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 constant drive to increase productivity, efficiency, minimize size, reduce inherent vibration, pulsation, adverse loads, cavitation, and wear of gear pump components, the requirements for materials, technologies, fits, and dimensional tolerances are continuously growing. This leads to the ongoing improvement of manufacturing methods for both the pumps themselves and the materials used in their production. The most important indicators are the minimally possible failure frequency, a wide range of applicability in the industry, resistance to changing conditions, and the minimum possible noise and pulsation generation.

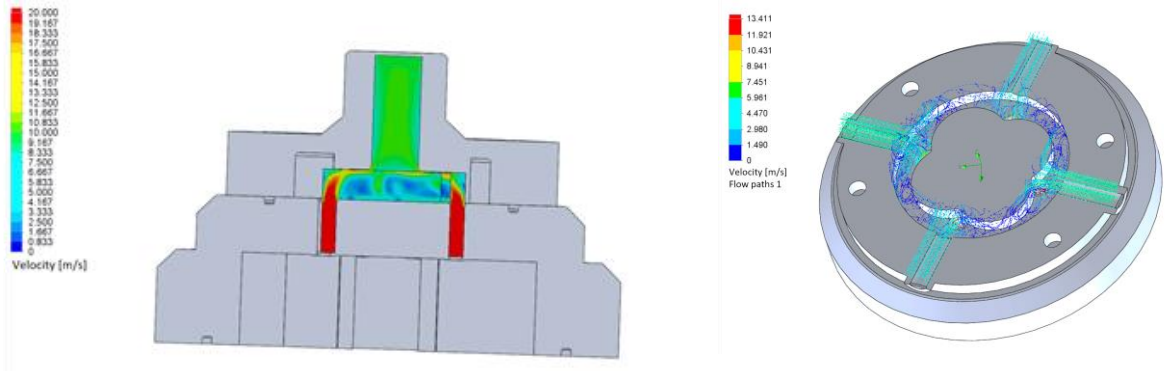
Therefore, the development of an innovative gear pump concept for hydraulic systems used in industrial machine control, utilizing various types of oils, as well as a compact structural solution for damping mechanical vibrations and reducing mechanical loads, is essential.

Objective of the project

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

Expected and Achieved Results

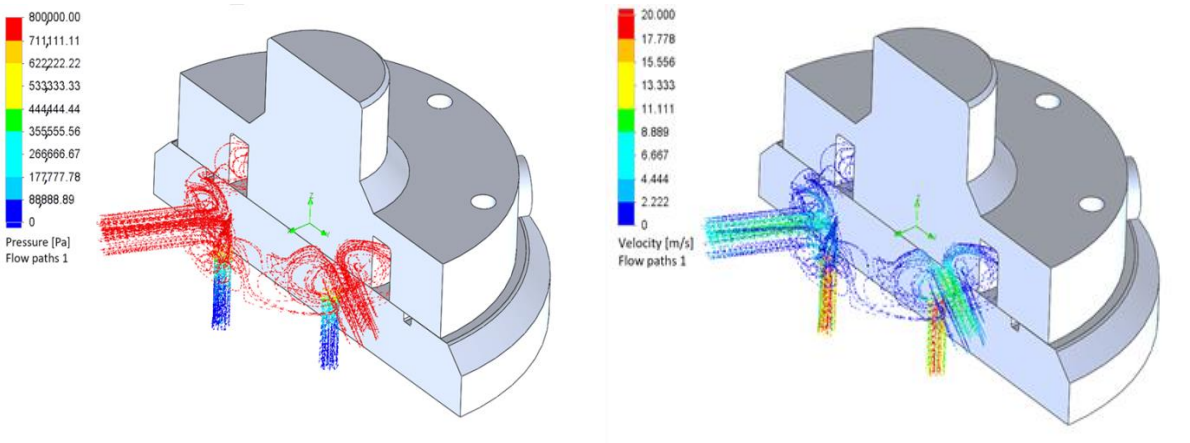
Strength calculations were performed for the housing of the gear pump made from three materials: aluminum, cast iron, and polycarbonate.



а) б)

a) Change in velocity in the discharge line (cross-sectional area); b) Change in velocity in the suction line (flow section)

	Figure 1 *– Simulation of fluid flow in the suction line of the gear pump distribution system*	



a) Pressure *b) Velocity*

***Figure 2** - Characteristics of fluid movement in the suction line of a five-six pump*

FEM modeling of the gear mesh of a five-pinion pump was carried out.

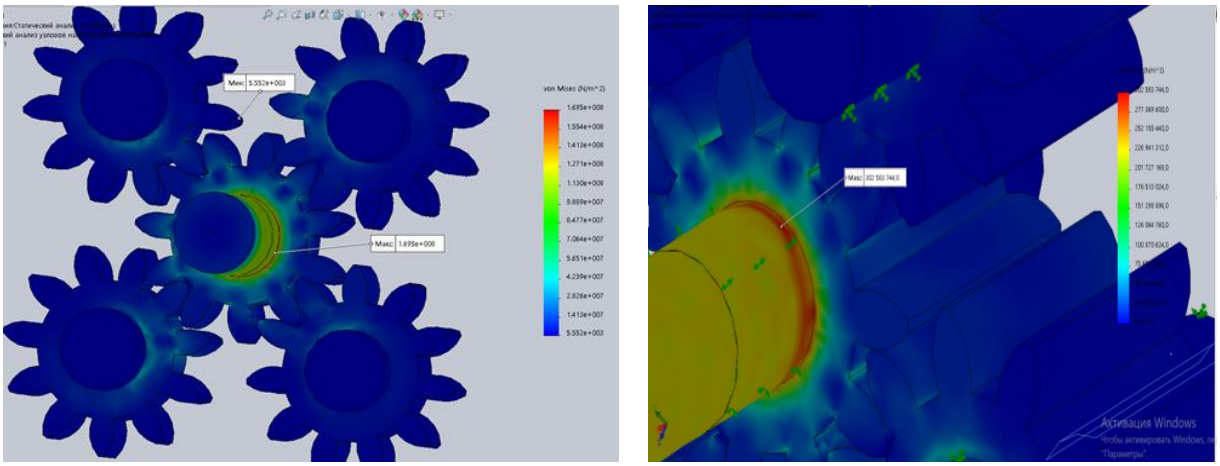


***Figure 3** - Stress distribution in the gear mesh of a five-six pump*

An improved design of a five-gear pump has been proposed, featuring the smallest linear dimensions, enhanced tribological properties, high efficiency, reduced operational costs, and lower manufacturing costs for the main components.

Studies have been conducted on the fluid distribution system, taking into account the variable temperature of the fluid in the hydraulic circuits of the multi-gear pump. It has been established that the five-gear pump can operate with liquids in the 5–10 viscosity class. The rotational speed does not exceed 1200 rpm at a kinematic viscosity coefficient of 10 cSt. The pressure drop depends on the number of rotations and the collector radius. The strength reserve of the gear connection in the gear pump is not ensured at a torque of 400-500 N·m. It has been found that as the torque increases, the stresses on the shaft increase, reaching a maximum value of 519.6 MPa at a torque of M = 500 N·m. The stress values on the gear teeth decrease from 135.2 MPa to 75.5 MPa. When the pressure increases to 20 MPa, the stress on the gear teeth increases to 250.5 MPa, which is higher compared to the shaft (226.2 MPa). The maximum possible torque on the shaft is M = 350 N·m.

One article has been published in Web of Science (Q2)/Scopus - Zharkevich O., Reshetnikova O., Nikonova T., Berg A., Berg A., Zhunuspekov D., Nurzhanova O. CFD-FEM

Analysis for Functionality Prediction of Multi-Gear Pumps //Design, 8, 2024, 115, 1-16 https://doi.org/10.3390/designs8060115 (Scopus, 68 percent)

Design documentation for the five-gear pump has been approved at “Hanza-Flex Hidraulik Almaty” LLP.

Expected Results

A methodology for contour blocks will be developed to reduce dynamic loads from blasting operations on the surrounding mass. The system will model drilling and blasting operations using the "Bigras" software or similar programs. One article or review will be published in a peer-reviewed international or domestic recommended journal, as well as one monograph in a publishing house of the Republic of Kazakhstan.

The effectiveness of the developed technical parameters for special drilling and blasting operations in open-pit mining will be determined by the customer: Deputy Chairman of the Committee for Science, Ministry of Science and Higher Education, D.R. Zhumabekov. The main benefits of the research work for the socio-economic environment will also be proposed.

Research Group

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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, with a percentile in CitcScore DOI: 10.3390/app132212154 (Scopus database 75%)

2. Zharkevich O.M., Nikonova T.Yu., Gierz L., Berg A.S., Berg A.A. Analysis of Design and Technological Features of Gear Pumps // Bulletin of the L.N. Gumilyov Eurasian National University. No. 2, Technical Sciences Series, 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 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 service life by at least four times, resulting in savings of approximately 60,000 euros over 10 years for just one pump, without downtime losses. Thus, the results of the project can be considered commercializable in any enterprise servicing hydraulic equipment.

Scope of application

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

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