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INNOVATIVE PUMP WITH VACUUM-PULSE SYSTEM FOR PUMPING VISIBLE OIL.

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Abstract: *The article presents the concept of an innovative pump with a vacuum-pulse system designed for efficient pumping of viscous liquids such as oil and other complex liquids. The pump consists of a vacuum-pulse chamber in which alternating zones of high and low pressure are created, which allows sucking and moving liquids with high viscosity. The design uses electromagnetic pistons that create pulses that push the liquid to the outlet. The turbine mechanism with adjustable blades stabilizes the flow and adapts to various operating conditions. A recirculation system is also provided to maintain constant pressure and minimize losses. This development allows to significantly increase the efficiency of transporting viscous liquids in the oil and chemical industries, as well as to improve the reliability and performance characteristics of pumping systems.*

Keywords: *vacuum-pulse system, pump, viscous liquids, oil, turbine mechanism, recirculation, pumping, efficiency*

Introduction

Pumping viscous liquids such as oil is one of the most challenging tasks in the petroleum and chemical industries. Conventional pumping systems often face problems such as high flow resistance, cavitation and reduced performance. To solve these problems, new approaches are needed to improve the efficiency and reliability of pumping systems. In recent years, more and more attention has been paid to the development of pumps using vacuum technologies and pulse mechanisms. The innovative pump with a vacuum pulse system presented in this paper offers a new approach to solving the problems of pumping highly viscous liquids. It combines the advantages of vacuum suction and pulse pressure, providing a stable and efficient flow. The purpose of this paper is to present the concept of this pump, its features, potential benefits and applications in industry.

Statement of the Problem

The objective of this work is to develop an innovative pump with a vacuum-pulse system for pumping viscous oils. The main objectives include:

Research modern pumping systems to identify their shortcomings when pumping viscous oils. Evaluate the efficiency of the new pump compared to traditional systems with an emphasis on productivity and energy costs. Consider industries where the pump can be effectively used, including the oil and chemical industries. Evaluate operating parameters such as pressure and flow rate, as well as the response to viscosity changes.

The work is aimed at creating an effective solution for transporting viscous oils, which is important for modern industry.

Research Methods

The work will use several research methods to develop an innovative pump with a vacuum-pulse system. The first stage will be the analysis of existing literature and technical documentation on modern pumping systems for pumping viscous oils. This will identify their shortcomings and determine areas for improvement. Next, the pump design will be modeled using CAD programs to visualize and optimize design solutions. It is also planned to conduct experimental tests of the pump prototype in laboratory conditions to evaluate its performance, stability and efficiency. The test results will be analyzed for further improvement of the design.

Scientific novelty

The scientific novelty of this pump lies in the combination of vacuum and pulse technologies, which ensures high efficiency of pumping viscous oils. The intelligent control system adapts to changing operating conditions, which optimizes pump operation and reduces energy costs, ensuring the reliability and durability of the system.

Research and discussion

The innovative pump with a vacuum-pulse system is designed to solve problems associated with the transportation of viscous oils.

Traditional pumping systems have difficulties pumping viscous liquids, which reduces productivity. The new pump uses vacuum technology and pulse mechanisms to significantly improve productivity. Existing pumps often break down and require frequent maintenance. The new pump with a simplified design and fewer moving parts increases reliability and reduces operating costs.

The innovative pump with an intelligent control system adapts to changing conditions and liquid characteristics, ensuring stable operation. Efficient pumping solutions help reduce energy costs and minimize resource losses, which is important for the environment. In the conditions of increasing competition in the oil and chemical industries, the pump is a step forward, meeting the requirements of the modern market.

Fig. 1 shows the design of the pump.

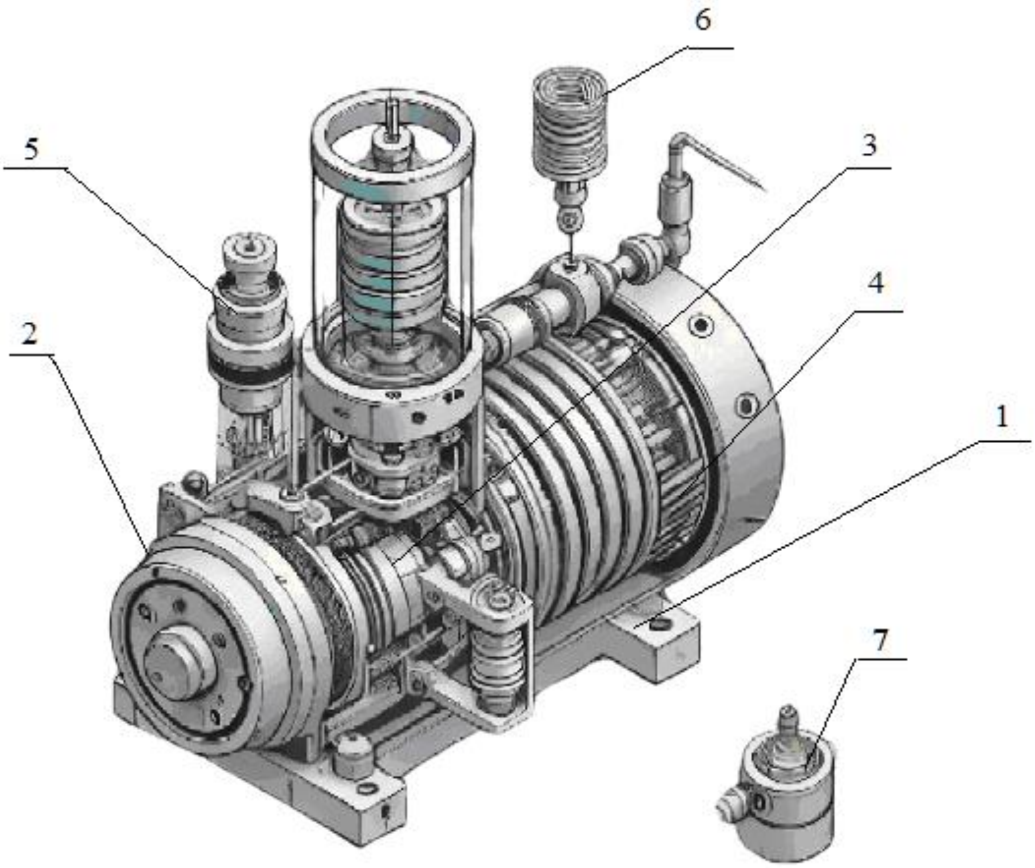

Fig. 1. The pump design consists of: 1 - body, 2 - vacuum-pulse chamber, 3 - pistons, 4 - turbine mechanism, 5 - control system, 6, 7 - connections and seals

The design of the innovative vacuum-pulse pump includes several key components, each of which plays an important role in its functionality and efficiency.

The pump body is made of high-strength steel or composite materials that are highly resistant to corrosion and mechanical damage. These materials ensure durability and reliability when working with aggressive and viscous liquids.

The vacuum-pulse chamber consists of several sections, each of which is equipped with pistons and valves. It is designed to create alternating zones of high and low pressure, which allows for efficient pumping of viscous liquids.

The turbine mechanism is installed behind the vacuum-pulse chamber and includes adjustable blades. This mechanism stabilizes the liquid flow and allows adaptation to various operating conditions.

The control system includes sensors for monitoring pump operating parameters (pressure, temperature, viscosity) and an intelligent controller that automatically adjusts the operating mode depending on the characteristics of the pumped liquid. All connections are made using high-quality seals that prevent leaks and ensure the tightness of the system, which is especially important when working with aggressive and toxic substances. Thus, the pump design is optimized for working with viscous oils, ensuring efficiency, reliability and stability in various operating conditions.

Research results

The following basic formulas and equations were used for the mathematical justification of the pump vacuum chamber:

1. Ideal gas equation of state:

$$PV=nRT,$$

where: P - is the pressure, V - is the volume, n - is the amount of substance, R is the universal gas constant, T - is the temperature. This equation is used to estimate the change in pressure in the vacuum chamber when the volume changes.

2. Navier-Stokes equation (for analyzing fluid flow):

$$p\ (+u\cdot\nabla u)=-\nabla P+\mu\nabla 2u+f,$$

where: ρ - is the fluid density, u - is the flow velocity, P - is the pressure, μ is the dynamic viscosity, f is the vector of external forces. This equation describes the movement of a viscous fluid in a vacuum chamber.

3. Bernoulli equation for steady flow:

$$P + 0.5\ \rho v + \rho gh=const,$$

where: P - is the static pressure, ρ - is the density of the fluid, v - is the flow velocity, g - is the acceleration due to gravity, h - is the height. This equation is used to estimate the changes in pressure and flow velocity in different sections of the chamber.

4. Formula for calculating the pump performance:

$$Q=A\cdot v,$$

where: Q - is the pump performance, A - is the cross-sectional area of the pipeline, v - is the average flow velocity. This formula helps to estimate the overall efficiency of the vacuum chamber.

5. Equation for calculating the impulse:

$$I = \Delta P\cdot V,$$

where: I - is the impulse, ΔP - is the change in pressure in the chamber, V - is the volume of liquid. This equation allows us to estimate the effect of the impulse action on the movement of liquid in the system.

These mathematical models and formulas formed the basis for analyzing the operation of the vacuum chamber, which confirmed its effectiveness and justified the use of vacuum-pulse technology in the design of the pump.

Main pump indicators. The tables below present the values of the main indicators of the pump with a vacuum-pulse system:

Table 1

Pump characteristics

Parameter	Value
Maximum pressure (bar)	10
Performance (m^3/h)	100
Viscosity of pumped liquid (mPa•s)	100-500
Operating temperature (°C)	0 до 80
Efficiency (%)	85

Table 2

Performance characteristics

Parameter	Value
Noise level (dB)	70
Durability (hours)	5000
Weight (kg)	150
Dimensions (mm)	1000 x 600 x 800
Power consumption (kW)	15

Table 3

Operating conditions

Parameter	Value
Density of pumped liquid (kg/m^3)	850-900
Maximum ambient temperature (°C)	50
Minimum inlet pressure (bar)	1.0
Maximum flow rate (m/s)	3.0

These data show the main characteristics and operating parameters of the pump, confirming its efficiency and reliability in working with viscous oils.

The innovative pump with a vacuum-pulse system operates on the following principle: The vacuum chamber of the pump creates a low-pressure area, which allows liquid to enter the chamber from a source (for example, a tank with viscous oil), due to the following processes:

Special pistons located in the vacuum chamber create cyclic movements. When the piston moves down, the volume of the chamber increases, which leads to a decrease in pressure inside it. When a vacuum is created, the upper valves close, which prevents backflow of liquid and maintains low pressure in the chamber. During pump operation, the system can be additionally equipped with air pumps, which contributes to a deeper vacuum and the removal of residual gases from the chamber. The use of pulse mechanisms creates alternating low and high pressure zones, which enhances the vacuum effect and helps suck in liquid from an external source.

The pulse motion in an electromagnetic pump is a process in which a piston located in the vacuum chamber of the pump is moved by a magnetic pulse created by an electromagnetic coil. An electromagnetic coil is installed at the top of the vacuum chamber, which generates a magnetic field when an electric current passes through it. Inside the coil is a core made of magnetic material, connected to the piston. Under the influence of the magnetic field, the core is attracted, moving the piston. When the electromagnet is activated, the piston moves quickly, which creates an area of low pressure in the chamber behind it. The low pressure allows liquid to be drawn into the chamber through the inlet valve, ensuring the flow of viscous oil into the pump. When the magnetic pulse is complete, the current is switched off, and the core returns to its original position due to the spring. This cycle is repeated many times, creating alternating high and low pressures inside the vacuum chamber. Each pulse causes an influx of liquid, and the return of the piston causes it to be expelled. When the piston moves back to its original position, the inlet valve closes and the outlet valve opens, allowing oil to be pumped from the pump into the pipe. The valves coordinate opening and closing synchronously with the movement of the piston, preventing backflow. At the inlet there is a check valve that opens only when a vacuum is created, and at the outlet there is a check valve that opens when the pressure increases.

The magnetic pulse that creates the movement does not require complex mechanical transmissions, which reduces energy losses. The electromagnetic mechanism provides precise and instantaneous movement, which improves control over the flow of liquid. The magnetic pulse avoids strong vibrations that occur in pumps with mechanical crankshafts. The pistons can be synchronized to create successive pulses, which enhances the pumping effect. When one piston creates a low-pressure area, the other can push the liquid out at the same time, creating a high-pressure area. When the pressure in the vacuum chamber changes, forces are exerted on the liquid. The viscosity of the liquid and its inertial properties cause it to move towards the low-pressure area, which facilitates efficient pumping. Special one-way valves installed in the system ensure the correct direction of the liquid flow. They open and close in response to pressure changes, which maintains the cyclicity of the pulses and prevents backflow. The intelligent control system monitors the pump's operating parameters and can adjust the frequency and amplitude of piston oscillations to optimize the pumping process depending on the viscosity of the liquid and other conditions.

These mechanisms together create pulsed oscillations that promote efficient movement of liquid through the pump.

Conclusion

The developed pump with a vacuum-pulse system demonstrates high efficiency and reliability for pumping viscous oils. The innovative use of an electromagnetic mechanism to create a pulsed piston movement ensures a stable flow and minimizes losses during transportation of high-viscosity liquids. During the study, design features and parameters that contribute to improved performance, reduced energy costs and increased durability of the device were analyzed.

The proposed pump design is capable of adapting to changes in the characteristics of the pumped liquids, which makes it a universal solution for the oil and chemical industries. The electromagnetic mechanism, reducing the need for mechanical transmissions, and the minimum number of moving parts also increase its environmental and economic efficiency.

Thus, the development of a pump with a vacuum-pulse system meets the current needs of the industry and is a promising solution for pumping complex liquids in modern industrial conditions.

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ÖZLÜKLÜ YAĞIN VURULMASI ÜÇÜN VAKUUM-PULSE SİSTEMLİ İNOVATİV NASOS

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Xülasə: *Bu məqalə neft və digər mürəkkəb mayelər kimi özlü mayelərin səmərəli şəkildə vurulması üçün nəzərdə tutulmuş innovativ vakuum impuls nasosunun konsepsiyasını təqdim edir. Nasos yüksək özlülüklü mayelərin sorulmasına və hərəkətinə imkan verən yüksək və aşağı təzyiqin alternativ zonalarını yaradan vakuum-puls kamerasından ibarətdir. Dizayn, mayeni çıxışa itələyən impulslar yaradan elektromaqnit pistonlardan istifadə edir. Tənzimlənən bıçaqları olan turbin mexanizmi axını sabitləşdirir və müxtəlif iş şəraitinə uyğunlaşır. Sabit təzyiqi saxlamaq və itkiləri minimuma endirmək üçün resirkulyasiya sistemi də təmin edilir. Bu inkişaf neft və kimya sənayesində özlü mayelərin daşınmasının səmərəliliyini əhəmiyyətli dərəcədə yaxşılaşdıra, həmçinin nasos sistemlərinin etibarlılığını və işini yaxşılaşdıra bilər.*

Açar sözlər: *vakuum-puls sistemi, nasos, özlü mayelər, yağ, turbin mexanizmi, resirkulyasiya, nasos, səmərəlilik*

ИННОВАЦИОННЫЙ НАСОС С ВАКУУМНО-ИМПУЛЬСНОЙ СИСТЕМОЙ ДЛЯ ПЕРЕКАЧКИ ВЯЗКОЙ НЕФТИ

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Резюме: *В данной статье представлена концепция инновационного насоса с вакуумно-импульсной системой, разработанного для эффективной перекачки вязких жидкостей, таких как нефть и другие сложные жидкости. Насос состоит из вакуумно-импульсной камеры, где создаются чередующиеся зоны высокого и низкого давления, что позволяет всасывать и перемещать жидкости с высокой вязкостью. В конструкции использованы электромагнитные поршни, которые создают импульсы, подталкивающие жидкость к выходу. Турбинный механизм с регулируемыми лопастями стабилизирует поток и адаптируется под различные условия работы. Также предусмотрена система рециркуляции для поддержания постоянного давления и минимизации потерь. Эта разработка может значительно повысить эффективность транспортировки вязких жидкостей в нефтяной и химической промышленности, а также улучшить надежность и эксплуатационные характеристики насосных систем.*

Ключевые слова: *вакуумно-импульсная система, насос, вязкие жидкости, нефть, турбинный механизм, рециркуляция, перекачка, эффективность*

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