EFFECT OF TEMPERATURE, PRESSURE, AND FRACTION OF NANOPARTICLES ON CHANGES IN THE THERMAL CONDUCTIVITY OF COLLOID NANOFLOIDS

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Abstract. The paper presents the results of studies on the thermal diffusivity of colloidal nanofluids depending on the change in one of the state parameters (pressure). Studies were carried out both with a change in the pressure of the experiment, and with a change in the nanometric size of silver particles in a liquid. Based on the results obtained, the corresponding empirical equations were derived and a proper comparative analysis was performed by comparing the experimental and calculated data on thermal diffusivity. The suitability of the derived equations is evidenced by the satisfactory agreement between the obtained data and the calculated ones within 1.79% at α=0.95.

1. Introduction
Colloidal systems refer to dispersed systems in which one substance in the form of various particle sizes is evenly distributed in another substance. The dispersed system consists of a dispersed phase (finely divided substance) and a dispersed medium (homogeneous substance), in which the dispersed phase is distributed. Dispersed systems include ordinary and colloidal solutions, as well as suspensions and emulsions, which, in turn, differ from each other in particle size or degree of dispersion. Disperse systems are classified according to their state of aggregation, according to particle size, according to the nature of the dispersed phase and medium. According to the degree of dispersion, they mainly distinguish between coarse and colloidal systems, the first of which include particles of the dispersed phase with a size of $10^{-7}$m, and the second particles of the dispersed phase with a size of $10^{-7}$m - $10^{-9}$m [6]. In this work, we studied a colloidal aqueous solution of nanosilver with different particle diameters from 2 to 10 nm. The work is devoted to the experimental study of the thermal diffusivity of a given substance depending on the change in the pressure of the experiment.

2. Experimental section
In recent years, to study the process of heat transfer, more and more people resort to the laser pulse method (Parker method [1]), which is based on the absorption of an energy pulse in a thin layer of the surface of the substance under study and fixing the temperature change of its opposite surface over time [2,3]. The values obtained using this method make it possible to calculate such thermophysical characteristics as heat conductivity, specific heat capacity, thermal conductivity of a wide range of materials in the form of solids, powders, liquids, pastelike substances, fibrous materials, films [4].
Table 1. Experimental values of thermal diffusivity (ν.10^{-7}, m^{2}/s) of a colloidal aqueous solution of nanosilver with a concentration of nanometalic particles of 0.05% depending on the particle diameter and pressure at room temperature [5].

| d, nm | P, MPa | 0.101 | 0.108 | 0.114 | 0.121 | 0.128 | 0.135 | 0.141 |
|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| 2     |        | 1.372 | 1.449 | 1.511 | 1.57  | 1.661 | 1.732 | 1.772 |
| 5     |        | 1.245 | 1.282 | 1.317 | 1.331 | 1.443 | 1.553 | 1.583 |
| 10    |        | 0.964 | 0.994 | 1.029 | 1.059 | 1.056 | 1.135 | 1.176 |

According to the values given in Table 1, it can be seen that with an increase in pressure from 0.101 MPa to 0.141 MPa, the thermal conductivity of the studied samples increases by ~20-29%, and as the diameter of silver nanoparticles increases at a pressure of 0.141 MPa with a concentration of 0.05% thermal conductivity decreases by ~33.6%. This can be explained by the fact that, like thermal conductivity, temperature conductivity depends on the intermolecular forces of interaction and the distance between these particles, through which the transfer of thermal energy is actually carried out, and since thermal diffusivity characterizes the rate of propagation of thermal energy, these factors have a significant impact on this parameter.

In the sample we are studying, particles of a liquid and particles of a solid body uniformly distributed in it interact. Due to the fact that small particles have a larger specific surface, compared to a solution of the same concentration, but a large size of silver nanoparticles, the contact surface with liquid particles increases accordingly, and the rate of thermal energy transfer also increases [5].

3. Conclusion
After performing the appropriate processing of the experimental data obtained by using the law of the corresponding states and thermodynamic similarity, we obtained an empirical equation in the form.

\[
\alpha = 0.8152 \left(\frac{P}{P^*}\right) + 0.2307 \cdot [-0.0545 \cdot 10^{-7} d + 1.61 \cdot 10^{-7}], \text{m}^2/\text{s}
\]

Using the proposed equation (at n=0.05% and d=2÷10 nm), it is possible to calculate the thermal diffusivity of the investigated colloidal aqueous solutions of nanosilver depending on the change in the experimental pressure in the range (0.101-0.141) MPa at room temperature with an error of 1.79%.

Low-temperature plasma can be used for the synthesis of various nanostructures and is well suited for the modification of various surfaces. This is shown in many works [7-27].

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