ANNOTATION

dissertations for the degree of Doctor of Philosophy (PhD) in the specialty 6D060400 – Physics

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Research and creation of an inertial hydrodynamic installation to increase the efficiency of heating of heat - carriers

Relevance of the research topic. Currently, the use of the results of converting one type of energy into another is found in all spheres of human life, it often becomes commonplace for us that we do not even think about the processes that occur during this process. The conversion of electrical energy into thermal energy by pushing the coolant through the throttle openings is no exception. The conversion of electrical energy into thermal energy has a number of advantages over other sources of thermal energy. The main ones include its easy accessibility, which makes it possible to create heating installations where it is convenient and efficient, which eliminates heat loss as a result of transporting the coolant over long distances. In the case of electricity generation from renewable sources such as solar, wind or hydropower, thermal energy is an environmentally friendly process without emissions of harmful gases. Despite these advantages, it is important to consider the cost of the converted thermal energy and compare it with other sources of thermal energy in order to choose the most economically and environmentally efficient option for specific conditions.

Today, liquid heating by pushing it through throttle openings (nozzles) is widely used in heat pumps, refrigeration units, cooling systems, etc. However, there is still little research on the physical phenomena occurring in hydrodynamic installations, where the pressure of the liquid in front of the throttle openings is created by the centrifugal forces of a rotating mass of liquid. Understanding the processes in an inertial hydrodynamic installation will have a direct impact on expanding the scope of its application and will help save energy resources in the production of thermal energy.

Thus, the creation of an inertial hydrodynamic installation using throttling is relevant in the context of striving for energy-efficient and sustainable heating systems for heat carriers.

The purpose of the thesis is to create an inertial hydrodynamic installation to increase the efficiency of heating coolants

The objects of research are an inertial hydrodynamic throttle-type installation and physical phenomena in heat carriers during the production of thermal energy.

The scientific novelty includes the following:

1. For the first time, the effect of centrifugal forces on the temperature of a coolant when it is forced through throttle openings has been investigated.

2. The influence of the presence of air in the rotor cavity on the temperature parameters of the coolant has been established.

3. It is determined that the inertial velocity of the coolant flow through the throttle openings is equal to the circumferential velocity of the rotor and does not depend on the diameter of the throttle openings. It has been found that the preliminary static pressure created in the system has a significant effect only at low angular velocities of the rotor. With an increase in the angular velocity of the rotor to 147 rad/s, the flow rate from the pre-pressure is 0.8% of the total flow rate.

4. For the first time, a coefficient has been established that takes into account the distribution of fluid flow from static pressure in the total flow. It was found that the small length of the throttle channel and the presence of a chamfer on the inlet edge contribute to an increase in the liquid flow rate. With an angular velocity of the rotor of 147 rad/s, the flow coefficient is $\mu = 0.82$. The values of the flow coefficients of the throttle holes with diameters of 1.5, 2.0, 3.0 mm are the same.

5. It was found that at an angular velocity of the rotor of 48.25 rad / s, the flow rate of liquid from the throttle openings of the rotor tube, located at an angle of 90^0 opposite to the direction of rotation, is 1.33% higher than with the radial direction.

The structure and scope of the dissertation. The structure of the thesis is determined by the tasks set and consists of an introduction, three sections, a conclusion and a bibliography. It is presented on 115 pages of typewritten text, illustrated with 46 figures, 12 tables, and contains a list of cited literature from 123 titles.

The main results include the following:

1. Theoretical studies have determined the optimal diameters of throttle openings from 1.5 mm to 3 mm and the range of angular rotational speeds of the rotor from 42 to 314 rad/s for heating coolants with a full-size inertial hydrodynamic installation.

2. With an increase in the diameter of the hole from 1.5 mm to 3 mm and a total area from $31.4 * 10^{-6}$ m^2 to $64.34*10^{-6}$ m^2, when the liquid is throttled for 20 minutes, the angular velocity of the rotor is 248 rad/s, the temperature increase in the heat generator set accelerates from 52.5 ° C to 82.5 ° C.

3. With a change in the angular velocity of rotation of the rotor from 0 to 248 rad / s, the flow rate of the liquid through the throttle openings increases and the proportion of storage flow increases from 0% to 99.8% at a pre-pressure in the supply line of the experimental stand of 0.01 MPa.

Scientific and practical significance of the work:

1. Development of technical solutions for the design of hydrodynamic installations protected by patents of the Republic of Kazakhstan for the invention;

2. The use of centrifugal forces caused by rotating masses of liquid to create pressure in front of the throttle openings of the rotor, which allows the use of low-power electric motors as an external source;

3. The theoretical and experimental results of the study can be useful in the development of various hydraulic equipment and for a better understanding of throttling processes.

Approbation of work and publications. The main results of the work were reported and discussed at conferences: V International Scientific and Practical Conference "Integration of modern scientific research into the development of society" (2018, Kemerovo, Russia); Republican Scientific and Practical Conference dedicated to the 80th anniversary of Professor J.S. Akylbaev "Actual problems of thermal power engineering and Applied Thermophysics" (2018, Karaganda, Kazakhstan); International Scientific and Practical Conference "Science, education and production in the context of the Fourth Industrial Revolution" (2018, Karaganda, Kazakhstan); Eighth International Conference "Modern Trends in Science" (2019, Blagoevgrad, Bulgaria); XII International Scientific Conference "Chaos and Structures in Nonlinear Systems" (2022, Pavlodar, Kazakhstan); I International Scientific and Practical Conference "Technical sciences new ways of creating scientific ideas for implementation" (2023, Varna, Bulgaria).

Publications. Based on the results of the dissertation, 15 printed papers were published: 5 papers in journals included in the WOS and Scopus databases (1 article Heat Transfer Research, (53% percentile); 2 articles Eastern-European Journal of Enterprise Technologies, (45% percentile); 2 articles Bulgarian Chemical Communications, (17% percentile)); 3 articles in journals recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the EOM of the Republic of Kazakhstan, 5 publications in the materials of international conferences, of which 3 articles in non-CIS countries.

In particular, two patents of the Republic of Kazakhstan for the invention "Device for heating liquid" w In particular, two patents of the Republic of Kazakhstan for the invention "Device for heating liquid" were obtained in co-authorship: 24.01.2020, bulletin No. 3; 02.04.2021, bulletin No.13.