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DETERMINATION OF THE BOUNDARY SHEAR STRESS OF THE TWO-PHASE SYSTEM ON THE EXAMPLE OF A PHARMACEUTICAL MIXTURE

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To determine the optimal conditions for controlling the properties of dispersed structures, it is necessary to establish the mechanism and kinetics of the formation and destruction of the spatial structural grid, that is, the kinetics of the interaction of the solid phase of the mixture, water and gaseous medium from the moment of appearance of the surface of separation between them until fission of the initial phases is complete.

Due to the presence of contact between the solid particles in the mixture, to overcome the structural framework they need to overcome the energy barrier, so for such a structured system is typical maximum shear stress τ (yield strength) [1].

The shear stress belongs to the integral characteristics which are taken as the structural and mechanical properties of the system as a whole such a set of interacting phases, that means a characteristic that determines the sum of elementary contact interactions between particles of the dispersed phase in the investigated volume of the dispersed system. At a load equal to the static shear stress (τ_0), the structure collapses and observed the shear deformation.

To get this parameter we used a methods that allows with very low (but variable) speed deformation characteristics to determine unruined structure [2].

There has been investigated the pharmaceutical suspension with different humidity (was investigated) 65, 70 and 75 % and different temperatures 24, 28 and 35°C. Such technological parameters are due to the fact that the suspension is formed by hydrophobic substances that are poorly wetted by water, and therefore the particles of solid phase usually accumulate in the aggregates, stick to the walls of the vessel or float to the surface.

To determine the shear stresses, was applied the method of absolute rheometry, namely a rotary rheometer with a controlled shear rate. During the work with the device to detect small values of stress was used a system of measurements S/S_1 (for it is constant 0.594 Pa). An example of the results of this series of experiments are presented in table 1.

Analyzing the curve built in logarithmic coordinates, we can get two parameters that describe the structural and mechanical properties of the mixture. Namely, the index of flow *n* will be numerically equal to the tangent of the angle of inclination of the graph of direct dependence $\lg \tau - \lg\dot{\gamma}$. The second parameter that is the purpose of our research, is a segment on the axis of the ordinate, which the resulting curves are cutting off, its value will be equal to τ_0.

This parameter acquires maximum values at minimum temperature and minimum humidity. We accept it within 2.5 Pa. This shows that at $\tau \leq \tau_0$ there is no flow of the mixture and external influences cannot disrupt its strength. With the further increase of the shear stress, at $\tau > \tau_0$ the system is out of balance and begins to move (flow). The speed of movement in this case is insignificant, the connections between solid parts manage to recover again after their destruction.

Table 1

Determination of shear stress at different humidity at temperature 28°C

Shear rate $\dot{\gamma}$, sec^{-1}	Indicator device readings α, scale divisions			Shear stress τ, Pa		
	65 %	70 %	75 %	65 %	70 %	75 %
0.5	4.9	0.1	0.0	2.9302	0.0637	0.001
0.9	5.6	0.5	0.1	3.3124	0.3185	0.0637
1	6.0	0.9	0.2	3.5672	0.5096	0.09555
1.5	7.2	1.2	0.3	4.2679	0.73255	0.1911
1.8	7.6	1.6	0.5	4.5227	0.9555	0.3185
2.7	9.5	2.5	0.9	5.6693	1.4651	0.5096
3	10.3	2.9	1.0	6.1152	1.7199	0.5733
4.5	12.0	3.4	1.3	7.1344	2.0384	0.7644
5.4	13.7	4.2	1.5	8.1536	2.4843	0.8918
8.1	17.4	5.6	2.1	10.3194	3.3124	1.274
9	18.4	6.1	2.3	10.9564	3.59905	1.3377
13.5	23.4	8.3	3.2	13.8866	4.9049	1.911
16.2	26.4	9.1	3.5	15.6702	5.4145	2.1021
24.3	33.5	12.9	5.3	19.8744	7.644	3.1213
27	35.8	13.7	5.5	21.2758	8.12175	3.2487

To obtain a specific value of the shear stress, we construct curves in double logarithmic coordinates, figure 1 and 2.

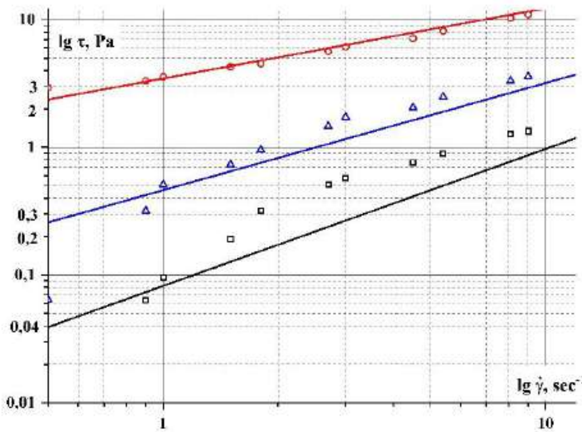

Fig. 1. Boundary shear stress for a mixture with different humidity (° – 65 %; Δ – 70 %; τ – 75 %)

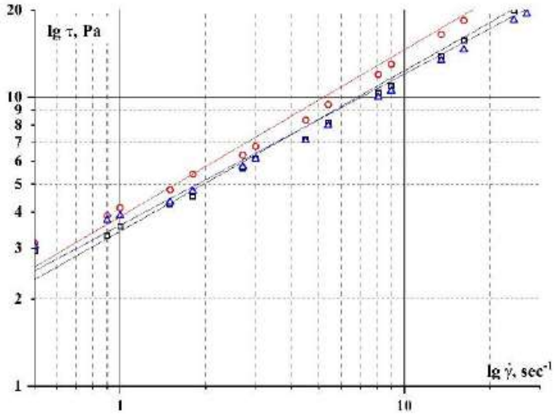

Fig. 2. Boundary shear stress for a mixture with different temperatures (° – 24 °C; Δ – 28 °C; τ – 35 °C)

Thus, such a pharmaceutical mixture can be classified as a viscoplastic liquid, which, in addition to viscosity, also has plastic properties, that consist in the presence of a certain shear stress, only after which occurs the "fluidity" of the medium.

The analysis of the results allows to make conclusions that the pharmaceutical mixture with a humidity of 65 % has the maximum shear stress. With increasing humidity up to 75 % its value such little that it can be neglected. Theoretically, accepting $\tau_0 = 0$, the mixture can be attributed to pseudoplastic liquids. Historically, the prefix "pseudo" which is added to a group of liquids that called plastic, and this is due to the fact that yield point of such liquids equal to zero [3].

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