The model of intermittency of transient flow of oil

Yu.A. Tolchinsky[1], V.E. Ved[1], M.K. Zhantasov[2], V.I. Satayev[2], A.A. Saipov [2]
[1]National Technical University "Kharkiv Polytechnic Institute", 21 Frunze st., Kharkiv, 61002 Ukraine, e-mail: valeriy.e.ved@gmail.com, tel. +38057 7076589;[2] M. Auezov South Kazakhstan State University, 5 avenue Tauke Khan, Shymkent, 160012 Kazakhstan.

The flow of oil and petroleum products, polymers, organosilicons and other liquids with a viscosity of one order of magnitude greater than the viscosity of water is often carried out in an intermediate hydrodynamic regime. In this regime, the volume occupied by the flow is divided into "laminar" and "turbulent" part so that it can be considered as a similar to two-phase flow in which the role of pseudophase plays laminar and turbulent areas. The model of transient current which contains two main positions is proposed. The first position is that in the flow without borders the intermittency growing through the development of the inherent instability of the flow. Within the Lagrange description of liquid particles in a stream through a sequence of instabilities that are growing, replacing each other and interacting. Then instabilities stabilize and fade. The duration of growth, stabilization and decay depend on the Reynolds number for flow and its value for the boundaries of hydrodynamic regimes - laminar and turbulent as well as on the characteristics of local velocity profile of the liquid particle. The model takes into account the first and second derivatives of the local velocity profile. On the basis of general phenomenological grounds general expressions for the duration of the periods depending on the difference between the values of the flow Reynolds number and hydrodynamic regimes borders, characteristics of flow speed profile and "diffusion" of turbulence are formulated. The essence of the second position is that flow in borders has another source of intermittency. Another source of intermittency is hydrodynamic boundary layer. Because of the greater curvature of the velocity profile near the borders the evolution of instabilities of liquid particles in the boundary layer is growing faster and expressed more strongly. "Boundary" between the boundary layer and the flow core has a fractal character. Between the core flow and boundary layer turbulence is exchanged so that the border of the core flow is a surface source and sink. In particular, some parts of turbulence from the boundary layer fall into the core flow, interacting with portions of the turbulence of the main flow. In the model the interaction of turbulence parts by analogy with the interaction point vortices and dissipative decay of turbulence is considered. The model includes a system of four equations: two equations to determine volume concentrations of laminar and turbulent pseudophases and two equations of like the Navier-Stokes equations to describe the flow pseudo-double-phase fluid with interfacial interaction. The magnitude of this interaction depends on the Reynolds numbers listed above, the first and second derivatives of the flow velocity.

Acknowledgement. Te finance support of Committee of Science at Ministry of Education and Science of Republic of Kazakhstan (Grand agreement №98) is sincerely acknowleged.