ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-515-x, Impact Factor: 9.23
American Academic publishers, volume 6, issue 02,2026

Journal: https://www.academicpublishers.org/journals/index.php/ijai

RESULTS FROM EXPERIMENTS ON VISCOUS-PLASTIC MEDIA

Department of Mathematics,
University of Economics and Pedagogy
Docent: **Meyliyev Xabibulla Jamolovich**
Assistant: **Khojakulov Farrukh Normamatovich**
Assistant: **Jamalov Madamin Habibulla's son**

Annotation: General concepts about complex specific environments, information studied by scientists are presented. The next paragraph provides a description and information about a special case of complex specific environments - viscous plastic environments. The work carried out with viscous plastic environments, research conducted to study them, and information obtained from experiments studied through research are presented in the third paragraph of the chapter.

Keywords: visco-plastic mediavisco-plastic deformation, rheological properties, force-strain relationship, plastic deformation, viscosity,hysteresis effect, energy loss, recoverable and non-recoverable deformation, temperature effect, time-dependent deformation, rheological models (Maxwell, Kelvin–Voigt)

These include highly viscous synthetic materials, as well as weak solutions of polymers in Newtonian fluids. It is worth noting that sometimes even a small addition of such media can transform Newtonian fluids into non-Newtonian fluids, giving them unique viscoelastic properties [1].

In order to explain the effect of elasticity and viscosity on the girder, two rheological models were used:

1) Feucht model based on elastic and viscous forces:

$$\tau = G\varepsilon + \mu\dot{\varepsilon} \qquad (1)$$

Here G is the shear modulus, ε is the shear strain, $\varepsilon = du/dy$ is the shear rate, and μ is the dynamic viscosity coefficient in this case, a smooth shear motion is considered as shown in Figure 1 *[v=0, u=u(y)]*.

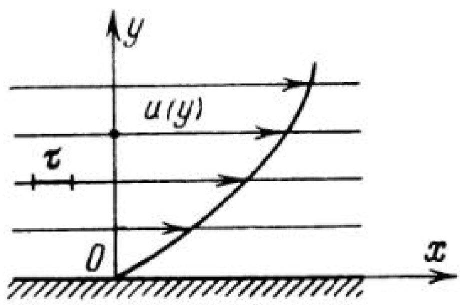

figure 1

2) Maxwell's model based on the coverage of elastic and viscous deformation rates:

$$\varepsilon = \frac{\tau}{G} + \frac{\tau}{\mu} \qquad (2)$$

Here, as in the above Feucht model, a smooth sliding motion is considered. If we set $\tau = const = \tau_0$ in the first model, i.e. equation (1), and ε=0 in the second model, the difference between these two models becomes clear. If we integrate equation (1) for the Feucht model, we obtain the following equation at $\tau = \tau^0$:

$$\varepsilon = \frac{\tau_0}{G}\left[1 - exp\left(-\frac{Gt}{\mu}\right)\right] \qquad (3)$$

The elastic deformation τ_0/G with increasing time t corresponding to a constant stress $\tau = \tau_0$ represents the delay in setting. The constant μ/G represents the delay time. Integrating equation (2) in the Maxwell model, assuming ε=0, we get:

ORIGINAL ARTICLE
INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE
ISSN: 2692-515-x, Impact Factor: 9.23
American Academic publishers, volume 6, issue 02,2026
Journal: https://www.academicpublishers.org/journals/index.php/ijai

$$\tau = \tau_0 \, exp\left(-\frac{Gt}{\mu}\right) \qquad (4)$$

This solution, which expresses the return of the stress τ to zero with increasing time t when the state of the medium is in equilibrium, leads to this solution.

The process of returning the medium to the equilibrium state is caused by a process called relaxation, and the characteristic time of the development of this process is called the relaxation time.

An example of stress relaxation in the Maxwell model of viscoelastic fluid flow, expressed by equation (4), can be

$$\lambda = \frac{\mu}{G} \qquad (5)$$

This quantity (5), which appears in both the Feucht model and the Maxwell model, can be interpreted as the "delay time" that constitutes the elastic deformation in the first case, and as the "relaxation time" of the stress in the second case.

(2) Maxwell's model can be written in terms of rectilinear motion as follows:

$$\lambda\dot{\tau} + \tau = \mu\dot{\varepsilon} = \mu\frac{du}{dy} \qquad (6)$$

relaxation vaqtining zero qiymatida (λ=0) yes (6) tenglamrasredia tezligi oniy kuchlanishga mos kaladidigan Newton qonuniga kaldi.

Taking into account the presence of viscous properties in viscous-plastic media, the propagation of vibrations, just like in gases, reaches a finite speed.

To determine the value of this velocity, we look at the basic equations of motion of dynamics written for forces in a uniform rectilinear motion. In the absence of bulk forces, the equation becomes:

$$\rho\frac{\partial u}{\partial t} = \frac{\partial \tau}{\partial y} \qquad (7)$$

If we derive both sides of equation (7) in terms of time:

$$\lambda\frac{\partial^2 \tau}{\partial t^2} + \frac{\partial \tau}{\partial t} = \mu\frac{\partial^2 u}{\partial y \partial t} \qquad \text{ёки} \qquad \frac{\partial^2 \tau}{\partial t^2} + \frac{1}{\lambda}\frac{\partial \tau}{\partial t} = \frac{\nu}{\lambda}\frac{\partial^2 \tau}{\partial y^2} \; (8)$$

These special hyperbolic equations represent wave-like distributions of stresses, since in these distributions the square root of the value ∂2τ/∂y2, which does not depend on the viscous medium, is determined and is equal to:

$$w = \sqrt{\frac{\nu}{\lambda}} = \sqrt{\frac{\nu G}{\mu}} = \sqrt{\frac{G}{\rho}} \qquad (9)$$

In viscoelastic media, the propagation of disturbances at a finite speed leads to the dependence of the motion of flow points of a moving viscoelastic fluid on points located upstream of the previous flow. This phenomenon is called the effect of history, and in fluids this property is called hereditariness. Viscoelastic fluids contribute to the emergence of similar hereditariness fluids.

Here we note an important difference between the Foucht and Maxwell models. The Foucht model is characterized by the fact that the displacement velocity ε, which can be obtained by differentiating with respect to time from (5) under the influence of a constant stress, quickly tends to zero as t→∞, i.e., the Foucht "model" under the influence of a constant stress does not have the property of infinite readability. The Maxwell "model" therefore has the following conditions, as can be seen from (4): $\tau=\tau_0$, τ=0, the relation holds:

$$\dot{\varepsilon} \to \frac{\tau_0}{\mu} \neq 0 \quad \text{(where t is arbitrary)} \qquad (10)$$

Unlike the Voigt model, the flow is under the influence of a constant shear stress with a constant shear rate

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-515-x, Impact Factor: 9.23
American Academic publishers, volume 6, issue 02,2026

Journal: https://www.academicpublishers.org/journals/index.php/ijai

$\varepsilon 0 = \tau 0/\mu$. Therefore, the medium obeying the Voigt rheological law is often a viscoelastic fluid, as proposed by Maxwell, in contrast to the viscoelastic solid.

Used literature.

1. Лойцянский Л.Г. Механика жидкости и газа. Учебник для вузов. — 7-е изд., испр. — М.: Дрофа, 2003. — 840 с,
2. Ишлинский А. Ю., Ивлев Д. Д. Математическая теория пластичности. — М.: Физматлит, 2001, 2003. — 704 с. — ISBN 5-9221-0141-2.
3. SIMULATION OF A TWO-LINK MANIPULATOR, http://sjifactor.com/passport.php?id=22257
4. Седов Л.И. Механика сплошной среды (том 2). М.: Наука, 1970 г., 568 стр.