Problems of energy-saving are important for different industrial tasks and technical applications connected with transporting of liquid fluids, operation of hydraulic devices and machines. Decreasing energy losses in pipelines and hydraulic machines with turbulent fluid flow due to can be obtained through the suppression of turbulence, which leads, ultimately, to a significant reduction of hydrodynamic resistance. The most promising and easy way to reduce hydrodynamic resistance and, hence, energy consumption, is adding small hydrodynamically active additives of polymers and surface-active substances (SAS) into a turbulent liquid. This is achieved by dosing the input of concentrated solutions of polymers and surfactants into process pipelines or liquid ends of hydraulic equipment and machinery.

**REDUCTION OF HYDRODYNAMIC RESISTANCE BY POLYMER ADDITIVES**

In terms of practical application, this method has certain limitations and disadvantages associated with destruction of polymer molecules and long time needed for preparation (according to classic scheme) of required concentrations from the powdered polymer solutions.

The destruction occurs with all polymers with high molecular weight, being particularly intense at high shear stress in flows in liquid ends of the flow of hydraulic equipment and machinery. In this regard, polymer additives should be used in systems and machines, where a force action on polymer molecules is minimized. These are fire extinguishing systems, sewerage systems, systems for emergency pumping of water, etc.

Long duration of the preparation process of polymer solution (according to the classical scheme) is caused by low rate of swelling of the polymer powder, formation of hardly soluble gel and the need for subsequent dissolving during solution stirring, which requires the use of special equipment.

In view of this, the authors carried out comprehensive studies aimed at improving the processes of dissolution and dispensing of high polymers such as polyethylene oxide and polyacrylamide. For this purpose, liquid, pasty and solid hydrodynamically-active polymer compositions (HAPC) were developed, to allow small intervals for obtaining the required concentrations of polymer solutions.

Classic examples of HAPC application are extinguishing systems, sewerage, emergency water extraction and pipelines for plaster solutions supply. In all these systems energy consumption during transportation of liquid media is considerably reduced due to application of compositions. For example, introduction of HAPC (though dissolving) into fire-extinguishing liquid (water or aqueous solutions of surface-active substances) significantly (60–80%) reduces hydraulic losses and thereby improve one of the parameters of fire extinguishing systems: either 60–80% reduction in power consumption of pumps, or 1.5–2.2 times increase in consumption of fire extinguishing liquid, or 3–5 times increase in the length of fire mains, or a 15–25% reduction in their diameter. In addition, polymer additives significantly improve the fire extinguishing properties of liquids.

The authors also performed studies on HAPC application for improving the processes of hydro-creation of rocks and waterjet cutting of hard materials. For example, introducing of polymer compositions into working fluid (water) has increased 2 times the efficiency of a pulsed hydraulic monitor for coal extraction (without changing its construction). Using of working fluids based on HAPC solutions can significantly improve the process of hard materials cutting: either by reducing energy consumption while maintaining the parameters of the process of cutting, or by increasing the depth of cut and reducing its width at a constant power consumption. Application of HAPC is also effective for underwater cutting of materials, such as rods, neutron poisons, used in nuclear power plants.
REDUCTION OF HYDRODYNAMIC RESISTANCE BY SURFACE-ACTIVE SUBSTANCES

In addition to polymers, the additives of micelle-forming surface-active substances (MSAS) have the property to reduce the hydrodynamic resistance of fluids. The authors demonstrate that MSAS additives preserve their hydrodynamic efficiency in closed piping systems for cold- and heat-supply, including pumps for liquids. This is due to the so-called “reversible destruction” effect. Its essence is that the MSAS micellar structures, responsible for the decrease of resistance (as well as polymer molecules), are destroyed in pumps’ liquid ends, but after removal of large shear stresses (after pumps) they are restored, and again begin to suppress the turbulence in the piping parts of the heat- and cool-supply systems (in contrast to polymers, for which destruction is irreversible).

Effect of “reversible destruction” allows to receive a steady decrease in resistance and, hence, in energy consumption, for a long time. For example, two years of trial operation of coolant with MSAS additives in the secondary hydraulic circuit of the mine air conditioning unit (with a total of pipeline length of 14.5 km) showed stable (50%) reduction of hydrodynamic resistance. And, importantly, heat exchangers continue working without any problems.

OTHER PRACTICAL APPLICATIONS OF ADDITIVES

Solid hydrodynamically-active polymer compositions, developed by the authors, in addition to their application in hydraulic systems, can be widely used in solving of environmental problems. Primarily, they include: cleaning of water and sewage from the suspended solids and thickening of resulting sludge, reducing of weathering of fine fractions during the transportation of bulk materials, the localization of sources of soil pollution with toxic fluids, neutralizing the sources of air pollution (for example, the decomposition of biological waste); improving vibroacoustic characteristics of hydraulic systems, etc.

Of particular practical interest are the results of studies on the use of low-concentrated solutions of polyethylene oxide (PEO) and polyacrylamide (PAA) as gypsum tempering liquids. It was found out that the use of microadditives of these compounds can increase 1.2-1.5 times the period from gypsum tempering to its initial setting. In addition, during the transportation of gypsum solution though the pipeline, hydraulic losses were reduced by 45–60%. The introduction of polymer microadditives also leads to 10–25% increase in compression strength of the formed gypsum rock. At the same time, the period from gypsum tempering to its initial setting is almost unchanged.

Practical application of solid HAPC greatly simplifies and speeds the preparation of polymer solutions. This enabled the authors to create a mobile unit for the reagent treatment of various wastewater, which can be used for technical purposes after removal of suspended contaminants. In the future, such systems can be used for preparation of drinking water.

The report also shows the results of systematisation of additives reducing a turbulent friction, compositions on their base, and describes technologies of their preparation and use for internal and external applications.