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 continuously improve performance, efficiency, minimize size, reduce inherent 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 improvements 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, a wide range of applicability in the industry, resistance to changing conditions, and the lowest possible noise and pulsation.

Thus, creating the concept of an 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.

The project purpose:

To develop the concept of an innovative gear pump for powering hydraulic control systems of working machines and pumping other edible oils, as well as a compact solution for damping mechanical vibrations.

Expected and achieved results:

A hydrodynamic model of an external multi gear pump has been analyzed to analyze the fluid flow in combinations of single and different viscosities at the same and different pressures and velocities.

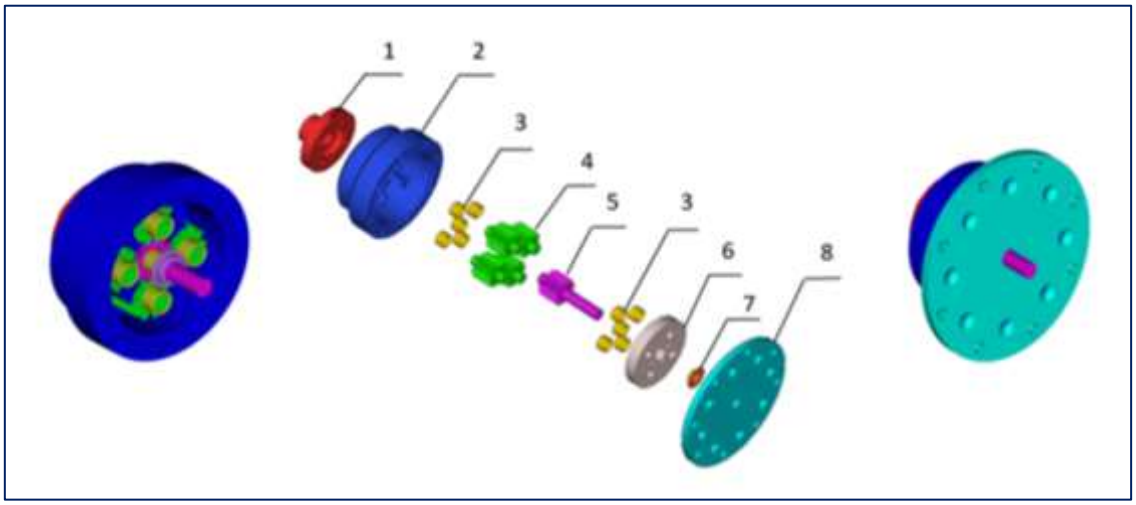

Figure 1 - Multiple gear pump design
1 - front cover; 2 - housing; 3 - bearings; 4 - idler gears; 5 - drive gear; 6 - flange; 7 - snap ring; 8 - rear part

Solidworks Flow Simulation was used to analyze the fluid flow. When the rounding radius of the inner surface of the manifold is increased from 3 mm to 15 mm, the pressure drop decreases by 13%. When the radius of the manifold is 3 mm, cavitations are observed.

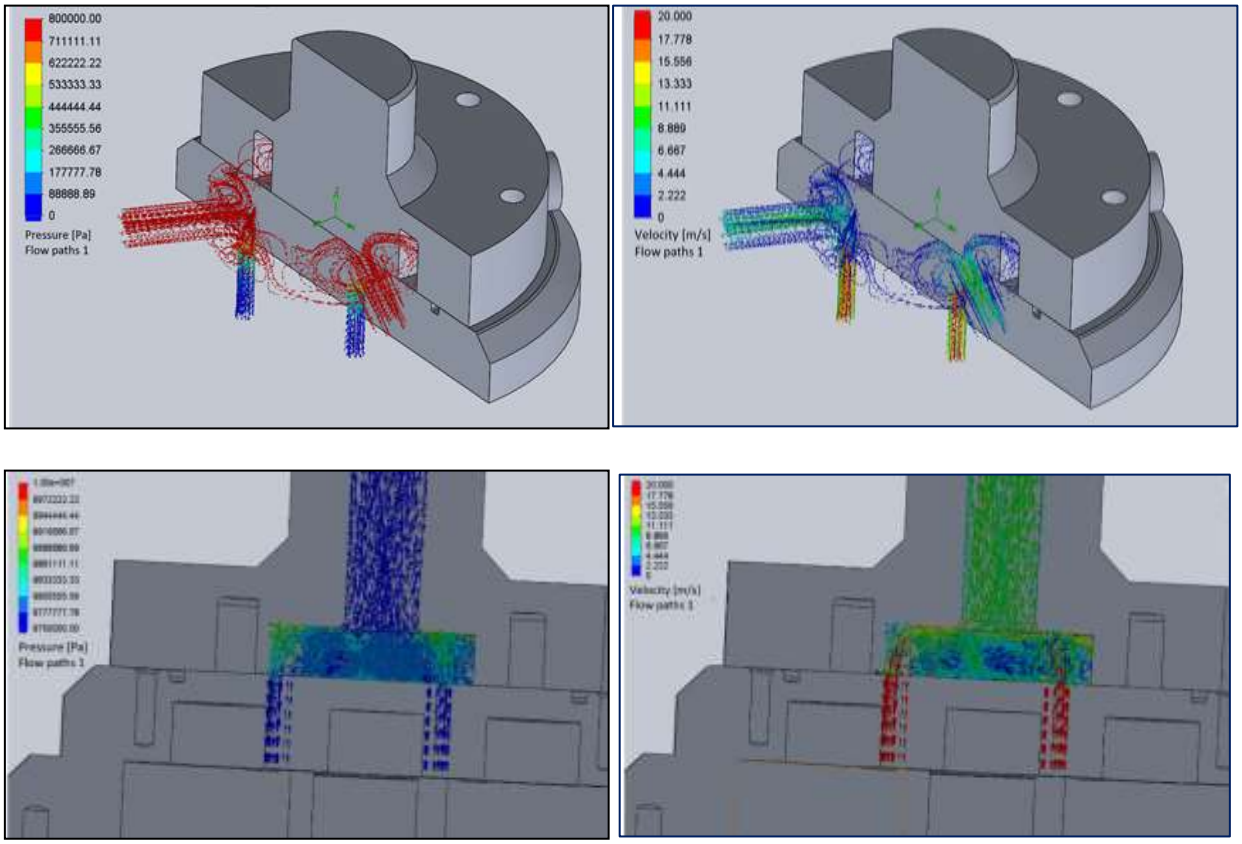

Figure 2 - Pressure and velocity changes in suction and discharge lines of a multiple gear pump

Due to the liquid distribution system with four inlets and one outlet in the top cover, the gear pump can pump liquids of viscosity classes 5 to 10. The rotational speed should not exceed 1200 rpm when the liquid has a kinematic viscosity of 10 cSt.

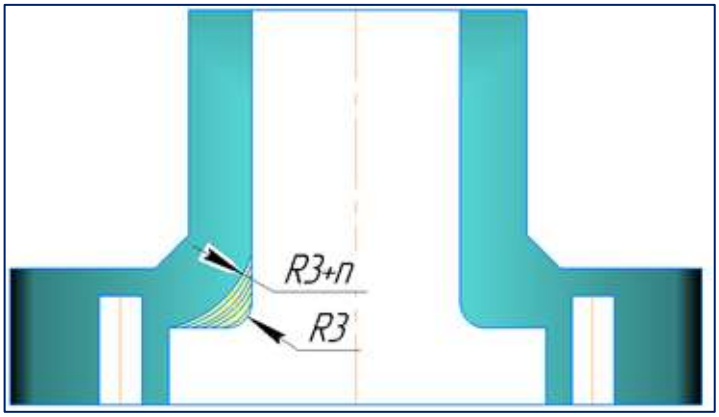

Figure 3 - Fluid velocity (a) and pressure (b) distributions at a transition radius of 3 mm in the manifold

Figure 4 - Fluid velocity (a) and pressure (b) distribution at the transition radius of 15 mm in the manifold

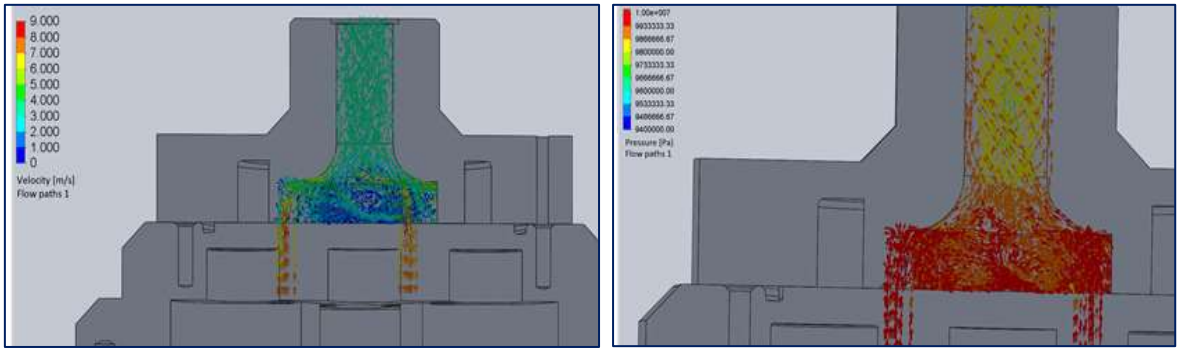

Figure 5 - Fluid velocity (a) and pressure (b) distribution at the transition radius of 15 mm in the manifold

The pressure drop and velocity distribution of the liquid in the pressure and suction lines are the same. When the speed changes from 400 to 1200 rpm, the pressure drop increases by a factor of 5 and the velocity increases by a factor of 3. At a constant speed of 1000 rpm and inlet pressure (10 MPa) but different viscosity, the pressure drop decreases by a factor of 8 and the velocity increases by a factor of 1.5. At inlet pressure from 6 to 24 MPa, constant speed and the same viscosity, pressure drop and fluid velocity practically do not change. The dependence of pressure drop on the number of revolutions, radius of rounding of the inner surface of the collector is statistically significant.

Research team
Olga Mikhailovna Zharkevich
Scopus Author ID 55339344600;
ORCID 0000-0002-4249-4710.

Tatiana Yurievna Nikonova
Scopus Author ID 57202087837;
ORCID 0000-0002-6539-126.

Gierts Lukash
Scopus Author ID 57203678825;
ORCID 0000-0003-4040-5718.

Berg Alexandra Sergeyevna
Scopus Author ID 57220610005;
ORCID 0000-0003-0528-640X.

Berg Andrey Alexeyevich
Scopus Author ID 57666724300;
ORCID 0000-0002-8907-1803.

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

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, on the scientific direction of the project, indexed in the Web of Science database and having a CitcScore percentile in the Scopus database of 75%. DOI: 10.3390/app132212154

2. Zharkevich O.M., Nikonova T.Yu., Gierts L., Berg A.S., Berg A.A. Analysis of design and technological features of gear pumps // Bulletin of L.N. Gumilev Eurasian National University. No. 2, Series Technical Sciences, 2023, 204 – 214

3. Zharkevich, O.; Nikonova, T.; Gierz, Ł.; Reshetnikova, O.; Berg, A.; Warguła, Ł.; Berg, A.; Wieczorek, B.; Łykowski, W.; Nurzhanova, O. Improving the Design of a Multi-Gear Pump Switchgear Using CFD Analysis //Applied Science, 2024, 14, 5394.

Information for potential consumers

The design of the gear pump will increase the service life by at least four times, thus saving about 60,000 euros after 10 years on just one pump without any downtime losses. Thus, the results of the project can be considered commercializable at any enterprise where hydraulic equipment is serviced.

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

Further work is planned to improve the system of liquid distribution in the multistage pump, in particular, to consider the possibility of performing suction holes in the pump housing. This will reduce losses in the suction line and increase the range of liquids pumped.

It is expected that this study will be a useful reference for design engineers and developers who can apply the results to obtain different flow parameters for a multistage pump.

Scope:

Power engineering and mechanical engineering.

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