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CREATING AN EXPERIMENTAL APPARATUS MODEL FOR INVESTIGATING COMPLEX FLUIDS BY NMR

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The phenomenon of magnetic resonance was discovered in 1945-1946 by two independent groups of scientists (Bloch, and Purcell), for which in 1952 they were awarded the Nobel Prize. Nuclear Magnetic Resonance is the resonant absorption of electromagnetic energy by a substance containing nuclei with nonzero spin.

With regard to rheology, it is the study of the flow of matter: mainly liquids but also soft solids or solids that under certain conditions flow rather than deform elastically.

Standard installations do not include devices for the investigation of rheological properties of complex fluids, so the aim of this work was the creation of such a facility.

The materials used in the design were chosen so that they were easy to handle and were invisible to NMR in the immediate vicinity of the receiving coil. In addition, the material should have a low friction coefficient and high durability. These materials are Teflon and caprolon.

The engine must be powerful enough, should not contain magnetic materials, and do not create an external magnetic field. These engines are: piezoengine, engines with hydraulic or pneumatic actuators.

It was decided to use asynchronous motor RD-09. The advantage of this engine is a fixed number of revolutions per minute that allows conducting experiments at a constant speed of rotation.

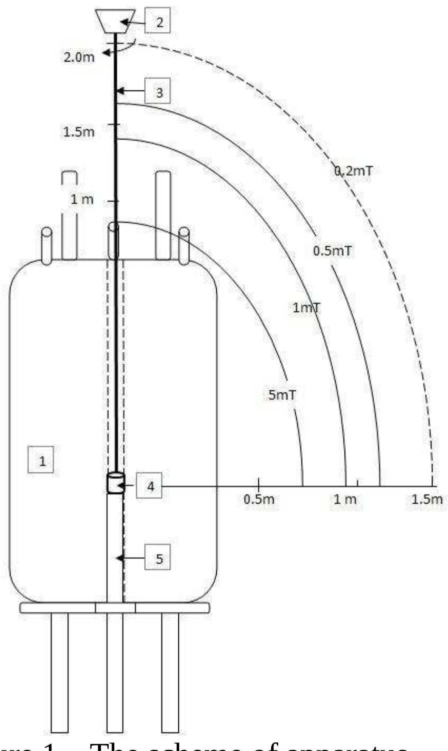

Figure 1 – The scheme of apparatus

The scheme of apparatus is on the Figure 1. Apparatus consists of a motor connected by the shaft with the rheological console, which, in turn, is located in a resonator. Engine (2) rotates the shaft (3) that drives the rotating part (rotor) of the rheological console (4).

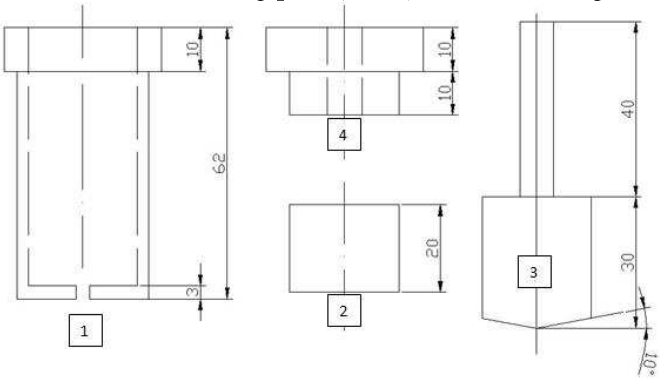

Figure 2 – The rheological console

The scheme of rheological console is on the Figure 2. The rheological console represents a barrel, in which are placed: a stuffer, a rotor, a cap. The hole in the bottom of the barrel (1) is intended to facilitate the process of assembling the device. The space between the stuffer and the rotor is filled with a liquid; the volume is approximately equal to 0.72 ml.

As an object for testing it was necessary to choose a substance which would possess the characteristics of complex fluids, and at the same time its properties were not possible to be determined by any other methods. The most suitable of fluids is the glair, a mixture of 90% water and 10% of various types of proteins.

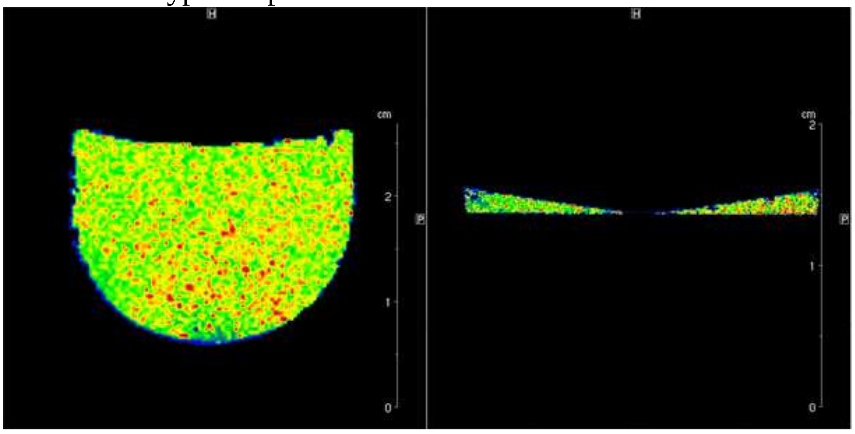

Figure 3 – The tomograms of the material in the absence of rotation in the sample in the glass ampoule (left) and in the rheological console (right)

During the test, it was confirmed that the spectral and tomographic characteristics of the material in the absence of rotation in the rheological console coincided with those for the sample in a glass ampoule (Figure 3).

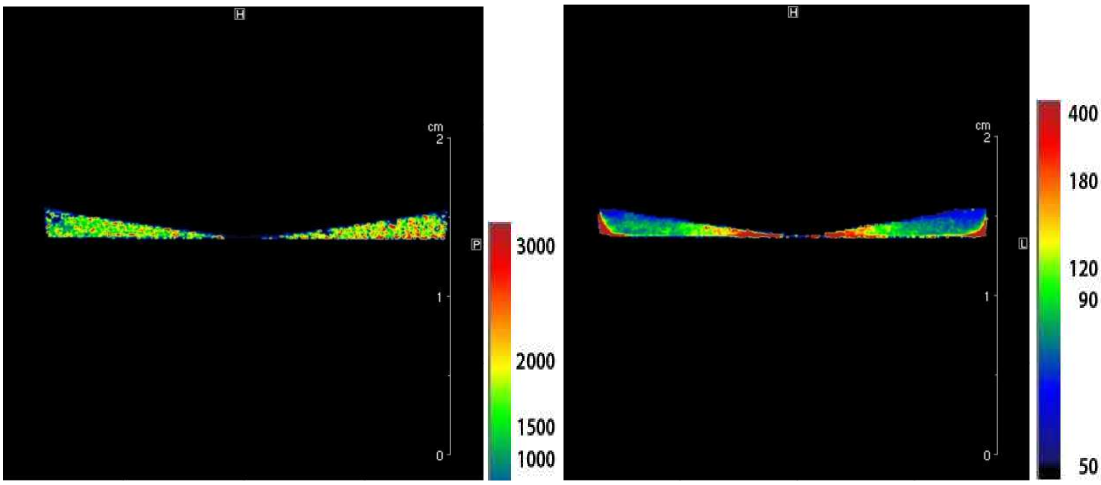

Figure 4 - The distribution of relaxation periods T_1 in the sample in quiescent state (left) and with rotation (right)

The tomogram shows that the distribution of relaxation periods T_1 in the sample with rotation is inhomogeneous and sharply differs from the distribution in the quiescent state (Figure 4), that proves the rheological console efficiency. It is assumed that the detected irregularities are caused by the spinning and the streamlining of protein molecules.

Conclusions:

1. In our work a model of the experimental apparatus for studying rheological properties of complex fluids has been designed, constructed and tested.
2. As a result of testing the installation was put into operation for conducting systematic investigations of the rheological properties of liquids.