DEPENDENCES OF DYNAMIC PROCESSES FROM THE PARAMETERS OF THE KNITTING SYSTEM

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Abstract. The purpose of the research is to analyze the influence of parameters of the knitting system on the dynamic processes occurring during the operation of the knitting machine.
Modern methods for determining the impact of knitting system parameters on dynamic loads are used in the research.
To investigate the effect of knitting system parameters on the magnitude of maximum dynamic loads (maximum load in the needle impact zone on the wedge and at the wedge attachment point), dependencies of loads on knitting system elements are constructed based on the studied parameters: wedge profile angles, friction between the needle and wedge pair (needle-presser bar), machine speed, technological load magnitude, etc.
The scientific novelty is exploring of the influence of the knitting system parameters on the value of the maximum dynamic loads of the knitting machine, while the practical significance involves the development of an engineering method for determining the impact of knitting system parameters on the value of dynamic loads.
Keywords: knitting machine, dynamic processes in the knitting machine, knitting system parameters.

Introduction

The peculiarity of circular knitting machines, including single-loop machines, is the significant dynamic loads that occur when the interaction of needle-platinum products with the wedges of the locks during the change of direction of their movement. The dynamic loads that occur in this case are one of the important factors in the reliability of the knitting machine, which in turn affects the quality of products.

During the operation of the knitting machine, the needles are subjected to significant loads, which is the main reason for their failure [1-5]. Studies [1] show that the shock phenomena that occur when needles interact with the wedges of knitting systems are the main cause of needle breakage.

The work [6] is devoted to the choice of parameters of dynamic models of machines and mechanisms. Further development of the methodology for designing elements of knitting systems is considered in the study [7].

Analysis of the influence of the parameters of the knitting system on the value of dynamic processes allows to develop methods for calculating the dynamic loads in knitting systems required for the design of modern types of knitting machines.

In the process of looping platinum as well as needles change the direction of their movement, which causes their shock interaction with platinum locks.

The maximum dynamic load that occurs when the platinum hits the lock can be determined by expression (2.25) [8] or (by elastic fastening of the lock, which takes place in the experimental study of loads when the lock is attached to an elastic beam) by expression (2.44) [8].

Analyzing expression (2.25) [8], we conclude that the decision on the influence of the parameters of the existing design of the knitting system of the knitting machine on the value of dynamic loads is not difficult. However, in the case of replacing the rigid wedge with an elastic one (which occurs during the modernization of the knitting system or during experimental research), this question deserves attention.

Analyzing the expressions (2.26), (2.29), (2.34) ... (2.39), (2.41), (2.44) in the study [8], we can conclude that the value of dynamic loads in the knitting mechanism is influenced by the following parameters knitting system:

- wedge profile angle – α;
- angle of friction money needle-wedge (needle-pins) – ρ;
- machine speed – υ;
- the magnitude of technological loads – F_1;
- the amount of static pressure of the heels of the needles on the wedge – F_3;
- stiffness of the needle-wedge system – C_1;
- rigidity of the wedge mounting unit – C_2;
- needle mass – m_1;
- wedge weight (in case of elastic wedge mounting) – m_2.

With purpose to determine the influence of the parameters of the knitting system on the value of the maximum dynamic loads, we build the dependences of the loads P_{1max} and P_{2max} on the studied parameters (P_{1max} – maximum load in the area of the needle on the wedge; P_{2max} – maximum load in the wedge mounting unit).

For the initial data we take the parameters of the knitting system of the circular knitting machine MS-9 (in case of needle impact on the cooler wedge; the wedge is mounted on an elastic beam with dimensions of 5x10x48 mm): $\alpha = 54°$; $\rho = 9°40'$; v =0,72 *m/s*; F_1 = 0,17 *N*; F_3 = 9,67 *N*;

C_1 = 1483,6·10^3 *N/m*; C_2 = 2486,6·10^3 *N/m*; m_1 = 0,713·10^{-3} *kg*; m_2 = 36,41·10^{-3} *kg*.

The range and interval of variation of parameters, based on practical considerations, is chosen within:

$\alpha = (20\ldots60)°$, $\Delta\alpha = 5°$;
$\rho = (4\ldots12)°$, $\Delta\rho = 2°$;
v = (0,5…2,5) *m/s*, Δv =0,25 *m/s*;
F_1 = (0,05…1,0) *N*, ΔF_1 = 0,05 *N*;
F_3 = (5…25) *N*, ΔF_3 = 5 *N*;
C_1 = (150…3000) 10^3 *N/m*, ΔC_1 = 150·10^3 *N/m*;
C_2 = (150…30000)·10^3 *N/m*,
$\Delta C_2 = 150\cdot10^3$ if $150\cdot10^3 \le C_2 \le 1500\cdot10^3$;
$\Delta C_2 = 1500\cdot10^3$ if $1500\cdot10^3 \le C_2 \le 30000\cdot10^3$;
m_1 = (0,2…1,5)·10^{-3} *kg*, Δm_1 = 0,1·10^{-3} *kg*;
m_2 = (5…100)·10^{-3} *kg*, Δm_2 = 5·10^{-3} *kg*.

The results of the calculations are presented in Fig. 1...6.

As can be seen from Fig. 1 angle of the wedge profile significantly affects the amount of dynamic load in the knitting system. The more noticeable effect of the angle of the wedge profile is observed on the load in the area of impact of the needle on the wedge. When $\alpha > 60°$ the system becomes virtually inoperable. The phenomenon of needle jamming occurs (dynamic loads increase to infinity).

The angle of friction of the needle on the surface of the wedge and on the clamps significantly affects the dynamic load in the knitting system of the machine MS-9 at $\rho > 8°$ (Fig. 1). In this case the influence of the friction angle on the dynamic loads in the knitting system is almost insignificant. When the phenomenon of jamming of the system is observed (loads increase to infinity).

The magnitude of the mass of the needle, significantly affects the magnitude of the load in the area of impact of the needle on the wedge, and in the elastic ligament C_2 (Fig. 2).

The increase in the mass of the wedge m_2 has virtually no effect on the impact loads in the needle-wedge pair, but significantly affects the dynamic loads in the elastic ligament of the wedge. At the same time, the increase in the mass of the wedge reduces the dynamic loads in the elastic ligament C_2.

The speed of the machine (Fig. 3) is directly proportional to the dynamic loads in the knitting system. The more significant effect of speed on the load is observed in the area of interaction of the needle with the wedge.

Technological loads have practically no effect on the value of dynamic loads in the knitting system (Fig. 4).

The amount of static pressure of the needles on the wedge affects the load in the elastic ligament of the wedge (wedge mount). Dependence $P_{2max} = f(F_3)$ is linear. The value of the dynamic load in the area of impact of the needle on the wedge parameter F_3 is practically not affected:

$$P_{1max} = f(F_3) = const.$$

The rigidity of the needle-wedge system significantly affects the dynamic loads in the area of impact of the needle on the wedge (Fig. 5). The increase in stiffness leads to an increase in dynamic loads in the needle-wedge system. At the same time, increasing the stiffness C_1 up to $9 \cdot 10^5$ *N/m* reduces the load in the elastic connection of the wedge. At $C_1 > 9 \cdot 10^5$ *N/m* the loads in the elastic ligament of the wedge fastening practically do not change, $P_{2max} \approx const$.

The value of the rigidity of the elastic fastening of the wedge does not affect the magnitude of the dynamic loads in the area of impact of the needle on the wedge (Fig. 5, 6). Hardness is practically not affected C_2 on loading in elastic knitting of fastening of a wedge at its increase up to $30 \cdot 10^5$ *N/m*. If $C_2 > 30 \cdot 10^5$ there is a significant effect of the parameter C_2 on the value of load P_2 (the increasing of C_2 causes an increase in dynamic load).

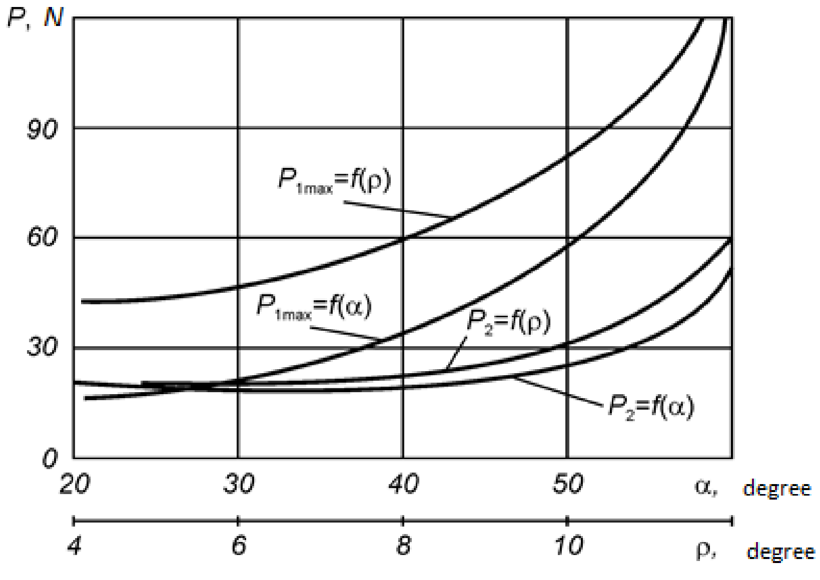

Fig. 1. Dependence of dynamic loads in the knitting system of the machine MC-9 from the angle of the wedge α profile and the angle of friction ρ

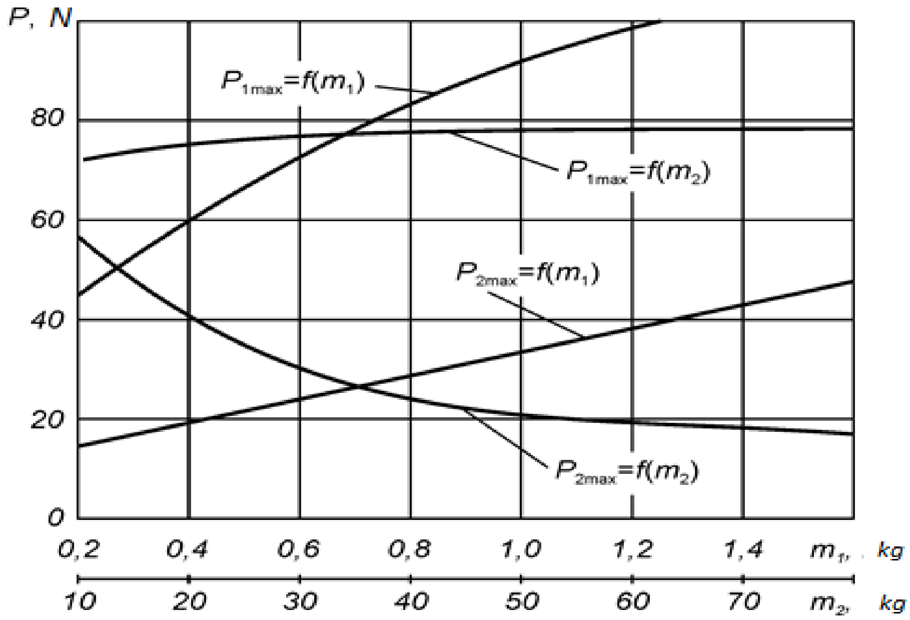

Fig. 2. Dependence of dynamic loads in the knitting system on the mass of the needle m_1 and a wedge m_2 taking into account its elastic fastening

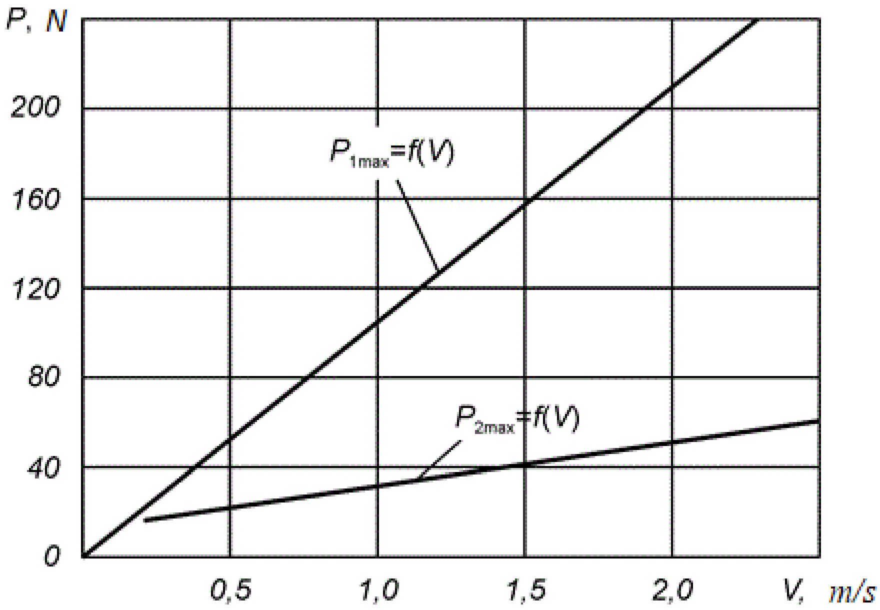

Fig. 3. Dependence of dynamic loads in knitting system from the speed of the machine

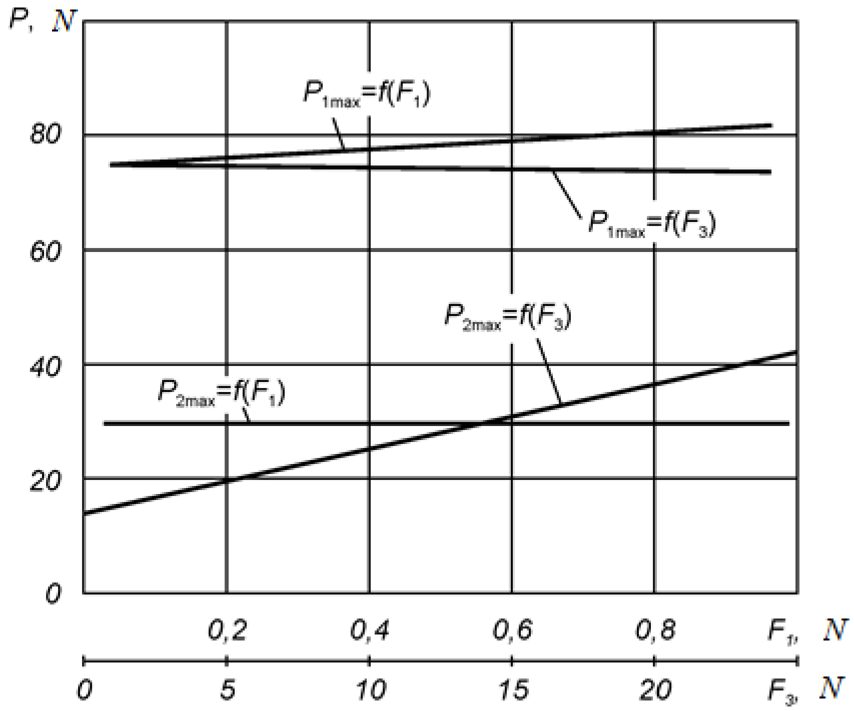

Fig. 4. Dependence of dynamic loads in the knitting system on technological loads and pressure force (static) of needles on a wedge F_3

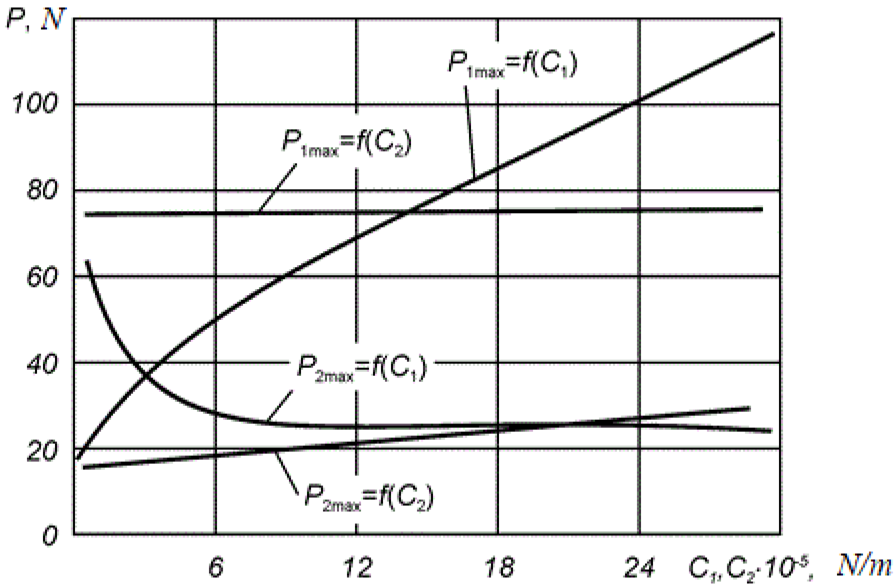

Fig. 5. Dependence of dynamic loads in the knitting system on the rigidity of the needle-wedge system C_1 *and stiffness of the wedge attachment* C_2

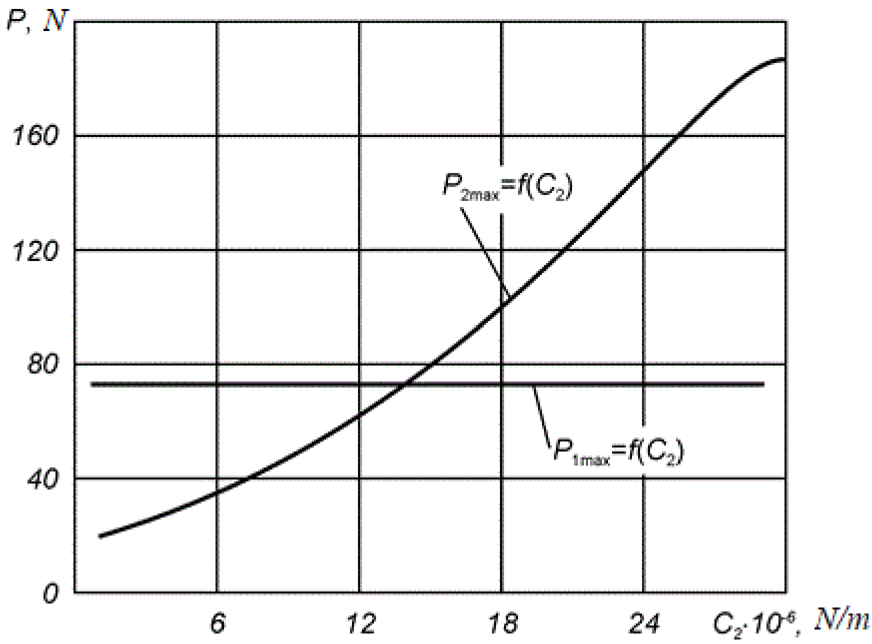

Fig.6. Dependence of dynamic loads in the knitting system on the rigidity of the wedge C_2 (at $C_2 \geq 1{,}5 \cdot 10^6$ Н / м)

Conclusions.

1. The angle of the wedge profile significantly affects the amount of dynamic load in the knitting system.
2. The angle of friction of the needle on the surface of the wedge and on the clamps significantly affects the dynamic load in the knitting system of the machine MC-9 at $\rho > 8°$. In case of $\rho \leq 8°$ the effect of the friction angle on the dynamic loads in the knitting system is almost insignificant. When $\rho > 12°$ the phenomenon of jamming of the system is observed (loads increase to infinity).
3. The magnitude of the mass of the needle, significantly affects the magnitude of the load in the area of impact of the needle on the wedge, and in the elastic ligament C_2
4. The increase in the mass of the wedge m_2 has almost no effect on the shock loads in the needle-wedge pair, but significantly affects the dynamic loads in the elastic ligament of the wedge. At the same time, increasing the wedge mass reduces the dynamic loads in the elastic ligament C_2.
5. The speed of the machine is directly proportional to the dynamic loads in the knitting system. The more significant effect of speed on the load is observed in the area of interaction of the needle with the wedge.
6. Technological loads have practically no effect on the amount of dynamic loads in the knitting system.
7. The amount of static pressure of the needles on the wedge affects the load in the elastic ligament of the wedge (wedge mount).
8. The rigidity of the needle-wedge system significantly affects the dynamic loads in the area of impact of the needle on the wedge.

The value of the stiffness of the elastic mounting of the wedge does not affect the magnitude of the dynamic loads in the area of impact of the needle on the wedge/

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