

**AP19579208 “Creation of a universal prototype of a gear pump for hydraulic systems capable of pumping viscous liquids of different nature” – p.m. Zharkevich O.M.**

***Relevance***

Due to the desire to continually improve performance, efficiency, minimize size, reduce intrinsic vibration, pulsation, adverse loads, cavitation and wear of gear pump components, the demands on materials, technology, fit and dimensional tolerances are constantly increasing. This leads to continuous improvement in manufacturing methods, both of the pumps themselves and the materials used to manufacture them, and the most important parameters are the lowest possible failure rate, wide range of applicability in the industry, resistance to changing conditions, minimum possible noise generation and pulsation.

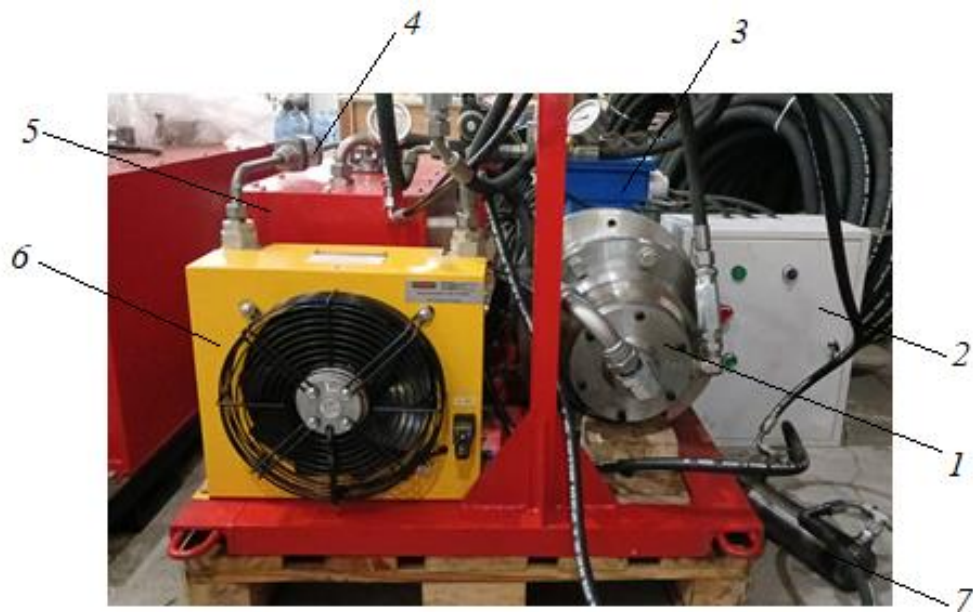
Thus, creation of the concept of innovative gear pump for hydraulic control systems of production machines using different types of oils, as well as a compact design solution for damping mechanical vibrations, reducing force loads.

***Project Goal***

Developing the concept of an innovative gear pump for supplying hydraulic control systems of production machines and pumping other edible oils, as well as a compact solution for damping mechanical vibrations.

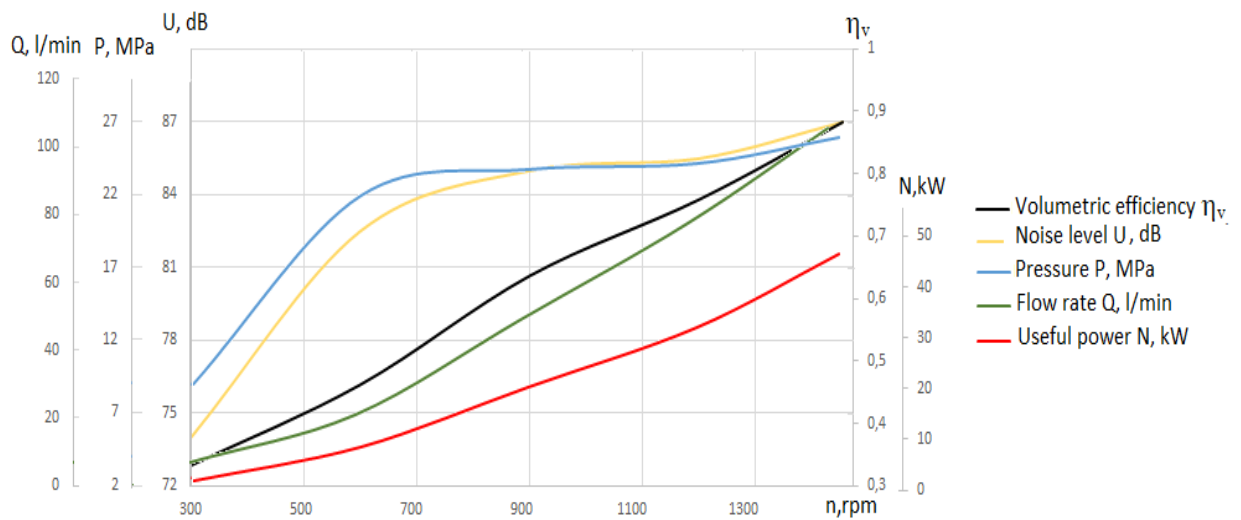
***Expected and achieved results***

A test bench for a multi-pinion pump was created.



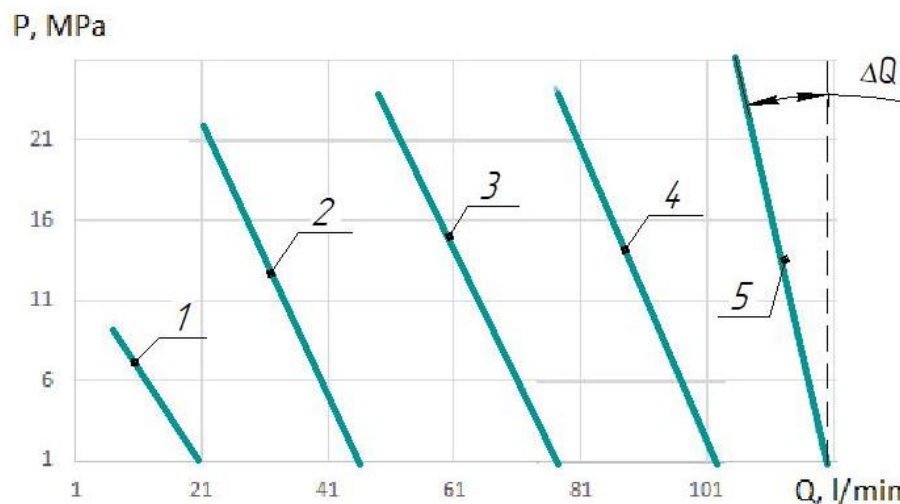
*1 - prototype of multi gear pump; 2 - frequency converter; 3 - electric motor; 4 - flow meter; 5 - hydraulic tank; 6 - oil cooler; 7 - hydraulic transmission*

	<b>Figure 1 – Multi-cell pump test bench</b>	
--	--	--



**Figure 2** – Output characteristics of the pump as a function of speed at a factor

The characteristics of the multiple gear pump at different speeds are established.



**Figure 3** – Pump characteristic  $P_n = f(Q)$  at different values of shaft speed: 1) for  $n = 300$  rpm; 2) for  $n = 600$  rpm; 3) for  $n = 900$  rpm; 4) for  $n = 1200$  rpm; 5) for  $n = 1450$  rpm

The following results were obtained in the course of the study:

1) It was found that the most efficient operation of the pump is achieved in the range of drive shaft speeds from 900 to 1450 rpm. In this range the volumetric efficiency demonstrates rather high values varying from 0.7 to 0.88 when working with VMGZ hydraulic oil with kinematic viscosity of 45 cSt;

2) Reducing the speed below 900 rpm leads to a significant increase in internal leakage and a drop in volumetric efficiency to 0.3 at 300 rpm, as well as a decrease in the developing pressure to 9 MPa at a valve setting pressure of 26 MPa;

3) When the kinematic viscosity decreases from 45 cSt to 15 cSt (due to heating up to 40 °C), there is an overall reduction in capacity and power of about 15-20%, while the noise level increases slightly by 2 dB;

4) There is a linear dependence of the increase in useful power with increasing system pressure, reaching, 19.5 kW at 900 rpm and 31.15 kW at 1200 rpm at a maximum pressure of 26 MPa;

5) Maximum noise levels recorded in the range of 88.5 - 88.9 dB at pressures of 15-20 MPa at 900 and 1200 rpm;

6) The expected increase in operating fluid leakage with increasing pressure was also observed, amounting to 4 l/min at 1450 rpm and 26 MPa pressure.

Thus, the experimental results confirm that this design of a multiple gear pump is promising for further study and potential application. The further prospect of the research will be to improve the sealing system to reduce leakage at low speeds and high pressures.

A monograph has been published in the publishing and printing center of Peter the Great St. Petersburg Polytechnic University in English Zharkevich O.M., Gierz L., Berg A.S., Berg A.A., Zhunuspekov D.S., Khrustaleva I.N., Reshetnikova O.S., Nurzhanova O.A., Altynbaev A.Zh. "Creation of a universal prototype of a gear pump for hydraulic systems capable of pumping viscous liquids of various nature".

The patent for useful model of RK (11.04.2025) - Multiple gear pump for hydraulic systems (№ 10379) has been received.

Design documentation for a five-pinion pump of "Hanza-Flex Hidraulik Almaty" LLP was approved.

#### *Expected results*

Industrial tests will be conducted on the five-pinion pump to evaluate its performance, speed range, pulsation with the possibility of using synthetic oils in it. An act of implementation of the pump design with recommendations for implementation will be obtained. 1 article in a peer-reviewed foreign journal will be published.

#### *Research group*

Olga Mikhailovna Zharkevich (Scopus Author ID 55339344600; ORCID 0000-0002-4249-4710)

Lukas Gierz (Scopus Author ID 57203678825; ORCID 0000-0003-4040-5718)

Alexandra Sergeevna Berg (Scopus Author ID 57220610005, ORCID 0000-0003-0528-640X)

Andrei Alekseevich Berg (Scopus Author ID 57666724300; ORCID 0000-0002-8907-1803)

Zhunuspekov Darhan Serikovich (Scopus Author ID 57209738503; ORCID 0000-0002-3922-738X)

Altynbaev Aset Zhanatovich (ORCID 0009-0000-1700-7645)

#### *List of publications*

1. Zharkevich O., Nikonova T., Gierz Ł., Berg A., Berg A., Zhunuspekov D., Warguła Ł., Łykowski W., Fryczyński K. Parametric Optimization of a New Gear Pump Casing Based on Weight Using a Finite Element Method» //Applied Sciences, 13(22):12154, по научному направлению проекта, индексируемом в базе Web of Science и имеющем проценты по CitScore DOI: 10.3390/app132212154 (в базе Scopus 75%)

2. Жаркевич О.М., Никонова Т.Ю., Гьерц Л., Берг А.С., Берг А.А. Анализ конструктивных и технологических особенностей шестеренчатых насосов // Вестник Евразийского национального университета имени Л.Н. Гумилева. №2, Серия Технические науки, 2023, 204 - 214

3. Zharkevich, O., Nikonova, T., Gierz, Ł., Reshetnikova, O., Berg, A., Warguła, Ł., Berg, A., Wiczorek, B., Łykowski, W., Nurzhanova, O. Improving the Design of a Multi-Gear Pump Switchgear Using CFD Analysis //Applied Sciences, 2024, 14, 5394 <https://doi.org/10.3390/app14135394> (в базе Scopus 78%)

4. Zharkevich O., Reshetnikova O., Nikonova T., Berg A., Berg A., Zhunuspekov D., Nurzhanova O. CFD-FEM Analysis for Functionality Prediction of Multi-Gear Pumps //Designs 2024, 8, 115 <https://doi.org/10.3390/designs8060115> (в базе Scopus 67%)

***Information for potential users***

The design of the gear pump will increase the operating life by a minimum of four times, thus saving around 60,000 euros after 10 years on just one pump without the loss of downtime. Thus, the results of the project can be considered commercializable in any enterprise where hydraulic equipment is serviced.

***Scope of application***

The proposed gear pump design can be used in hydraulic equipment capable of pumping liquids of different viscosities.

*Date of information update: 01.07.2025.*