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**SECTION 2. Applied mathematics. Mathematical modeling.**

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# COMPARISON OF HYDRODYNAMIC PARAMETERS OF NON-NEWTONIAN FLUID FLOW IN PACKET CHOKES WITH A DIFFERENT GEOMETRY

***Abstract****: Changing ranges of pressure, shear rate, vorticity, Prandtl number, shear stress and flow velocities of non-Newtonian fluid in hydraulic packet chokes with a different geometry are calculated in the article. The dependence of maximum and minimum drops of hydrodynamic parameters from flow velocity of non-Newtonian fluid and the packet choke geometry is determined.*

***Key words****: a hydraulic packet choke, non-Newtonian fluid, a model, velocity, pressure.*

***Language****: English*

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## Introduction

Hydraulic resistances (hydraulic chokes) are set in hydraulic systems of a various technological equipment [1 – 5]. The hydraulic resistance is used to control of movement speed of executive bodies of the technological equipment. Working fluid, which has certain viscosity, moves through channels of the hydraulic choke in which special elements are placed. Purpose of the special elements is reduction of the cross section of the channel or direction changing of the hydraulic choke channel [6]. This leads to changing of pressure and other hydrodynamic parameters of moving working fluid in the channels and at the output of the choke. In the works [7 – 8] is presented changing of some hydrodynamic parameters (pressure, temperature, dynamic viscosity, vorticity and Prandtl number) of non-Newtonian fluid at constant initial flow velocity from changing of the packet choke geometry. Changing of hydrodynamic parameters of non-Newtonian fluid at changing of initial flow velocity at the inlet of the packet choke was subjected to review in this article.

## Materials and methods

Computer calculations of transition flow of industrial oil in the sections of the three models of the hydraulic packet chokes were carried out under the following conditions:

*I. Geometry*

1. An orifice diameter in a plate – 1/2/3 mm.
2. Distance between the orifice plates – 5/10/15 mm.
3. The plate thickness – 0.5/1/1.5 mm.

*II. Inner walls roughness in all models – 5 μm.*

*III. Flow velocity of industrial oil in each model – 0.5/1/1.5 m/s.*

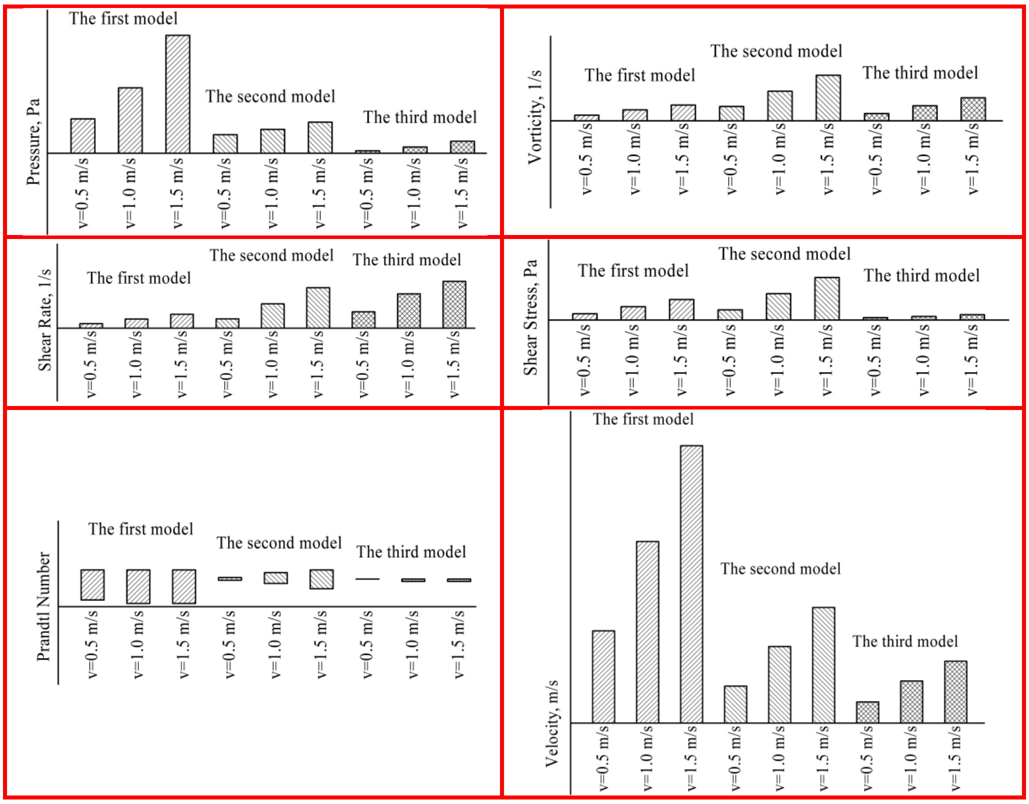
*IV. Initial temperature of working fluid – 293.2 K.*

## Results and discussion

Changing ranges of the calculated values of hydrodynamic parameters (pressure, vorticity, shear rate [9 – 10], shear stress, Prandtl number and velocity) of industrial oil flow at different velocities in the first, the second and the third models of the hydraulic packet chokes are presented in the table 1.

**Table 1**

**Changing ratios of hydrodynamic parameters of industrial oil flow in the hydraulic packet chokes models with the different geometry.**




On the graphs *v* is initial velocity of industrial oil flow in the hydraulic packet chokes models. The graphs were built by the minimum and maximum calculated values of non-Newtonian fluid flow parameters in the hydraulic packet chokes models. Changing ranges of hydrodynamic parameters increase with increasing of initial velocity of non-Newtonian fluid flow. Significant changing of Prandtl number, pressure and flow velocity is observed at maximum initial flow velocity of non-Newtonian fluid in the first model of the hydraulic packet choke. Vorticity and flow shear stress of non-Newtonian fluid have the maximum values along the full length of the second model of the hydraulic packet choke. Calculated shear rate of flow is three times more than in the first model of the hydraulic packet choke at flow velocity of industrial oil of 1.5 m/s in the second and the third models of the hydraulic packet chokes. Pressure changes (increases) in proportion to calculated flow velocity of non-Newtonian fluid in the sections of the hydraulic packet chokes models. Minimum changing of hydrodynamic parameters of non-Newtonian fluid flow were determined at the maximum hydraulic resistance (the orifice diameter in the plate) in the packet chokes.

**Conclusion**

Range of motion control of working fluid for setting movement of the executive body of the technological equipment with required speed increases at the small orifice diameter in the steel plates and distances between the plates of the hydraulic packet choke. However, this leads to heating of working fluid by 25-35% of initial temperature, significant deformation of the plates material of the packet choke under action of hydraulic pressure of working fluid and possible partial destruction of the hydraulic resistance. Therefore, for eliminate these disadvantages, it is necessary to use the hydraulic packet chokes with the geometry adopted according to the research condition for the second model.

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