UDC 631.363.7

Forage mixture rheology RESEARCH UNDER THE INFLUENCE OF VIBRATION FIELD

VS Loveykin, PhD
Y. Chovniuk, AV Hudova, Ph.D.

The results of theoretical studies of the effect of vibration forces on indicators blending process of transportation. Posted scheme rheological state Forage mixture under vibration.
Rheology, Forage mixture, vibration, strain shear viscosity.

Problem. One of the technological problems in production and transportation Forage mixture is to bring them into a state of flow (when staying in auger). This problem is solved by dynamic alternating load (vibration). In addition, the vibration Forage mixture (a certain frequency, amplitude, polarization) helps reduce the resistance (friction) arising during transportation-mixing.

The feasibility of the separation process in formoutvoren Forage mixture, dictated by the peculiarities of physical and mechanical phenomena that occur in mixtures under the influence of vibrational fields. Studying the process of transforming dry friction forces in viscous, elastic and causes of dissipative forces, mechanism of viscosity reduction and other issues Forage mixture rheology Forage mixture helps solve many technological problems and primarily focused on the selection of rational modes of vibration Forage mixture during their transportation via screw devices.

Analysis of recent research. Issues related to the mechanism of vibrating movement of bulk materials discussed in the works: II Blehmana[2]P. S. Bernik [11], I. H. Honcharevycha [3,4],LV Mezhuyev [5], VA Plachkova [6], VM Poturayev [7], SARusanov[8] and others. In particular, LV MezhuyevThe mathematical model of vibrozmishuvannya bulk feed the masses in the preparation of feed for pigs in Batch mixer with internal vibroaktyvnymy surfaces; installed and grounded influence of physical and mechanical, rheological, structural and operational and technological parameters of the process of mixing.

Plachkov VA [6] Experimentally substantiated limits the angular intensity vibration; put the differential equations of motion in vibrohvyntovomu feed dispenser by which we can estimate the influence of the parameters of angular vibration and friction coefficient on the value of feed and specific energy process.

Typically, the rheological study Forage mixture conduct in static condition or mode steady oscillations (after transients).

In this (goal) study to provide an informed assessment theory rheological properties Forage mixture during the vibratory action.

Results. The most important rheological parameter is the relaxation time Forage mixture. It is known that at the time of termination of dynamic effects normally any mixture passes out of viscous flow in a structured system.

This time interval can be some approximation to consider the magnitude of relaxation and evaluate the relation:

$$t_p \equiv \tau_{релакс} = \frac{1}{\tilde{n}} \cdot \ln\left(\frac{y_n}{y_{n+1}}\right), \qquad (1)$$

where $\tilde{n}$ - Coefficient of viscous resistance; y_n, y_{n+1}- Amplitude oscillations in Forage mixture n-th and $(n+1)$th oscillation periods, respectively.

Duration relaxation Forage mixture $(\tau_{рел})$ have a significant influence on the choice of modes of dynamic load and, in particular, the frequency of vibration. This dependence can be presented as a ratio:

$$w \geq \frac{\tilde{n}}{\ln\left(\frac{y_0}{\alpha}\right)}, \qquad (2)$$

where w - Frequency of vibration; y_0- Vibration amplitude fluctuations of the field; α- The number of periods of natural oscillations Forage mixture until the fade.

Dependence (2) allows for the known values of the coefficient of viscous resistance and forced vibration amplitude assign frequency parameter, which provides the highest efficiency of vibration.

In Forage mixture of dry friction, resulting in low values of elastic characteristics momentum fades over a period of natural vibration frequencies $(\tau_{релаксації} << T)$, that a period of relaxation in the mix much less oscillation period ($T = {2\pi}/{w}$).

For Forage mixture of predominantly viscous properties of a single pulse vibrations are damped periodic nature $(\tau_{релаксації} >> T)$. Depending on the ratio of elastic and dissipative properties Forage mixture period and decrement will be different. Where to mix a little liquid components (viscous properties Forage mixture), another notable is the influence of dry friction, which, incidentally, is some non-linearity and aperiodychnist fluctuations. The behavioral Forage mixture under short-term pulses file allows qualitative and quantitative assessment of rheological state. So to determine the viscous resistance can be used regardless of the form:

$$\tilde{n} = \frac{y^{*} \cdot w_1}{2\pi}, \qquad (3)$$

where w_1 - Natural frequency of oscillation of the system; $y^{*} = \ln \frac{y_n}{y_{n+1}}$ - Decrement.

Scheme rheological state Forage mixture under vibration. Depending on the nature of the overall vibration compaction cycle Forage mixture can be divided into three stages.

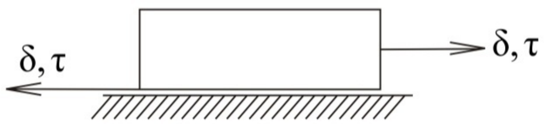
1. Initially vibration Forage mixture dominated by dry friction forces. Manifestation and duration of their different. For mobile Forage mixture expectancy is calculated by several seconds, but for moderately hard and hard - tens of seconds. There renewal Forage mixture components, random placement and part-mentioned contact particles mix with each other. This movement elements Forage mixture reduces the frictional forces between particles mixture, more compact location.

2. Under the influence of dynamic loading system easily passes through to the second stage of restructuring the post random patterns as a result of renegotiation and the relative orientation of the solid particles mixture.

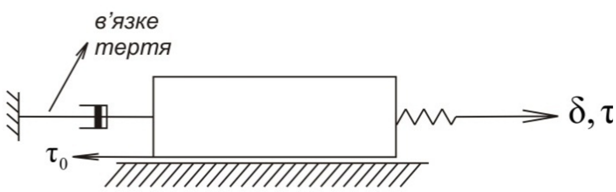
3. In the last stage vibration characteristic Coulomb friction forces disappearance. Fluctuations particles and Forage mixture as a whole are sinusoidal in nature, the phase shift between them is close to zero, the amplitude of the oscillation is stabilized. In very ruined state Forage mixture has only viscoelastic properties.

The above considerations allow to propose a general scheme rheological state Forage mixture under vibration (Fig. 1). Here zone and - II -III are the phases characterized by rheological states Forage mixture in the form of dry friction models, Shvedova-Binhama, Kelvin-Voigt.

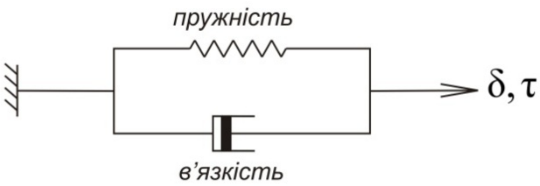
And:
Dry friction



II:
Shvedova viscoplastic medium-Binhama $\tau = \tau_0 + \eta\dot{\gamma}$,
τ_0 – threshold voltage shift;
η – plastic viscosity Forage mixture



III:
Viscoelastic Kelvin-Voigt
model



$$I \to II \to III$$

Fig. Figure 1. Rheological (evolving) state Forage mixture under the influence of vibrational fields.

At this stage Forage mixture is dry friction elements, but are superior forces of viscous and elastic resistance. The period is $1/3$ or more of the total cycle vibration mixture.

Effect of vibration frequency on display of properties Forage mixture within the Kelvin-Voigt model. Effect of vibration frequency on display of properties Forage mixture as environment, rheological model described by the Kelvin-Voigt [9], And can be defined by the equation of the following type:

$$\frac{\tau}{G} = \gamma + \lambda \cdot \dot{\gamma}, \tag{4}$$

where τ - Shear stress in the mixture; G - Shear modulus; γ - Shear strain; $\lambda = \frac{\eta}{G}$ - Relaxation time of the system (ie how long the system remembers that it was loaded); η - Dynamic viscosity Forage mixture.

If you change the strain on sinusoidal law $\gamma = \gamma_0 \cdot \sin wt,$ have:

$$\tau = G \cdot \gamma_0 \cdot \left(\sin wt + \lambda w \cdot \cos wt\right) = G \cdot \gamma_0 \cdot \sqrt{1 + \lambda^2 w^2} \cdot \sin\left(wt + \varphi\right), \tag{5}$$

where γ_0 - Amplitude shear strain; w - Frequency (circular) vibration; t - Time; $\varphi = arctg\left(\frac{1}{\lambda w}\right)$. Then:

$$\sin\varphi = \frac{1}{\sqrt{1 + \lambda^2 w^2}}; \ \cos\varphi = \frac{\lambda w}{\sqrt{1 + \lambda^2 w^2}}. \tag{6}$$

Let us analyze the expression (5).

A. If λw>> 1, the viscosity of the medium Forage mixture large and high frequency vibration:

$$\frac{\eta \cdot w}{G} >> 1, \tag{7}$$

then:

$$\tau = G \cdot \gamma_0 \cdot \sqrt{1 + \lambda^2 w^2} \cdot \sin wt, \ \ \varphi \to 0, \tag{8}$$

that is, τ and γ the same phase fluctuations, and have approximately:

$$\tau \approx G \cdot \gamma_0 \cdot \lambda w \cdot \sin wt, \qquad \gamma = \gamma_0 \cdot \sin wt. \tag{9}$$

Thus, vibration increases tension in Forage mixture. That is, with increasing frequency wA mixture increasing shear stress, which contribute to more rapid destruction of the mixture and stirring it easier to components (within the Kelvin-Voigt model).

B. If $\lambda w << 1$, The viscosity of the medium was Forage mixture, low frequency vibration:

$$\frac{\eta \cdot w}{G} << 1, \tag{10}$$

then:

$$\tau = G \cdot \gamma_0 \cdot \sqrt{1+\lambda^2 w^2} \cdot \sin\left(wt + \frac{\pi}{2}\right), \quad \varphi \to \frac{\pi}{2}, \tag{11}$$

that is, τ and γ shifted in phase fluctuations, and have approximately:

$$\tau \approx G \cdot \gamma_0 \cdot \cos wt, \qquad \gamma = \gamma_0 \cdot \sin wt. \tag{12}$$

In this case, the vibration slightly changes the tension in Forage mixture.

B. Ifλw ~ 1,

$$\frac{\eta \cdot w}{G} \sim 1, \tag{13}$$

then:

$$\tau = G \cdot \gamma_0 \cdot \sqrt{2} \cdot \sin\left(wt + \frac{\pi}{4}\right), \ \varphi \to \frac{\pi}{4}, \tag{14}$$

that is, τ and γ shifted in phase fluctuations on $\pi/4$And vibration increases tension in Forage mixture of $\sqrt{2}$ times, while $\gamma = \gamma_0 \cdot \sin wt$.

Thus, vibration increases shear stress Forage mixture of 1.4 times, which leads to improvement in uniformity mix within 8-10%.

Conclusion. In any rheological model, the resistance movement in Forage mixture components with reduced vibration, namely mixing it with kormosumishshyu intensified. Thus, depending on the oscillation frequency changes in shear stress Forage mixture, which in turn affects its homogeneity.

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In the work predstavlenы Theoretically Results of research of influence vybratsyonnыh forces on the transport of process indicators-smeshyvanyya. The scheme rheological STATUS kormosmesey vibration pod actions.

***Rheology, kormosmes, Vibrate, voltage shift, viscosity*.**

The paper presents results of theoretical studies of nfluence of vibrational forces on parameters of transportation-mixing. The scheme of rheological state of forage mixture under vibration is submitted.

Rheology, forage mixture, vibration, shear stress, viscosity.

UDC 631.331.54

Experimental device for laboratory research accuracy of dosing process SEEDS

OO Bath, Ph.D.
PS Popik Engineer*

In the paper the experimental setup, which withthrough studies of pneumatic sowing device for the accuracy of its key features. Displaying installation structure of the scheme and describes how it works.

Pnevmomehanchnyy seeding machine, experimental setup, the exact crop, seed sowing, dosage.