REDUCTION OF FRICTION IN A TURBULENT FLOW OF POLYVINYL ALCOHOL SOLUTION

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Experiments have shown a reduction of drag in a turbulent flow of some solutions of substances of high molecular weight. In these experiments the pressure drop in a flow in tubes of different diameter [1–3] or the drag of a round cylinder mounted across the flow [4] was measured.

Below we give the results of measurements of turbulent friction in a flow of aqueous solutions of polyvinyl and glycerol between two coaxial cylinders.

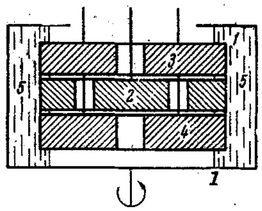

Fig. 1

The experiments were conducted in the apparatus illustrated in Fig. 1. The cylindrical vessel 1 was rotated by an electric motor; the rate of rotation was measured by a frequency meter. The friction on the inner fixed Dural cylinder 2 was measured by a spring dynamometer. The edge effect was reduced by the fixed cylinders 3 and 4, which were not connected to the measuring cylinder 2. Their diameter was the same and was 90 mm. The height of cylinder 2 was 19 mm and that of cylinders 3 and 4 was 18 mm. The gap between the outer and inner cylinder was 10 mm. In the investigated conditions the liquid occupied space 5. The flow surfaces were polished.

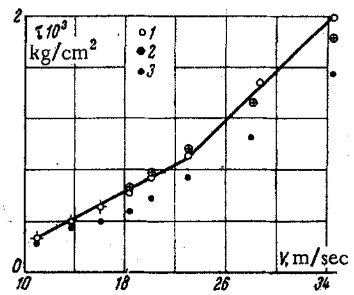

Fig. 2

Aqueous solutions of polyvinyl alcohol and glycerol (the latter was used for comparison) were prepared by weighing on an analytical balance. Their viscosity was measured in a Höppler viscometer (the diameter of the falling ball was 15.804 mm). We give the values of the viscosity μ(cp) and the concentrations of the investigated solutions of polyvinyl alcohol C_1 and glycerol C_2 in per cent

μ =	1.009	1.012	1.031	1.064	1.099
$C_1\%$ =	0.001	0.005	0.010	0.050	0.100
$C_2\%$ =	—	0.20	0.70	1.55	2.40

A plot of the friction stress τ [kg/cm^2], averaged over the whole flow surface of the cylinder 2, against the linear velocity V (m/sec) of the outer cylinder for water and the solutions is shown in Fig. 2, where the points 1 are for distilled water, 2 for a 2.4% glycerol solution, and 3 for a 0.1% polyvinyl alcohol solution. The polyvinyl alcohol and glycerol solutions had a viscosity μ = 1.099 cc.

The reduction of the turbulent friction τ[kg/cm^2] of the solutions in comparison with water depended on the viscosity μ of the solution and the structure of the dissolved molecules. This is clearly shown by the curves in Fig. 3. Curve 1 was obtained for flows of polyvinyl alcohol solutions with the velocity of the outer cylinder V = 34.5 m/sec. Curve 2 is for glycerol solutions and the same velocity.

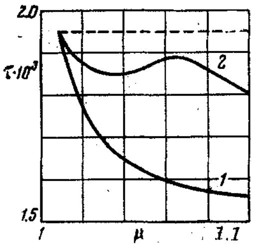

Fig. 3

From our data and other published data we cannot devise a physical theory of the process occurring in a solution of macromolecules. However, the very fact of the reduction of friction is sufficiently interesting to justify new and more extensive investigations.

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