M.I. Kalenyuk, Master student
V.P. Manoilov Prof., D.E., Prof., research advisor
L.Mohelnytska, PhD in Philol., Ass. Prof., language advisor
Zhytomyr State Technological University

RF ENERGY FOR PASSING FLUID THROUGH THE CAPILLARY

Electromagnetic waves (EM) are inevitable companions of domestic comfort. They permeate our bodies and the space around us. The sources of EM radiation warm and illuminate buildings. They are used for cooking. They provide instant communication to any corner of the world. All working appliances create an electromagnetic field around them. An electromagnetic field causes the motion of charged particles: electrons, protons, molecules-dipoles. Ions of water also have weak electromagnetic fields. In this experiment we investigate the influence of electromagnetic waves on the flow of fluid through the capillary. For this we use the laws of hydro-and electrodynamics. Namely, we find the value of E – tension of an electric field and H – tension of the magnetic field. We also find F – internal friction, dielectric constant of the solution due to capillary walls friction and flowing water solution:

$$E = F / q,$$

where F – force, q – electric charge, E – electric field tension;

$$Fpr = \eta \, dv / dx \, S, \; \eta = const,$$

η – coefficient of internal friction or of dynamic viscosity (dimension is in SI: PAS).

Electric and magnetic fields in the substance are characterized by additional vectors: the electric induction and magnetic field tension, associated with, respectively, the electric field tension and magnetic induction of correlation, which are called material. In general, material correlations have a complex nonlocal form, so when writing the basic equations of electrodynamics they are not cited. Therefore, we use the basic equations of classical electrodynamics that describe the electric and magnetic field created by charges and currents. It is Maxwell's equations.

$$rotH = 1 / c \, \partial D / \; t + 4 \; / c \, j;$$

$$rotE = -1 / c \, \partial B / \; t;$$

$$divB = 0;$$

$$div D = 4\pi\rho_f,$$

where ρ_f – density of free charges; B – magnetic induction vector.

Contribution of bound charges is taken into account in determining the electric induction vector D. A charge in a continuous medium is affected by forces of other charges which are different from those in vacuum. This is due to the polarization of the medium. Any material consists of electrons and ions, which shift under the action of an external field. As a result these charges create their fields, according to the principle of Le Chatelier – Braun. Reaction of any system on the outside impact tries to reduce this effect. The electric field acting on the test charge from other external charges is less than in the absence of protection. The electric field tension calculated without taking into account the above charges and polarization is called the electric induction vector in the CGC system. In the SI system the electric induction vector is defined with a different dimension than the dimension of the electric field, and therefore the result of the calculation must be multiplied by ε– permittivity of vacuum.

Most of the equipment used in the manufacture of drugs is very expensive and requires more maintenance costs and service. This makes it necessary to create new methods and devices for monitoring of substances that allow cheaper production and allow the control of drugs in real time during production.

Experiments conducted in this area are only theoretical and are not so numerous. Of all the articles most attention deserves A.V. Harlanov’s work. He is an Associate Professor of Physics Department at Volgograd State Technological University. His work is based on the phenomenon of fluids moving in porous solids under the influence of an electric field. The cause of the phenomenon is considered to be the existence of two substances different in nature on the distribution border of which occurs charge. For example, the boundary phase fluid-solid, liquid acquires a positive charge, and solid takes a negative. The difference in the phase charges leads in the case of a still porous body in an electric field to moving exchange ions together with the liquid phase to the corresponding pole. In A.V. Harlanov’s experiment, when irradiating the capillary by an electromagnetic wave with intensity $I = 100$ W/m^2, it is believed that the amplitude of the electric field equals 90 N / Kl. The amplitude of high frequency force on the surface unit is higher than adhesion force per area unit. Adhesion is a clutch of surface of heterogeneous solid or liquid bodies. The surface density of water must have order 1 Kl/m^2, but based on A.V. Harlanov’s calculation, surface density may have a higher value. In this case, the Coulomb force acting on a layer of water adjacent to the pipe wall corresponds to the high-frequency force F, and the force F_S corresponds to U_0. Based on the results of A.V. Harlanov’s calculation fluid will increase by the amount equal to:

$$\Delta W = U_0 \, \pi R^2.$$

In real fluid, due to mutual gravity and thermal motion of molecules, there is internal friction or viscosity.

If we put the liquid solution in a capillary and make it move and make water circulate, we will observe forces occurred due to circulation. The forces act between the walls of the capillary and water levels and they are directed tangentially to the surface layers. They are called internal friction. These forces are proportional to the square of interacting layers S and velocity gradient. For many liquids the internal friction forces obey Newton's equation. For Newton's equation, we need the value of Newtonian fluids which is known in advance. The internal friction coefficient of Newtonian fluid depends on its structure, temperature and pressure, but is independent of the velocity gradient. With these values, we can examine the process of water flow through the capillary. Using a thin capillary enables us not only to measure the dielectric constant of the liquid of a certain volume, but also in real time to observe the change in dielectric constant of the investigated water solution flow. However, such measurements have certain peculiarities. For example, for a 1 mm diameter capillary a critical speed is 0.96 m/s. Air bubbles will be formed inside the capillary at such speeds in liquid. Their formation is caused by turbulence. We should not forget about the rigidity of the inner surface of the capillary. In addition, it should be noted that the viscosity and density of the liquid decreases with increasing temperature, which must be taken into account when calculating.

Interconnected vibrations of electric (E) and (D) magnetic fields make the electromagnetic field. They distinguish forced and own electromagnetic waves (oscillations). In infinite space or in systems with energy losses electromagnetic waves with a continuous spectrum of frequencies are possible. Systems with limited space have a discrete range of frequencies. Each frequency corresponds to one or more independent types of oscillation. Presentation of vibrations as a superposition of modes with continuous or discrete spectrum is possible for an arbitrary component of the dielectric system, In our case this component is water solution. Electromagnetic waves are described by the general for electromagnetic phenomena Maxwell equations. When there are no electric charges and currents in space Maxwell's equations have nonzero solutions. These solutions describe the electromagnetic waves that will affect the flow of water solution.

The proposed calculation method allows us to investigate the influence of electromagnetic waves on the process of water solution flow and a possible change in the process velocity to reduce fluid spending. Electromagnetic waves absorbed by water excite molecules vibrations leading to the effect of vibration displacement.