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# Simulation model of thrust bearing with a free-melting and porous coating of guide and slide surfaces

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**Abstract.** The method for the formation of an exact self-similar solution of the hydrodynamic calculation of wedge-shaped support (sliding bearing, guide bearing) with a porous coating of a slide, which operates in the presence of a lubricant and the melt of a guide coated with a free-melting metal cover. The analytical dependence for the molten guide surface is obtained on the basis of the equation of motion of a viscous incompressible fluid for a “thin layer,” the equation of continuity and the equation for the dissipation rate of mechanical power. In addition, the main performance characteristics of the investigated friction pair are determined. The assessment of the effect of the parameter caused by the guide melt and the parameter characterizing a porous layer on the slide surface on the bearing capacity and friction power is made.

## 1. Introduction

It is known that the stable operation of machines and their service life largely depend on the design and quality of bearing assemblies. New machines, as a rule, are designed to increase the static and mechanical loads acting on sliding bearings. This is determined by the tasks of modern engineering practice. It is necessary to note that one of the most important equal structural elements of fluid-friction bearings is the lubricating medium.

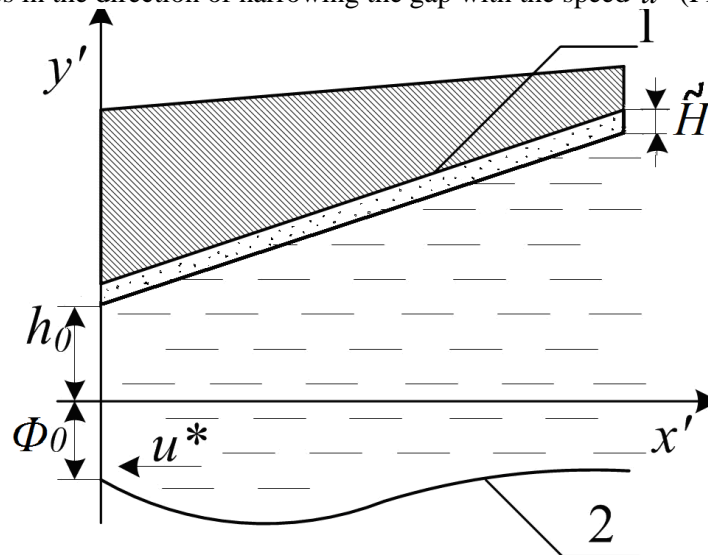
One of the methods for the solution of design and operational task is the use of lubrication of a free-melting bearing coating. Lubrication with liquid metals is used at temperatures at which conventional lubricants undergo irreversible physical and chemical changes. The issue of melt lubrication was studied in many applied tasks, in particular, in the processes of forming and cutting metals [1–8]. A great number of research works is devoted to the hydrodynamic calculation of a system consisting of a “slider – guide” when the slide is located at an angle to the guide surface, in the absence of a lubricant [9–13]. A significant drawback of the investigated friction pair, operating on the basis of lubrication with a melt, is the low bearing capacity. In addition, the process of lubricating plastic lubricant is not self-maintaining.

Thus, the development of a design model of sliding bearings, operating on lubricants in the form of metal liquid melts with a porous coating of surface of the slide, taking into account the above mentioned aspects of functioning, is one of the promising areas of theoretical studies of modern tribology.



## 2. Research purpose

A wedge-shaped support consisting of a “slider-guide” system is considered. It is assumed that the surfaces of the slide covered with a porous layer and a guide covered with a free-melting metal coating are separated by a layer of lubricant. The slider is fixed, and the guide, made of a material with a low melting point, moves in the direction of narrowing the gap with the speed  $u^*$  (Figure 1).



**Figure 1.**

In the Cartesian coordinate system  $x'o'y'$  (Figure 1), the equation of the contour of the slider with a porous coating and the molten surface of the guide can be formulated as:

$$y' = h_0 + x' \operatorname{tg} \alpha + \tilde{H}, \quad y' = -\eta' f'(x'). \quad (1)$$

The conditions of motion of an infinitely wide slider are investigated under the following assumptions:

1. Liquid medium is a viscous incompressible fluid.
2. All the heat released in the tribo-contact melts the coating with a free-melting metal melt of the guide surface.

## 3. Basic equations and boundary conditions

The motion of a lubricant is described by the flow equation of a viscous incompressible fluid in the approximation for the case of a “thin layer”, the continuity equation and the Darcy equation.

$$\mu' \frac{\partial^2 v_{x'}}{\partial y'^2} = \frac{dp'}{dx'}, \quad \frac{\partial v_{x'}}{\partial x'} + \frac{\partial v_{y'}}{\partial y'} = 0, \quad \frac{\partial^2 P'}{\partial x'^2} + \frac{\partial^2 P'}{\partial y'^2} = 0. \quad (2)$$

Where  $v_{x'}, v_{y'}$  – the components of the speed vector of lubricating medium;  $p'$  – hydrodynamic pressure in the lubricant layer;  $\mu'$  – coefficient of dynamic speed,  $P'$  – hydrodynamic pressure in the porous layer.

Boundary conditions in this case are as follows:

$$\begin{aligned} v_{x'} &= u^*, \quad v_{y'} = 0 \quad \text{at} \quad y' = -\eta' f'(x'); \\ v_{x'} &= 0, \quad v_{y'} = 0, \quad \text{at} \quad y' = h_0 + x' \operatorname{tg} \alpha; \\ p'(0) &= p'(l) = p_a; \end{aligned}$$

$$\begin{aligned}
\eta' f'(x') &= \Phi(x) \quad \text{at } x' = 0, \\
\frac{\partial P'}{\partial y'} &= 0 \quad \text{at } y' = h_0 + x' \operatorname{tg} \alpha; \\
\frac{k'}{\mu'} \frac{\partial P'}{\partial y'} &= v_{y'} \quad \text{at } y' = h_0 + x' \operatorname{tg} \alpha + \tilde{H}; \\
p' &= P' \quad \text{at } y' = h_0 + x' \operatorname{tg} \alpha + \tilde{H}.
\end{aligned} \tag{3}$$

Where  $\Phi(x)$  – the function characterizing the thickness of molten film. In order to determine  $\Phi(x)$  functions caused by the melting of guide surface, we use the formula of dissipation rate of mechanical energies

$$-\frac{d\eta' f'(x')}{dx'} \cdot u^* L' = -2\mu' \int_{-\eta' f'(x')}^{h_0 + x' \operatorname{tg} \alpha} \left( \frac{\partial v_{x'}}{\partial y'} \right)^2 dy', \tag{4}$$

Where  $L'$  – specific heat of melting per unit volume.

The transition to non-dimensional variables is implemented on the basis of the following formulas:

$$\begin{aligned}
x' &= lx; \quad y' = h_0 y; \quad v_{x'} = u^* v; \quad v_{y'} = u^* \frac{h_0}{l} u; \\
p' &= p^* p; \quad p^* = \frac{\mu u^* l}{h_0^2}; \quad \mu' = \mu.
\end{aligned} \tag{5}$$

In porous layer:  $x' = lx^*$ ;  $y' = h_0 y^*$ ;  $P' = P^* P$ ;  $k' = k$ ;

Making substitution (5) and (6) into the system of differential equations (2) and (4), as well as into the boundary conditions (3), the following system of differential equations is obtained:

$$\frac{\partial^2 v}{\partial y^2} = \frac{dp}{dx}; \quad \frac{\partial v}{\partial x} + \frac{\partial u}{\partial y} = 0; \quad \frac{\partial^2 P}{\partial x^{*2}} + \frac{\partial P}{\partial y^{*2}} = 0. \tag{6}$$

$$\frac{d\Phi(x)}{dx} = K \int_{-\Phi(x)}^{h(x)} \left( \frac{\partial v}{\partial y} \right)^2 dy, \tag{7}$$

Where  $K = \frac{2\mu_0 u^*}{h_0 L'}$

To boundary conditions:

$$\begin{aligned}
v &= 0, \quad u = 0, \quad \text{at } y = 1 + \eta x = h(x); \\
v &= -1, \quad u = 0 \quad \text{at } y = -\Phi(x); \\
p(0) &= p(1) = \frac{p_a}{p^*}; \\
\frac{\partial P}{\partial y^*} &= 0 \quad \text{at } y^* = 1 + \eta x; \\
v &= \tilde{M} \frac{\partial P}{\partial y^*} \quad \text{at } y^* = 1 + \eta x + \frac{\tilde{H}}{h_0}; \\
p &= P \quad \text{at } y^* = 1 + \eta x + \frac{\tilde{H}}{h_0},
\end{aligned} \tag{8}$$

Where  $\eta = \frac{l \operatorname{tg} \alpha}{h_0}$ ;  $\tilde{M} = \frac{lk}{h_0^3}$

Taking  $K$  as a small parameter caused by the melt and energy dissipation rate, the function of  $\Phi(x)$  is in the form:

$$\Phi(x) = -K\Phi_1(x) - K^2\Phi_2(x) - K^3\Phi_3(x) + \dots = H. \quad (9)$$

Boundary conditions for non-dimensional components of speed  $u$  and  $v$  at the edge  $y = -\Phi(x)$  can be written in the following form:

$$\begin{aligned} v(0 - H(x)) &= v(0) - \left( \frac{\partial v}{\partial y} \right) \Big|_{y=0} H - \left( \frac{\partial^2 v}{\partial y^2} \right) \Big|_{y=0} \frac{H^2}{2} + \dots = -1; \\ u(0 - g(x)) &= u(0) - \left( \frac{\partial u}{\partial y} \right) \Big|_{y=0} H - \left( \frac{\partial^2 u}{\partial y^2} \right) \Big|_{y=0} \frac{H^2}{2} + \dots = 0. \end{aligned} \quad (10)$$

The asymptotic solution of the system of differential equations (6) - (7) with regard to the boundary conditions (8) and (10) is sought in the form of series in degrees of the small parameter  $K$

$$\begin{aligned} v &= v_0(x, y) + Kv_1(x, y) + K^2v_2(x, y) + \dots \\ u &= u_0(x, y) + Ku_1(x, y) + K^2u_2(x, y) + \dots \\ \Phi(x) &= -K\Phi_1(x) - K^2\Phi_2(x) - K^3\Phi_3(x) - \dots \\ p &= p_0 + Kp_1(x) + K^2p_2(x) + K^3p_3(x) \dots \end{aligned} \quad (11)$$

Making the substitution (11) into the system of differential equations (6) - (7) with regard to the boundary conditions (8), the following equations with boundary conditions are obtained:

For zero approximation:

$$\frac{\partial^2 v_0}{\partial y^2} = \frac{dp_0}{dx}, \quad \frac{\partial v_0}{\partial x} + \frac{\partial u_0}{\partial y} = 0; \quad \frac{\partial^2 P_0}{\partial x^{*2}} + \frac{\partial P_0^2}{\partial y^{*2}} = 0. \quad (12)$$

$$\begin{aligned} v_0 &= 0, \quad u_0 = 0, \quad \text{at } y = 1 + \eta x; \\ v_0 &= -1, \quad u_0 = 0 \quad \text{at } y = 0; \end{aligned} \quad (13)$$

$$p(0) = p(1) = \frac{P_a}{p^*}$$

$$\frac{\partial P_0}{\partial y^*} = 0 \quad \text{at } y^* = 1 + \eta x;$$

$$v_0|_{y=0} = \tilde{M} \frac{\partial P_0}{\partial y^*} \quad \text{at } y^* = 1 + \eta x + \frac{\tilde{H}}{h_0};$$

$$p_0 = P_0 \quad \text{at } y^* = 1 + \eta x + \frac{\tilde{H}}{h_0},$$

For the first approximation:

$$\frac{\partial^2 v_1}{\partial y^2} = \frac{dp_1}{dx}; \quad \frac{\partial v_1}{\partial x} + \frac{\partial u_1}{\partial y} = 0; \quad \frac{\partial^2 P_1}{\partial x^{*2}} + \frac{\partial P_1^2}{\partial y^{*2}} = 0. \quad (14)$$

$$\frac{d\Phi_1(x)}{dx} = K \int_0^{h(x)} \left( \frac{\partial v_0}{\partial y} \right)^2 dy;$$

$$v_1 = \left( \frac{\partial v_0}{\partial y} \right) \Big|_{y=0} \cdot \Phi_1(x); \quad u_1 = \left( \frac{\partial u_0}{\partial y} \right) \Big|_{y=0} \cdot \Phi_1(x);$$

$$\begin{aligned}
v_1 &= 0 \quad u_1 = 0 \quad \text{at} \quad h(x) = 1 + \eta x; \\
p_1(0) &= p_1(1) = 0. \\
\frac{\partial P_1}{\partial y^*} &= 0 \quad \text{at} \quad y^* = 1 + \eta x; \\
v_1|_{y=0} &= \tilde{M} \frac{\partial P_1}{\partial y^*} \quad \text{at} \quad y^* = 1 + \eta x + \frac{\tilde{H}}{h_0}; \\
p_1 &= P_1 \quad \text{at} \quad y^* = 1 + \eta x + \frac{\tilde{H}}{h_0},
\end{aligned} \tag{15}$$

**The precise auto-similar solution** of the task for the zero approximation is sought in the form:

$$\begin{aligned}
v_0 &= \frac{\partial \psi_0(x, y)}{\partial y} + V_0(x, y); \quad u_0 = -\frac{\partial \psi_0(x, y)}{\partial x} + U_0(x, y); \\
\psi_0(x, y) &= \tilde{\psi}_0(\xi); \quad \xi = \frac{y}{h(x)}; \quad \tilde{u}'_0(\xi) - \xi \tilde{v}'_0(\xi)_0 = 0; \\
V_0(x, y) &= \tilde{v}(\xi); \quad U_0(x, y) = \tilde{u}_0(\xi) \cdot h'(x);
\end{aligned} \tag{16}$$

Substituting (16) into the system of differential equations (12) with the regard to the boundary conditions (13), the following system of differential equations is obtained:

$$\tilde{\psi}_0'''(\xi) = \tilde{C}_2; \quad \tilde{v}_0''(\xi) = \tilde{C}_1; \quad \frac{dp_0}{dx} = \frac{\tilde{C}_1}{h^2(x)} + \frac{\tilde{C}_2}{h^3(x)} \tag{17}$$

And boundary conditions:

$$\begin{aligned}
\tilde{\psi}_0'(0) &= 0, \quad \tilde{\psi}_0'(1) = 0; \quad \tilde{u}_0(1) = 0 \quad \tilde{v}_0(1) = 0; \\
\tilde{u}_0(0) &= 0, \quad \tilde{v}_0(0) = -1, \quad \tilde{M} \frac{\partial P}{\partial y^*} \Big|_{y^*=1+\eta x+\frac{\tilde{H}}{h_0}} = \tilde{u}_0. \\
\frac{\partial P_0}{\partial y^*} &= 0 \text{ at } y^* = 1 + \eta x; \quad p_0 = P_0 \text{ at } y^* = 1 + \eta x + \frac{\tilde{H}}{h_0}
\end{aligned} \tag{18}$$

Using immediate integration the following equation is obtained:

$$\tilde{\psi}_0'(\xi) = \frac{\tilde{C}_2}{2}(\xi^2 - \xi), \quad \tilde{v}_0(\xi) = \tilde{C}_1 \frac{\xi^2}{2} + \left(1 - \frac{\tilde{C}_1}{2}\right)\xi - 1, \tag{19}$$

From the equation  $p_0(0) = p_0(1) = \frac{P_a}{p^*}$  up to terms of the second order of smallness of  $O(\eta^2)$ , the following equation is obtained:

$$\tilde{C}_2 = -\tilde{C}_1 \left(1 - \frac{1}{2}\eta\right). \tag{20}$$

**Hydrodynamic pressure.** Taking into account (20) for non-dimensional hydrodynamic pressure the following equation is obtained:

$$P_0 = \tilde{C}_1 \int_0^x \frac{dx}{h^2(x)} + \tilde{C}_2 \int_0^x \frac{dx}{h^3(x)} + \frac{P_a}{p^*} = \frac{\eta}{2} \tilde{C}_1 (x^2 - x) + \frac{P_a}{p^*} \tag{21}$$

Taking into account (21) the solution for Darcy equation is presented in the form of:

$$P_0(x, y^*) = R_0(y^*) + \frac{\eta}{2} \tilde{C}_1 (x^2 - x) + \frac{P_a}{p^*} \tag{22}$$

Substituting the expression (22) into the Darcy equation of the system (12) for the  $R_0(y^*)$  function the following equation is obtained:

$$R_0''(y^*) + \eta \tilde{C}_1 = 0 \quad (23)$$

$$R(0) = \frac{p_a}{p^*}; \quad \frac{\partial R_0}{\partial y^*} = 0 \quad \text{at} \quad y^* = 1 + \eta x + \frac{\tilde{H}}{h_0}; \quad (24)$$

The solution (23)-(24) has the form of:

$$R_0(y^*) = -\eta \tilde{C}_1 \left( \frac{y^{*2}}{2} + \left( 1 + \eta x + \frac{\tilde{H}}{h_0} \right) y^* \right) + \frac{p_a}{p^*} \quad (25)$$

The constant  $\tilde{C}_1$  is found from the equation of continuity integrated in the range from 0 to 1.

$$\tilde{M} \frac{\partial P_0}{\partial y^*} \Big|_{y^*=1+\eta x+\frac{\tilde{H}}{h_0}} = \int_0^1 \tilde{v}_0(\xi) d\xi \quad (26)$$

With regard to (19), (22) and (25) for  $\tilde{C}_1$  the following equation is obtained:

$$\tilde{C}_1 = \frac{6}{-12\tilde{M}\eta \left( 2 + \frac{\tilde{H}}{h_0} \right) + 1} \quad (27)$$

Then for the hydrodynamic pressure for the zero approximation the following equation is obtained:

$$p_0 = \frac{3\eta(x^2 - x)}{-12\tilde{M}\eta \left( 2 + \frac{\tilde{H}}{h_0} \right) + 1} + \frac{p_a}{p^*} \quad (28)$$

For the determination of  $\Phi_1(x)$  with the regard to (19), the following equation is obtained:

$$\frac{d\Phi_1(x)}{dx} = h(x) \int_0^1 \left( \frac{\psi_0''(\xi)}{h^2(x)} + \frac{\tilde{v}_0'(\xi)}{h(x)} \right)^2 d\xi. \quad (29)$$

Integrating the equation (29), it is obtained:

$$\Phi_1(x) = \int_0^x \frac{\Delta_1 dx}{h^3(x)} + \int_0^x \frac{\Delta_2 dx}{h^2(x)} + \int_0^x \frac{\Delta_3 dx}{h(x)}, \quad (30)$$

Where  $\Delta_1 = \int_0^1 (\psi''(\xi))^2 d\xi = \frac{\tilde{C}_2^2}{12}$ ;  $\Delta_2 = \int_0^1 2\psi''(\xi) \cdot \tilde{v}'(\xi) d\xi = \frac{1}{6} \tilde{C}_1^2 \tilde{C}_2^2$ ;  $\Delta_3 = \int_0^1 (\tilde{v}'(\xi))^2 d\xi = 4$ .

Solving the equation (30) up to terms of the second order of smallness  $O(\eta^2)$ , it is obtained:

$$\Phi_1(x) = \frac{\tilde{C}_1^2}{12} \left( \frac{\eta}{2} x^2 - x \right) + 4 \left( x - \frac{\eta}{2} x^2 \right) + \alpha^* \quad (31)$$

The precise auto-similar solution of the task for the first approximation is sought in the form

$$v_1 = \frac{\partial \psi_1(x, y)}{\partial x} + V_1(x, y); \quad u_1 = -\frac{\partial \psi_1(x, y)}{\partial y} + U_1(x, y); \quad \tilde{u}_1(\xi) - \xi v_1(\xi) = 0; \quad (32)$$

$$\psi_1(x, y) = \tilde{\psi}_1(\xi); \quad \xi = \frac{y}{h(x)}; \quad U_1(x, y) = -\tilde{u}_1(\xi) h'(x); \quad V_1(x, y) = \tilde{v}(\xi).$$

Substituting (32) into the system of differential equations (14) with regard to the boundary conditions (15), the following system of differential equations is obtained:

$$\tilde{\psi}_1'''(\xi) = \tilde{C}_2; \quad \tilde{v}_1''(\xi) = \tilde{C}_1; \quad \frac{dp_1}{dx} = \frac{\tilde{C}_1}{h^2(x)} + \frac{\tilde{C}_2}{h^3(x)}. \quad (33)$$

And boundary conditions:

$$\tilde{\psi}'(0) = 0; \quad \tilde{\psi}'(1) = 0; \quad \tilde{u}_1(1) = 0; \quad \tilde{v}_1(1) = 0;$$

$$\tilde{u}_1(0) = 0; \quad \tilde{v}_1(0) = M; \quad p_1(0) = p_1(1) = 0$$

$$\tilde{v}_1(0) = \tilde{M} \frac{\partial P_1}{\partial y^*} \bigg|_{y^* = 1 + \eta x + \frac{\tilde{H}}{h_0}}; \quad \frac{\partial P_1}{\partial y^*} = 0; \quad \text{at } y^* = 1 + \eta x;$$

$$p_1 = P_1 \quad \text{at } y^* = 1 + \eta x + \frac{\tilde{H}}{h_0}, \quad (34)$$

Using immediate integration the following equation is obtained:

$$\tilde{\psi}_1'(\xi) = \frac{\tilde{C}_2}{2}(\xi^2 - \xi); \quad \tilde{v}_1(\xi) = \tilde{C}_1 \frac{\xi^2}{2} - \left( \frac{\tilde{C}_1}{2} + M \right) \xi + M;$$

$$\text{Where } M = \sup_{x \in [0;1]} \left| \left( \frac{\partial v_0}{\partial y} \right) \right|_{y=0} \Phi_1(x) = \sup_{x \in [0;1]} \left| \left( \frac{1}{1 + \eta x} - \frac{\eta}{4} \tilde{C}_1 (2x - 1) \right) \left( \frac{\tilde{C}_1^2}{12} \left( \frac{\eta}{2} x^2 - x \right) + 4 \left( x - \frac{\eta}{2} x^2 \right) + \alpha^* \right) \right|;$$

In order to determine the pressure in the contact zone for the first approximation based on the equation the following equation is used:

$$\frac{dp_1}{dx} = \frac{\tilde{C}_1}{h^2(x)} + \frac{\tilde{C}_2}{h^3(x)}. \quad (35)$$

With regard to the boundary condition  $p_1(0) = p_1(1) = 0$  for  $\tilde{C}_2$  the following equation is obtained:

$$\tilde{C}_2 = -\tilde{C}_1 \left( 1 + \frac{\eta}{2} \right) \quad (36)$$

Taking into account (36) the solution for Darcy equation is presented in the form of:

$$P_1(x, y^*) = R_1(y^*) + \frac{\eta}{2} \tilde{C}_1 (x^2 - x) \quad (37)$$

Substituting the expression (37) into the Darcy equation of the system (14) for the  $R^*(y)$  function the following equation is obtained:

$$R_1''(y^*) + \eta \tilde{C}_1 = 0 \quad (38)$$

$$R_1(0) = 0; \quad \frac{\partial R_1}{\partial y^*} = 0 \quad \text{at } y^* = 1 + \eta x + \frac{\tilde{H}}{h_0}; \quad (39)$$

The solution (37)-(38) has the following form:

$$R_1(y^*) = -\tilde{C}_1 \eta \left( \frac{y^{*2}}{2} + \left( 1 + \eta x + \frac{\tilde{H}}{h_0} \right) y^* \right); \quad (40)$$

The constant  $\tilde{C}_1$  is found from the equation of continuity integrated in the range from 0 to 1.



$$\tilde{M} \frac{\partial P_1}{\partial y^*} \bigg|_{y^*=1+\eta x+\frac{\tilde{H}}{h_0}} = \int_0^1 \tilde{v}_1(\xi) d\xi \quad (41)$$

With regard to (35), (37) and (40) for  $\tilde{C}_1$  the following equation is obtained:

$$\tilde{C}_1 = \frac{6M}{-12\tilde{M}\eta \left(2 + \frac{\tilde{H}}{h_0}\right) + 1} \quad (42)$$

Then for the hydrodynamic pressure for the first approximation the following equation is obtained:

$$P_1 = \frac{3M\eta(x^2 - x)}{-12\tilde{M}\eta \left(2 + \frac{\tilde{H}}{h_0}\right) + 1} \quad (43)$$

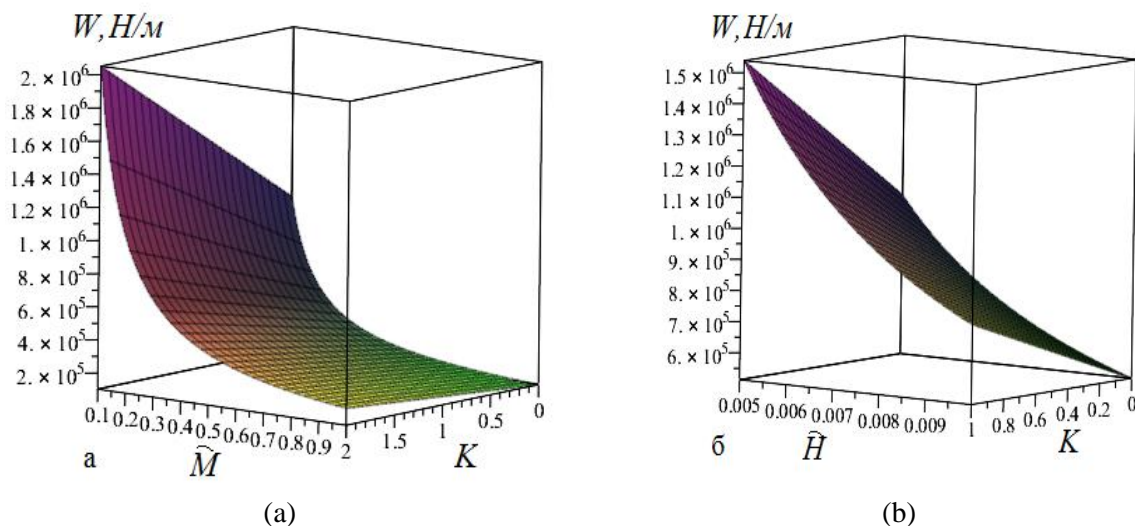
Basic performance properties:

$$W = p^* l \int_0^1 \left( \left( p_0 - \frac{p_a}{p^*} \right) + K p_1 \right) dx = \frac{\mu l^3 u^*}{2h_0^2} \left[ \frac{3\eta}{1 - 12\tilde{M}\eta \left(2 + \frac{\tilde{H}}{h_0}\right)} (1 + KM) \right] \quad (44)$$

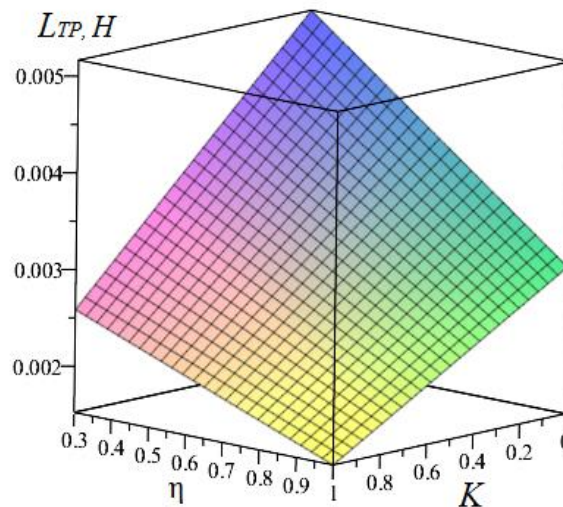
$$L_{TP} = \mu \int_0^1 \left[ \frac{\partial v_0}{\partial y} \bigg|_{y=0} + K \frac{\partial v_1}{\partial y} \bigg|_{y=0} \right] dx = \mu (1 - KM) \left( 1 - \frac{\eta}{2} \right) \quad (45)$$

For verification calculations based on the obtained theoretical models, the following values are used:  $h_0 = 10^{-7} - 10^{-6}$  m;  $l = 0.1256 \dots 0.1884$  m;  $p_a = 0.08 \dots 0.101325$  MPa;  $C_p = 473$  J/kg·degree;  $\mu = 0.0608$  Hs/m<sup>2</sup>;  $\eta = 0.3 \dots 1$ ;  $u^* = 1 \dots 3$  m/s;  $L' = 2,7 \cdot 10^5$  J/kg;  $K = 0 \dots 1$ .

According to the results of numerical calculations, the graphs are created and shown in Figure 2–3.



**Figure 2.** The dependence of bearing capacity: (a) on the parameter  $\tilde{M}$  characterizing the permeability of the porous layer and  $K$  parameter, which characterizes the rate of dissipation of mechanical energy; (b) on  $K$  parameter, which characterizes the rate of dissipation of mechanical energy and  $\tilde{H}$  thickness of the porous layer.



**Figure 3.** The dependence of the friction force of  $K$  parameter, which characterizes the rate of dissipation of mechanical energy and non-dimensional parameter  $\eta$ .

### Conclusion

As a result of numerical analysis of the obtained models it was found that:

- the friction force decreases with the increase in both  $K$  parameter, characterizing the rate of dissipation of mechanical energy, and  $\Phi$  parameter, determining the film thickness of molten material; moreover,  $K$  parameter affects the growth of the friction force by 6.5 times more intense than  $\Phi$  parameter;
- the bearing capacity of thrust bearing increases rapidly with increasing  $K$  parameter and decreases slightly with increasing  $\tilde{M}$  parameter.

It is necessary to note that when forming the edge of the slider profile parallel to the abscise axis, the bearing capacity increases rapidly with increasing  $K$  parameter and practically does not depend on  $\tilde{M}$  parameter. The bearing capacity in this case is  $\approx 2$  times smaller than that of a slider with a profile at an angle not equal to zero.

The dependence of friction force  $L_{ff}$  on the thickness of the molten film is close to linear within 0.001-0.004.

The tribotechnical mathematical values are specified in the following order: friction force by 27%, bearing capacity - 15%.

The slide bearings of the described construction provide a significant decrease of the effect of operating loads on thrust bearings. The obtained results in the form of simulation models can be used for the development and verification calculations of the structures of sliding supports operating on lubricants in the form of a metal melt. With due regard to the above-mentioned factors of tribosystem functioning they provide a significant decrease of the impact of operating loads on friction units, which are one of the promising areas of modern tribology.

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