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# THE PECULIARITIES OF DISPERSION PAINT-AND-LACQUER MATERIAL FLOW IN THE GAP OF ROLLER MACHINE

**Abstract.** The behaviour of paint-and-lacquer material in the application zone of roller machine has been examined using the hydrodynamic analysis of viscous-plastic fluid flow. The obtained dependences are needed to substantiate the technological parameters for the thin-layer application of water-dispersion paint-and-lacquer coating.

**Key words:** water-dispersion material, roller machine, viscous-plastic fluid, roller, gap, technological parameters.

**Introduction and relevance of the problem.** The most labor-intensive and important stage of the production process in woodworking is finishing of products. In recent years, due to aggravation of energy crisis and adoption of more stringent laws on environmental protection, there have been significant changes in the range of paint-and-lacquer materials (PLM).The furniture industry is shifting to thin-layer finishing as the most economic alone since it provides the reduction in PLM consumption rate, labor intensity and cost price. Among the materials for thin-layer finishing, water-dispersion materials currently occupy an important place.

Thin-layer application of PLM calls for the widespread use of roller equipment that provides the application with a minimal consumption of the material.

**An analysis of the studies and publications**.Water-dispersion materials belong to the group of soliquids of hydrosols, but if the solid particles are polymers and the medium is water,suchhydrosols are called latexes. Latexes are obtained by emulsion polymerization of monomer in water. Thus obtained latex is but one of many ingredients of the complex system which, apart from latex,also includes pigments, protective colloids, emulsifiers, antifoam generators, stabilizers and sometimes plasticizers.

Protective colloid increases the viscosity of the dispersion medium and thus contributes to the stabilization of the dispersed particles. It also influences the extent of viscosity dependence on shear rate. This leads to the fact that the viscosity significantly increases at low shear rate, the material does not drip from the surface, does not sag; however, in case of considerably high shear rate, the latex flows easily in the process of applying the material. Stabilizing system must be chosen so that the destruction of the latex in the process of coating formation occurs at the right time. In the process of applying the latex, the water should form a continuous phase.

When the water evaporates, the latex is destroyed, that is the water becomes the disperse phase, distributed in a continuous phase of the polymer. The destruction of the latex should take place only after the film application on the substratum.

**Presentation of the basic material**. The latexes are characterized both by yield point $\tau_т$ and a variable plastic viscosity $\eta$. Depending on the shear rate dv/dy, their flow can be modeled by the Shvedov-Bingham rheological equation [1]

$$\tau = \tau_т + (dv/dy) \qquad (1)$$

where $\tau$ is shear stress.

Schematic application of PLM on the roller machine in the zone of the coating formation is shown in Fig. 1. Hydrodynamic analysis of the viscous-plastic fluid flow [2] makes it possible to identify the essence of the phenomena occurring in the deformation zone as well as the general character of the kinematics and dynamics of flow. It turns out that the fluid flow is heterogeneous and consists of two zones of viscous flow within the surfaces of the paintwork panel and roller and the plastic core in the middle part, where the shear stress exceeds the yield point.

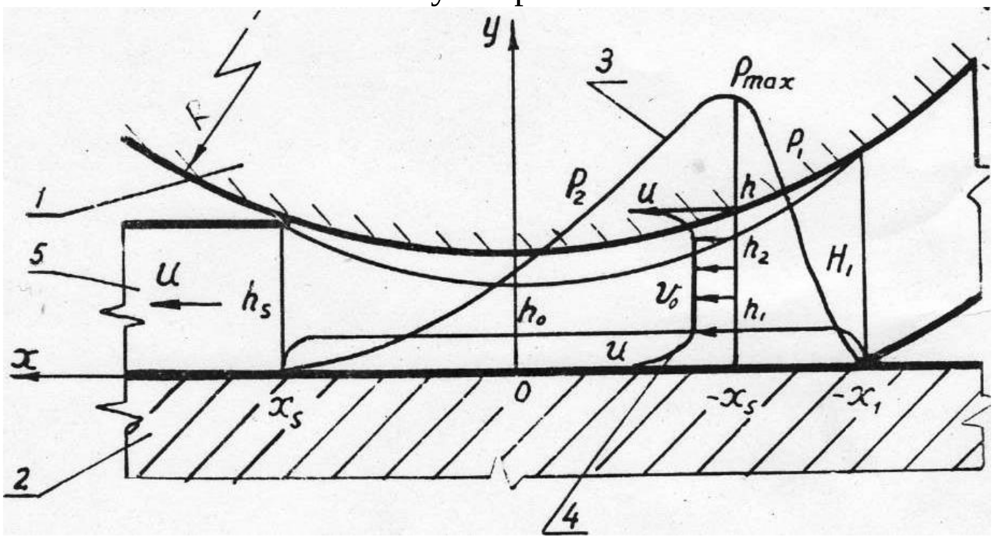


***Fig. 1. Diagram of the coating formation on the roller machine***
***1 - applicator roller; 2 - substratum; 3 – pressure distribution P(x);***
***4-velocity distribution of material movement***

Equations for flow velocities:

- near the surface of the paintwork panel

$$v_1 = u - \frac{2h_1 y - y^2}{2\eta}\frac{dp}{dx}\ ; \qquad (2)$$

- near the surface of the roller

$$v_2 = u - \frac{(h^2 - y^2) - 2h_2(h - y)}{2\eta}\frac{dp}{dx}\ . \qquad (3)$$

On the surface of the roller and the paintwork panel, flow velocity is maximum and is equal to **u**.

- for plastic core $$v_0 = u - \frac{(h - h_2)^2}{2\eta}\frac{dp}{dx}\ , \qquad (4)$$

where u is the feed rate of the paintwork panel and the peripheral speed of the applicator roller**;** $\mathbf{h_1}$ and $\mathbf{h_2}$ are the ordinates of viscosity zone**; h** is theheight of deformation zone; **y** is the variable ordinate; **dp/dx** is the pressure gradient of the fluid.

Specific consumption of material is defined as the product of the height of the cross-section by the flow velocity through the cross-section

$$q = \int_{-x_1}^{-x_s} p_1 dx + \int_{-x_1}^{-x_s} p_2 dx\ \ , \qquad (5)$$

or

$$q = uh - \frac{1}{\eta}\frac{dp}{dx}\left(\frac{2}{3}h_1^3 + \frac{h_1^2(h_2 - h_1)}{2}\right). \qquad (6)$$

During the movement of material through the area of deformation, specific pressure ranges from **0**in the cross-section of the entrance to the gap $(-x_1)$ to a maximum value in the cross-<u>section</u> $(-x_s)$ and again decreases to **0** in the section $(-x_s)$ **).**

The distribution of the specific pressure in the deformation region is asymmetrical, so the pressure is determined separately for areas of accelerated motion of the material **$dp_1/dx$** and its deceleration **$dp_2/dx$.**

The interaction of forces **$p_1$** and **$p_2$** creates a separating force **F**, which must be compensated by the pressure force of the rollers

$$F = \int_{-x_1}^{-x_s} p_1 dx + \int_{-x_1}^{-x_s} p_2 dx \,. \qquad (7)$$

**Conclusions**. The analysis of obtained equations and their experimental verification will allow creation of preconditions for substantiation of parameters of roller machines when applying water-disperse paint-and-lacquer coatings.

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### Особливості течії дисперсійних лакофарбових матеріалів у зазорі вальцевого верстату

Проаналізованоповедінку лакофарбового матеріалуу зоні нанесення вальцевого верстату,з використанням гідродинамічного аналізу течії в'язкопластичної рідини. Отримано залежності, необхідні для обґрунтування технологічних параметрів при тонкошаровому нанесенні воднодисперсійних лакофарбових покриттів.

**Ключові слова:** воднодисперсійний матеріал, вальцевий верстат, в’язкопластична рідина, валець, зазор, технологічні параметри.

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## CALCULATION FEATURES OF VARIABLES PROCESS LOADS ACTING ON THE CABLE TIMBERTRANSPORTING PLANTS DRIVE

Improved the theoretical methods of calculation of technological tension in cable timber transporting plants drives taking into account the duration of the technological cycle of the plant, multilayer cable winding on driving drums, cable tension force that varies and depends on the working mode of plant and operating parameters.

**Keywords:** cable timber transporting plant drive, technological loads, haul-lifting cable, cable tension force.

**Introduction**. About one-third of forests in Ukraine are in the mountainous and difficult terrain. The experience of logging in mountains in our country and abroad showed that cable timber transporting plants are an effective means of primary timber transport that best correspond modern environmental and industrial requirements [1, 5, 6, 7]. The creation of new and improvement of existing methods of calculating the basic structural elements of cable timber transporting plants is an actual task.