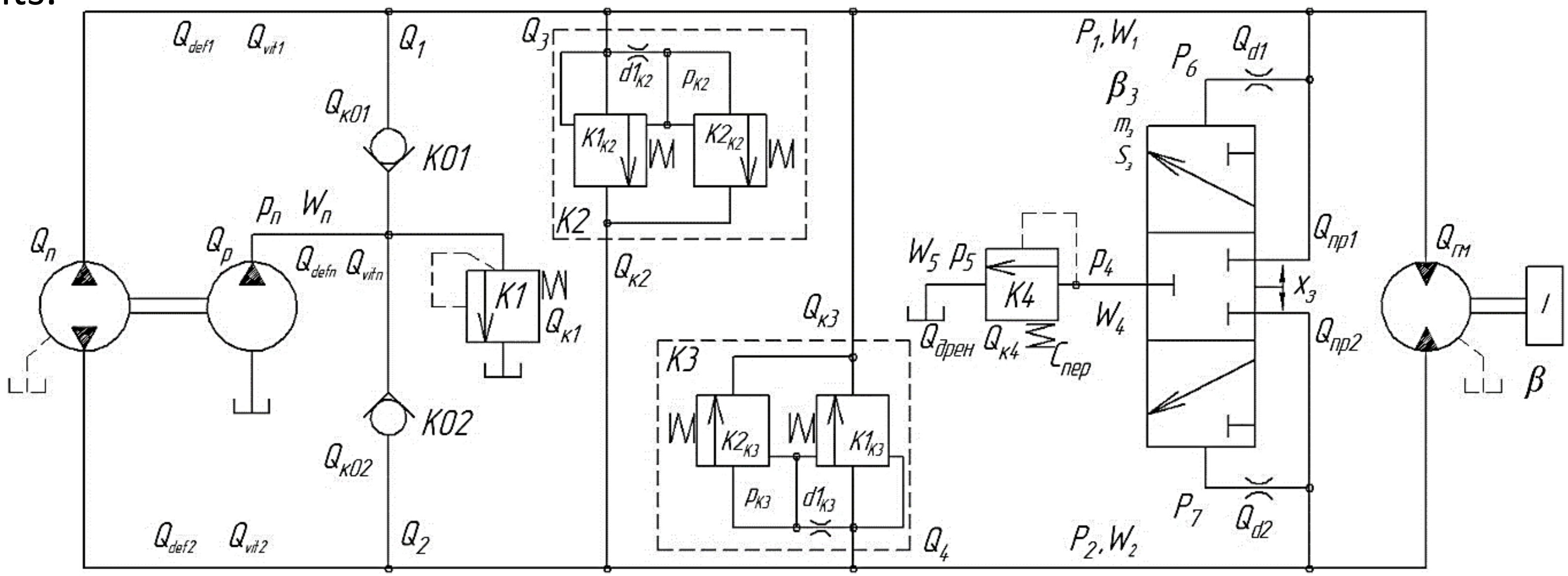
1. Development of methods for computer simulation of hydrostatic transmission type HST 90 in modes that differ in the magnitude of technological and inertial loads.

2. To analyze the influence of hydrotransmission parameters on the occurrence of unstable operating modes.

3. To perform the synthesis of parameters of hydraulic devices that ensure stable operation of the hydrostatic transmission when changing the technological and inertial loads in a wide range.

3 Research Methodology

To study the operation of a hydrostatic transmission of the HST90 type by mathematical modeling, a design diagram is developed, which is shown in Figure 2. The diagram shows the generalized coordinates of the elements of the system - for mechanical links it is linear or angular displacement, and for a hydraulic system - pressure and flow rate of the working fluid in typical areas. Also, the calculation diagram indicates the parameters of physical processes that were considered during mathematical modeling, namely: the volume of cavities of characteristic sections, leakage and overflow coefficients, viscous friction coefficients, masses and moments of inertia of moving parts, and stiffness of elastic elements.



Calculation scheme of hydrostatic transmission type HST90

3 Research Methodology

The mathematical model of hydrostatic transmission includes equations that describe the change in each generalizing coordinate.

The mathematical model of hydrostatic transmission includes such equations of continuity of working fluid flows in characteristic sections of the hydraulic system.

$$\begin{cases} Q_P = -Q_{k01} + Q_{k2} - Q_{k3e} + Q_{d1} + Q_{sp1} + Q_{hm} + Q_{leak1} + Q_{def1}, \\ Q_{hm} = Q_{sp2} + Q_{d2} - Q_{k2e} + Q_{k3} - Q_{k02} + Q_p + Q_{leak2} + Q_{def2}, \\ Q_n = Q_{k01} + Q_{k02} + Q_{k1} + Q_{leakn} + Q_{defn}, \\ Q_{sp} = Q_{k4} + Q_{vk4} + Q_{leak3} + Q_{def3}, \\ Q_{d1k2} = Q_{d2k2} + Q_{ut1} + Q_{def4}, \\ Q_{d1k3} = Q_{d2k3} + Q_{ut2} + Q_{def5}, \\ Q_{d1} = Q_{vsp} + Q_{ut3} + Q_{def6}, \\ Q_{d2} = Q_{vsp} + Q_{ut4} + Q_{def7}, \end{cases}$$

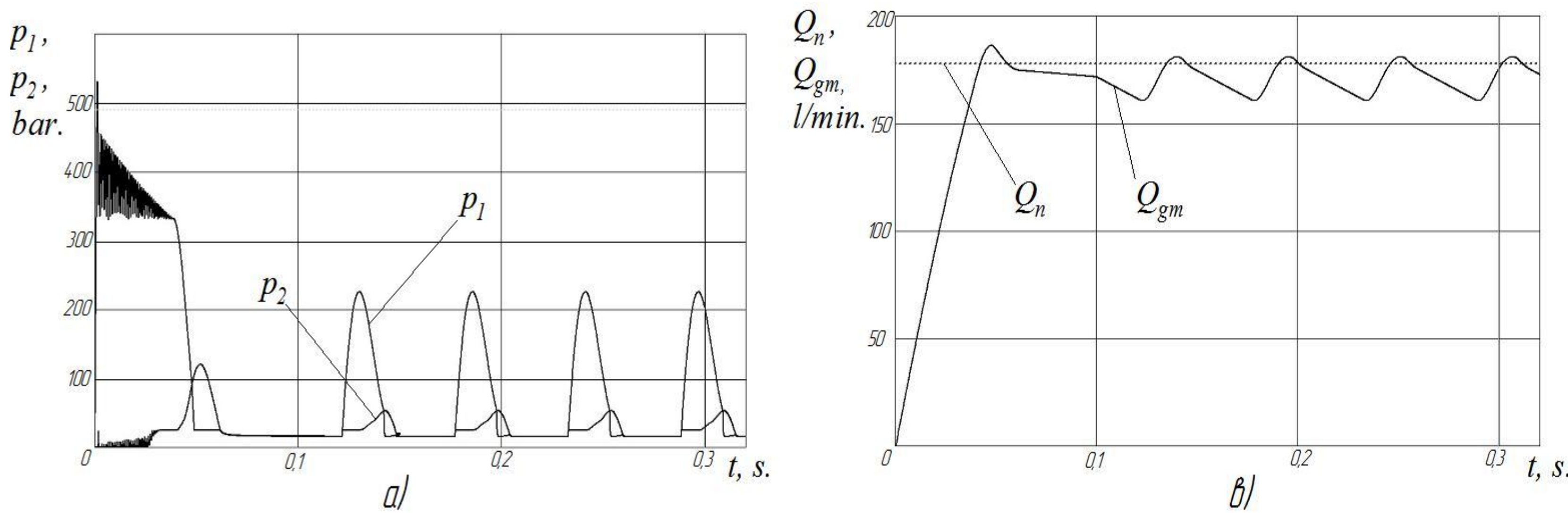
3 Research Methodology

The mathematical model of hydrostatic transmission includes such equations of force and motion of mechanical links.

$$\begin{cases}
F_{\kappa 1 \kappa 2} = C_{1 z\kappa} \times \Delta x_{\kappa 1 k 2} + m_p \times \dfrac{d^2 x_{\kappa 1 k 2}}{dt^2} + \beta_{zk} \times \dfrac{dx_{\kappa 1 k 2}}{dt}, \\
F_{\kappa 2 \kappa 2} = C_{2 z\kappa} \times \Delta x_{\kappa 2 k 2} + m_{г} \times \dfrac{d^2 x_{\kappa 2 k 2}}{dt^2} + \beta_{zk} \times \dfrac{dx_{\kappa 2 k 2}}{dt}, \\
F_{\kappa 1 \kappa 3} = C_{1 z\kappa} \times \Delta x_{\kappa 1 k 3} + m_p \times \dfrac{d^2 x_{\kappa 1 k 3}}{dt^2} + \beta_{zk} \times \dfrac{dx_{\kappa 1 k 3}}{dt}, \\
F_{\kappa 2 \kappa 3} = C_{2 z\kappa} \times \Delta x_{\kappa 2 k 3} + m_{г} \times \dfrac{d^2 x_{\kappa 2 k 3}}{dt^2} + \beta_{zk} \times \dfrac{dx_{k 2 \kappa 3}}{dt}, \\
F_{\kappa 4} = C_{\kappa 4} \times \Delta x_{\kappa 4} + m_{\kappa 4} \times \dfrac{d^2 x_{\kappa 4}}{dt} + \beta_{\kappa 4} \times \dfrac{dx_{\kappa 4}}{dt}, \\
F_{з} = C_{з} \times \Delta x_{з} + m_{з} \times \dfrac{d^2 x_{з}}{dt} + \beta_{з} \times \dfrac{dx_{з}}{dt}, \\
M_{гм} = I \times \dfrac{d^2 j}{dt} + \beta_{гм} \times \dfrac{dj}{dt} + M_{мех},
\end{cases}$$

4 Results

In the process of studying the mathematical model, the existence of compounds of hydrostatic transmission parameters was revealed, in which unstable operating modes arise. Such modes occur under conditions when a hydrostatic transmission is operating when the inertial load on the motor shaft changes (decreases). This leads to a significant amplitude of pressure fluctuations in the discharge and suction hydraulic lines, and the operation of the hydraulic motor in a galloping mode.

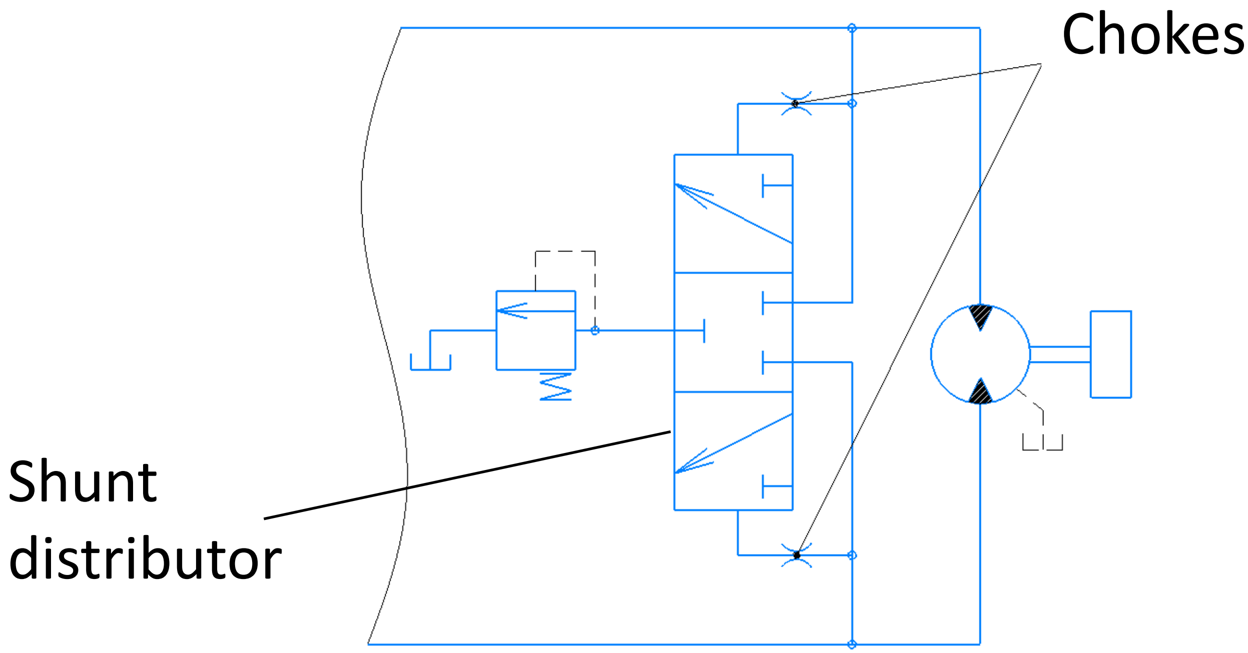


a) a change in pressure in the pressure p1 and suction p2 hydraulic lines,

b) graphs of the change in the pump supply time Qn and the flow rate Qgm, which the hydraulic motor consumes.

4 Results

The problem is solved by making changes to the design of the hydrostatic transmission by adding new elements. Due to the installation of permanent chokes at the inlet to the cavities under the ends of the spool of the shunt distributor 9, the speed of its spool decreases when the hydraulic line switching signal is worked out to direct part of the working fluid from the main hydraulic line, which is under low pressure, to the cooling tank.

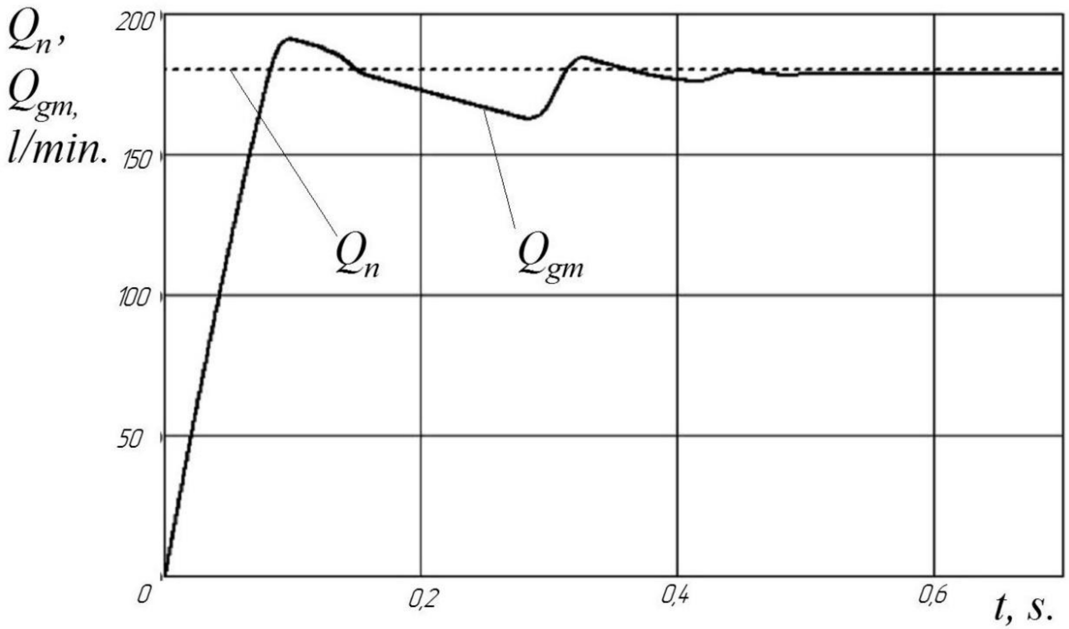


Installation of permanent chokes at the inlet to the cavities under the ends of the spool of the shunt distributor

4 Results

Due to this, while reducing the technological and inertial loads on the shaft of the hydraulic motor, there is no excitation of oscillations of the shunt distributor and, accordingly, fluctuations in the speed of the hydraulic motor and pressure.

Operation of hydrostatic transmission with chokes at the entrance to under the ends of the spool of the shunt distributor

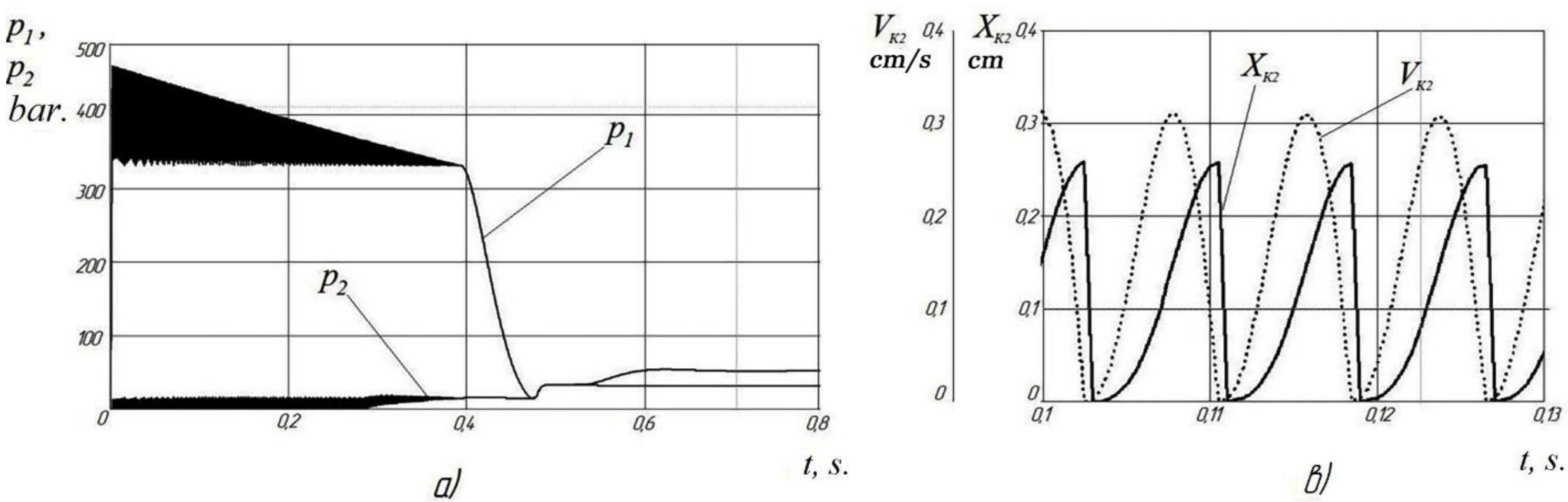


Graphs of the change in the pump supply time Qn and the flow rate Qgm, which the hydraulic motor consumes.

4 Results

In the design of hydraulic actuators of past years, direct-acting safety valves are widely used. However, such valves have a number of drawbacks, they must have a spring designed for significant compression force, there is also a significant increase in pressure with an increase in fluid flow through the valve and instability in operation, especially at high pressure. The absence of damping elements in the design of these valves makes them very sensitive to pressure fluctuations.

Start of hydrostatic transmission with safety valves of direct action



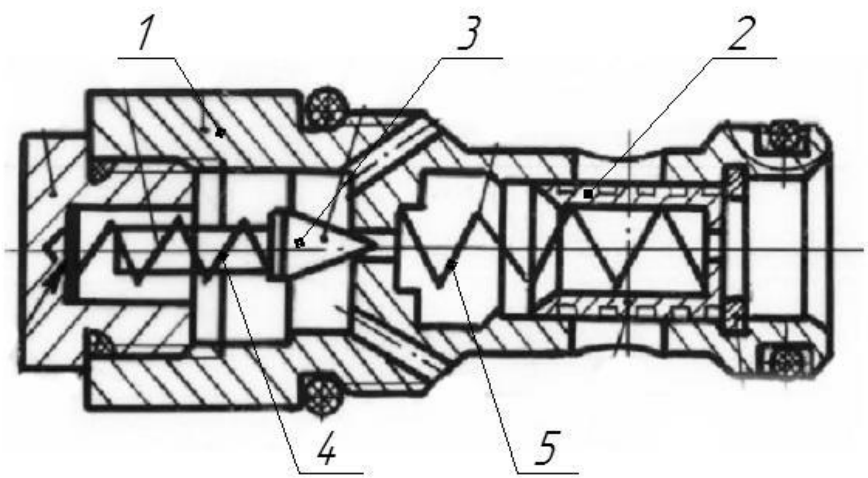
a) a change in pressure in the pressure p_1 and suction p_2 hydraulic lines;

b) graphs of changes in the movement of X_{k2} and speed V_{k2} of the spool of the direct-acting warning valve.

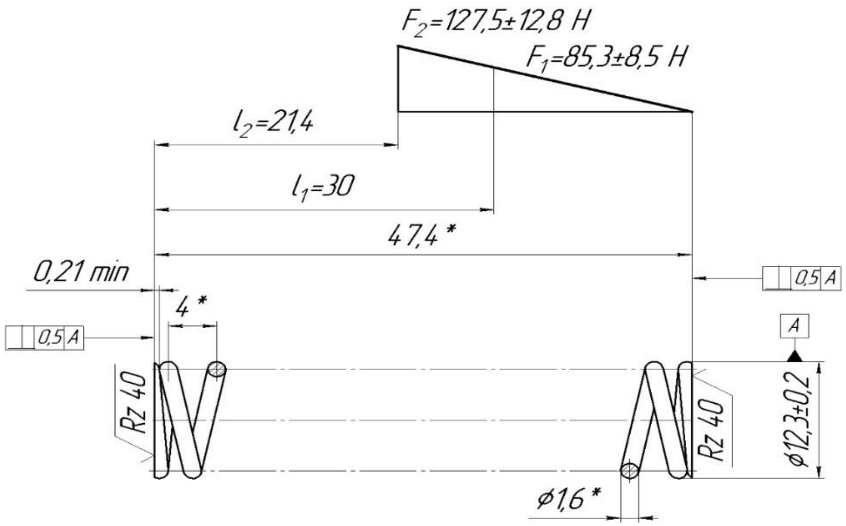
4 Results

To ensure reliable operation, the latest hydrostatic transmissions, which operate at a peak pressure of 400-500 Bar, use safety relief valves of indirect action.

Safety valve of indirect action



Safety valve of indirect action
1 - body; 2 - spool; 3 - needle;
4- spring of the needle;
5 - piston spring.

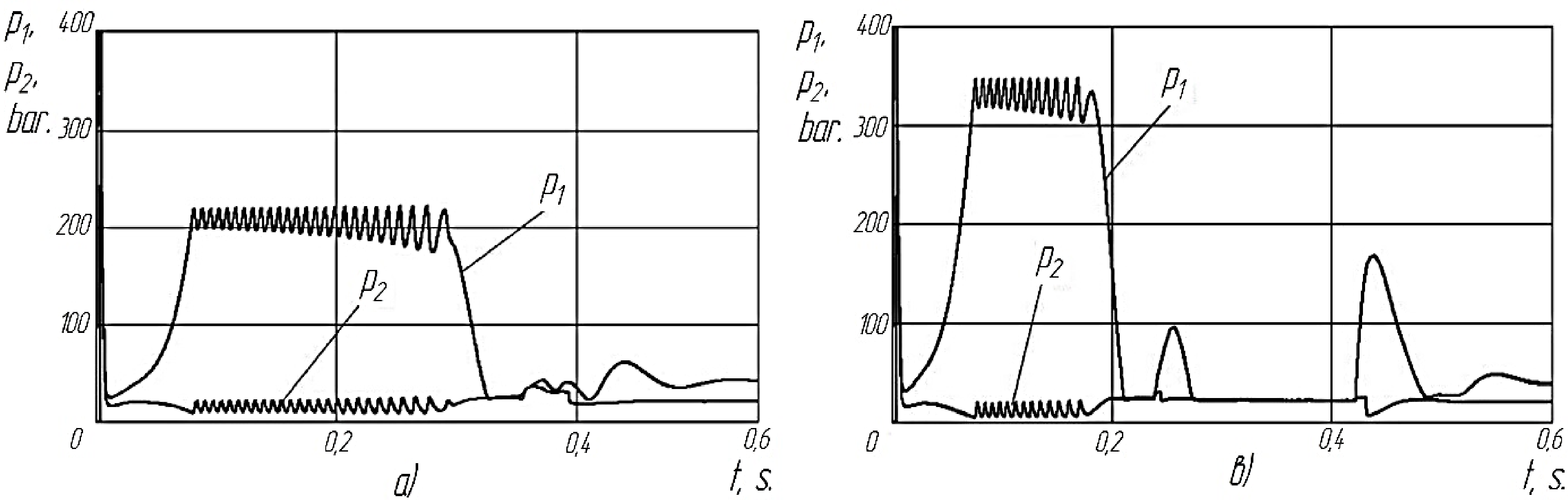


Spring needle indirect safety valve

4 Results

As a result of a computer simulation of the operation of a hydrostatic transmission with indirect warning valves, the influence of the spring stiffness of the warning valve needle on the vibration resistance and the nature of the HTS 90 operation was revealed.

Start of hydrostatic transmission with indirect warning valves



a) with the spring of the needle warning valve initial stiffness;
b) with a spring of a needle of the warning valve of the increased rigidity.

5 Conclusions

The study hydrostatic transmissions was conducted by mathematical modeling and computer simulation. As a result, the causes of oscillations and vibrations in the hydraulic system, which may be the cause of the failure of the entire drive, are identified. The use of hydrostatic transmissions in drives with a change in the inertial load on the motor shaft in a wide range can lead to a pumping mode of operation at a low inertial load on the shaft. This mode leads to self-oscillations in the hydraulic system and the machine as a whole, which excludes the possibility of operating such machines. To solve this problem, it was proposed to establish constant throttle at the entrance to the cavities under the ends of the spool of the shunt distributor. Laboratory studies confirm the effectiveness of this proposal. This made it possible to establish serial production of hydrostatic transmissions of an improved design.

Factors are found due to which the safety valves can cause oscillations in the hydrostatic transmission. The use of safety valves of archaic designs, such as direct-acting safety valves, is not rational at present. In addition to the known drawbacks, computer simulation showed that such valves are the cause of fluctuations in the hydraulic system, which negatively affect the reliability of the hydrostatic transmission. Therefore, it is advisable to use indirect pressure relief valves that do not cause pressure fluctuations in the hydraulic system. At the same time, it is obvious that with current trends in increasing nominal pressure, there is a need for significant changes in the design of safety valves.

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СЕРТИФІКАТ

Оргкомітет ***XVI-ої міжнародної науково-технічної конференції “Герметичність, вібронадійність та екологічна безпека насосного і компресорного обладнання” – “ГЕРВІКОН+НАСОСИ-2020”***, присвяченої пам’яті засновника і беззмінного голови організаційного комітету Конференції, відомого вченого і вчителя, д.т.н., проф., dr.h.c. Марцинковського Володимира Альбіновича, засвідчує, що автор доповіді: “Vibration resistance of HST 90 hydrostatic transmission” (Вінницький національний аграрний університет) Шаргородський Сергій Анатолійович 8 вересня 2020 року з 9.00 до 18.00 згідно з програмою Конференції (http://hervicon.sumdu.edu.ua/images/stories/Doc-Pdf/Program.pdf) виступив з презентацією та прийняв участь у онлайн засіданнях віртуальної Конференції “ГЕРВІКОН+НАСОСИ-2020”, яка проводилась англійською мовою.

Запис трансляції віртуальної Конференції “ГЕРВІКОН+НАСОСИ-2020” знаходиться за посиланням https://youtu.be/eoep3HcETRw.

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співголова Оргкомітету Конференції
“ГЕРВІКОН+НАСОСИ-2020”

ГРОМАДСЬКА ОРГАНІЗАЦІЯ “НАУКОВЕ ОБ'ЄДНАННЯ “ГЕРВІКОН” Ідентифікаційний код 39162265 Україна м. Суми

Андрій Загорулько