Modeling of a resource-saving method of drawing

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Abstract. In this article examines the possibility of modernization of the drawing of the machine by means of preliminary modeling of resource-saving method of drawing (building information and mathematical models) and the definition of expediency of the further implementation of the physical model of the process equipment.

Improving the efficiency of cable production is an urgent problem, the solution of which is based on the resource-saving technology of drawing process.

The wire-drawing machine is a sophisticated electromechanical complex that consists of various objects, combined into a single control system. One of the main characteristics of these machines is productivity [1]. The main source of productivity gain is increase in drawing speed and reduction of time and shutdown rate, which is achieved by mechanization and automation of production process [1, 2].

The problem of increasing the economic efficiency of the technical process of drawing can be solved by combining of die and dieless drawing [7]. This method has a number of advantages, as it produces economic effect of about 25% due to increase in the lifetime of expensive imported diamond tools. Change in the design of a drawing machine (modernization) is done by adding the auxiliary unit, which creates an extra force in the area of wire output from the finishing die to obtain additional stretching to ensure compliance with the

requirements imposed on finished products, i.e. match of the output diameter of a finished product. However, the proposed modernization of the drawing machine leads to a change in the design, and the solution of this problem resolves itself into analysis of the calculations performed and determination of feasibility of the structure change by modelling [9], namely:

- Building of an information (virtual) model of drawing according to both the existing technology and the proposed one;
- Building of a mathematical model of the object - drawing machine, both working (actual) and modernized.

The information model will provide a real opportunity to improve the management of wire-drawing process taking into account the geometric, mechanical and physical similarity with their observance. The actual physical model is to take into account the basic parameters of the physical effects of drawing, including secondary ones, the effect of which is taken into account in the development of effective technical solutions [5].

Fig.1. The scheme of creating an information model built on the basis of a phased selection of data on relevant physical effects

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Development of technical solutions and analysis of the impact of physical effect is based on a hierarchical classification of physical effects – a static information model (Fig.1), through a phased selection of data on relevant physical effects that occur during drawing: diameter of the object (product), the chemical

composition of the material, and physical effect parameters are: the diameter of the rod; the diameter the wire drawn; maintenance of the constant volume of material. Deviation of a single value from established norms will result in defective products [8,10].

Fig. 2. Virtual model of the technological process of drawing

Research of the technology of drawing process is considered a series circuit of stages - links, each of which, acting on the metal passing through them, transmits to or extracts energy (heat) from it. In practice, the progress of the process is determined by three factors: a pulling plate, a drawing tool, and a rod.

The pulling plate is used to create a pulling force, defined as the power of drawing; the technological tool forms required dimensions and ensures clean surface [4, 5, 7]. The object affected by the mechanism is metal that is also a link of the entire model of drawing as a whole. Analyzing physical phenomena, the created information model allows evaluating a method of combining of die and dieless drawing as metal forming, taking into account increased load upon the equipment, since testing of these processes may cause accidents and damage to equipment. Reliability assurance is determined by the necessary parameters of forming by modelling with the use of similarity theory, which is represented in the general procedure of analyzing physical phenomena on the basis of similarity theory [6, 9, 10].

Thus, the virtual model of the process takes the form (Fig.2), and the listed working modes are realized by using a generalized mathematical model (1).

$$\left\{ \begin{array}{l} W(z, t, T) = f_{11}(z)f_2(T) \\ W(z, t, T) = f_{12}(z)f_2(T) \\ f(z) = \frac{dp}{dl} qS(l - z) \\ f = ES \frac{du}{dz} \\ N = \sum_{v=0}^m \frac{dp}{dl} \frac{dv}{dt} \\ f(t) = \sum_{n=1}^m d_m dt \\ \Omega = (0 < z < l, 0 < r < r_0, 0 < t < t_0); T(r, z, 0) = T_0(z, r) \in \Omega \end{array} \right. \quad (1)$$

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