The longitudinal flow of oil and petroleum products in the channels and pipes

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The process of heat transfer is considered and the model to describe heat transfer for the transportation of oil and oil products is proposed. The process of heat transfer is considered to be so that takes place in two-phase or three-phase environments. Carrying phase is petroleum or petroleum products. Carried phase (dispersed phase) is water, gas, solid core. The reasons for presence of the solid phase are chemical-physical reactions by type of paraffin forming reaction. The corresponding chemical kinetics of these processes is not considered. Stratal water or the gas is present in the flow in dispersed form. Their distribution has two characteristic scales: macroscopic (about the size of a cross pipe or apparatus) and microscopic. The microscopic scale is determined by the kinetics of emulsification. The curing process and emulsification process are considered to have reached equilibrium. This means that the solid particles are unchanged and set. Equilibrium of emulsification process is achieved by equal velocities emulsification and coagulation. Flowing portion of the flow which located outside the boundaries of the solid core and borders the flow region is considered as a Newtonian with temperature-dependent viscosity. The heat transfer model uses a heat transfer coefficients at the boundaries of the solid core are the flow region. On the boundary of the flow heat transfer coefficients depend on the local flow velocity by the power law with an exponent of one-third and on the boundaries of the solid core with an exponent of one quarter. Two situations are considered. The first situation is when the emulsified phase fills the entire volume of the flow. The second situation is when this phase is concentrated near the boundary flow or solid core. Accounting of multiphase is carried out within multi-phase cell model to the values of viscosity and thermal conductivity. As the result the expressions for these quantities as a function of volume concentration and scale so that the heat transfer coefficients become functions of volume concentrations are obtained. In the case of macroscopic inclusions of the gas phase the contribution of thermal convection inside the inclusion is taken into account. For in such a way determined heat transfer coefficients the equation of convective heat transfer is formulated. This equation is a one-dimensional with the variable of the coordinate along the axis of the tube or apparatus. In this equation the transverse heat transfer is taken into account in the form of surface sources and sinks located at the boundaries of the pipe or the apparatus and the internal borders of the flow region.

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