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THE METHOD FOR THE DEFINITION OF REDUCED COEFFICIENT OF FRICTION IN CRANK-CONNECTING MECHANISM OF PRESS

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Summary. Dependences for the definition of reduced coefficient of friction based on the experimental values of torque moment and force in crank-connecting mechanism are considered.

Key words: press, torque moment, torque moment

INTRODUCTION

In the modern technical literature, as well as in the press-forging equipment text-books [Givoff 1981], [Lanskoy 1982] the power calculations of the crank press fictional losses are determined by the use of the reduced arm of friction force that contains the coefficient of friction.

In the work of [Givoff 1981] cited the value of the coefficient of friction μ=0,03…0,04 – for fluid lubricant and μ=0,05…0,06 for the grease. E.N. Lanskoy [Lanskoy 1982] in practical calculations proposed to use a value of the coefficient of friction equal f=0,06 with grease in hinges and f=0,04 with fluid lubricant in automatic machines. In the same time in the work [Perevozchekoff 1980] is appointed that with increasing the pressure on the surface of friction in definite limits the coefficient of friction is decreasing as a rule. But we could not find any work dedicated to this question.

OBJECTS AND PROBLEMS

The majority of the metal forming technological processes is worked with the variable force of deformation; the variable will also be the pressure in kinematics pairs of crank-connecting mechanism. The energy losses on friction are proportional to force of friction equal the product of the coefficient of friction on the normal force on the friction surfaces.

The energy losses on friction in crank-connecting mechanism with the constant coefficient of friction are equal:

$$A = \mu B \int_{\alpha_K}^{\alpha_H} P_\alpha d\alpha \ , \qquad (1)$$

where: μ = coefficient of friction; B= value depended on kinematical characteristics of mechanism, from the works [Givoff 1981], [Lanskoy 1982] $B = (1 + \lambda \cos\alpha) r_a + r_{\hat{a}} \cos\alpha + r_o$; λ = R/L, R – radius of crank arm, L – length of crankpin; r_a, r_o – radiuses of crankpin and main journal bearing shaft; $r_в$ – radius sliding bearing of crankpin; $\alpha_í$, $\alpha_ę$ – angles of the beginning and the end of working stroke of the press; P_α – the force at the slide block in the function of rotation of the crank shaft with the variable coefficient of friction equality (1) will look like:

$$A = B \int_{\alpha_ę}^{\alpha_í} \mu_\alpha P_\alpha d\alpha \ , \qquad (2)$$

where: μ_α – coefficient of friction in the function of turning angle of the main shaft.

Changing the variable value of friction coefficient by the constant value, that will be taking according to the results of the account of the energy losses on friction by (1) and (2) will be equal, so that:

$$\mu B \int_{\alpha_ę}^{\alpha_í} P_\alpha d\alpha = \hat{A} \int_{\alpha_ę}^{\alpha_í} \mu_\alpha Ð_\alpha d\alpha \ . \qquad (3)$$

From (3) can be found the dependence of the definition of the constant value of the friction coefficient μ that is known as reduced coefficient of friction:

$$\mu = \int_{\alpha_ę}^{\alpha_í} \mu_\alpha P_\alpha \Big/ \int_{\alpha_ę}^{\alpha_í} P_\alpha \ . \qquad (4)$$

To calculate the dependence (4), the instantaneous friction coefficient values in the function of rotation of the main shaft are necessary.

The torque moment on the main shaft for any angular position of the shaft is accounted by the dependence

$$M_\alpha = P_\alpha (m_\alpha + \mu_\alpha B) \ , \qquad (5)$$

where m_α – the ideal arm of force of the useful resistances of the central crank-connecting mechanism, is defined by the dependence

$$m_\alpha = R(\sin\alpha + \alpha / 2 \sin 2\alpha) \ . \qquad (6)$$

If we calculate (5) relatively the value of instantaneous friction coefficient we get

$$\mu_\alpha = (M_\alpha / P_\alpha - m_\alpha) / B \ . \qquad (7)$$

The dependences (4) and (7) have no analytical computations. The values of the reduced coefficient of friction are determined by the experiment. Equation (4) will be

$$\mu = \sum_{i=1}^{i=n} \mu_i P_i \Big/ \sum_{i=1}^{i=n} P_i \ , \qquad (8)$$

where n – number of parts on which the loading graph of the press was divided; P_i – the force at the slide block corresponded to this parts, μ_i – the instantaneous values of the friction coefficient on the same parts calculated by the numerical method based on the dependence (7) using the experimental graphs of the torque moment on the crank shaft and the force at the slide block of the press.

The reduced friction coefficients were determined for stamping from the sheet of steel with 2 mm thickness on press. There were two cases. The force of stamping was 115kN, the working stroke angle was 10°, and the angles were marked in the 1° interval in first case. The 10 instantaneous values of the friction coefficient were calculated, the minimum value μ_i = 0,034, maximum - μ_i = 0,1, the reduced coefficients of friction was calculated by dependence (8) and was 0,048. The same calculations were made for stamping the billet with the diameter two times bigger while the other conditions were the same. The force of stamping was 235kN, the minimum value of friction coefficient was μ_i = 0,023, maximum- μ_i = 0,12, the reduced coefficients of friction μ = 0,031. In both cases the lubricant of the crank shaft bearing was cup grease.

The increasing of the deformation force in two times let to the lowering of the reduced coefficients of friction on 35%, that was unexpected result for us. So to calculate the error of experimental system we used the method [Perevozchekoff 1980]. This experimental system consisted of: strain transducer – strain measurement amplifier, mirror -galvanometer oscillograph, oscillogram, method of oscillogram decoding. The maximum experimental error of the system was ±6%. If we suggest that the maximum value of the reduced coefficients of friction was calculated bigger on 6%, and the minimum– smaller on 6%, even in this case the increasing of the stamping force in two times made the reduced coefficients of friction lower on 27%.

CONCLUSION

The considered method allows to defined value of the reduced friction coefficients in crank-connecting mechanism of press based on the experimental values of the torque moment and the force on the slide block.

To decrease the frictional losses of stamping we are to choice the press with the nominal force as nearly as possible to the stamping force.

REFERENCES

1. Givoff L.I., Ovchinikoff A.G., 1981. Press forging machines. - K.: Vysha shcola, 1981, 375 p.
2. Lanskoy E.N., Banketoff A.N., Bocharoff U.A., Dobrinskiy N.S., 1981. Press forging machines. M.: Mashinostroenie, 578 p.
3. Perevozchekoff B.S., 1980. Methods and measurement means to examine machines and technical processes. Voroneg, 98 p.

МЕТОДИКА ОПРЕДЕЛЕНИЯ ПРИВЕДЕННОГО КОЭФФИЦИЕНТА ТРЕНИЯ ГЛАВНОГО ИСПОЛНИТЕЛЬНОГО МЕХАНИЗМА КРИВОШИПНОГО ПРЕССА

Рей Р., Рей М.

Аннотация. Рассмотрена методика определения приведенного момента трения кривошипно-поступательного механизма на основе экспериментальных значений момента крутящего и усилия.

Ключевые слова: пресс, крутящий момент, усилие