СЕКЦІЯ 1.
ТЕХНОЛОГІЧНІ ПРОЦЕСИ ТА СИСТЕМИ МАШИНОБУДІВНОГО ВИРОБНИЦТВА

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LAW OF ABRASIVE INSTRUMENT WEAR WHEN CUTTING POLYMER COMPOSITES

Like any physical process, wear in the contact of the tool tip - polymer composite material, must obey some law (wear law), which describes the time of the material removal and can predict the tool performance (tool life). Numerous theoretical and experimental studies show that the rate of wear depends on various factors in the process of interaction. These include the physical and chemical properties of interacting bodies materials, the roughness of their surfaces, the presence of oil, the load-speed regime, temperature and composition of the environment, and others. All these factors, to some extent, must be taken into account in the law of wear, a detailed description of which can be found in publications.

In the proposed study, an attempt is made to justify the need to use a special formulation of the wear law in contact of the tool tip with polymer composite, which allows to take into account the specifics of contact interaction, hereditary abrasive wear and change the tool shape.

Assume that the wear in contact of the tool tip with the polymer composite is abrasive, i.e. the harder material is removed by cutting or splitting another, less hard. This assumption has been confirmed by numerous experimental studies by many authors. For a complete analytical representation of the abrasive wear law, we take it as the rate of the volume change of the tool tip material over time (density is considered constant)

$$\frac{dv(t)}{dt} = K_{wear} \cdot \frac{\mu \cdot F_n}{\left[\tau_{sh}\right]} \cdot \frac{HV_{fill}}{HV_{tool}} \cdot V \cdot e^{-\frac{Q}{R \cdot T}}, \tag{1}$$

where dv/dt – the rate of the material volume removal of the tool tip, m^3/c, F_n – the normal component of the cutting force in contact, N; μ – friction coefficient in contact; $\left[\tau_{sh}\right]$ – allowable shear stress of the filler material, N/m^2; HV_{fill}, HV_{tool} – the hardness of the filler material (reinforcing element) and the material of the cutting tool, N/m^2; V – relative sliding speed (tool tip movement), m/c; Q – activation energy, J / mol; R – universal gas constant, J/(mol·°C); T – temperature in the cutting zone, °K; t – time, c; K_{wear} – volume wear coefficient, which determines the shape and intensity of tool surface wear over time.

In the presented ratio, preference is given directly to the time parameter, and not to any other parameter, such as the number of drilled holes. This is a more general approach, which takes into account the time of the tool, regardless of the operation type and the quantitative equivalent of each operation it performs.

The force F_n, the normal component of the integral force that takes place on the flank tool. It is a function of the technological parameters: feed; spindle speed; depth of cut; tool constructive execution; the amount of filler; accumulated wear and the mutual location of the processing direction and the direction of composite reinforcement. Currently, a lot of experimental data has been accumulated on the cutting forces empirical determination of composites and analytical models that allow to calculate this force. Therefore, in the general case, this force nonlinearly depends on the tool operating time due to changing geometric parameters of the tool due to its wear and changes in technological parameters of the product over time.