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ABSTRACT

In this dissertation, an experimental study of the process of drilling deep holes in five different materials (C45 steel, 40HM+QT tempered steel, PA6 aluminum alloy, MO58 brass alloy and Inconel 718) was performed using three different kinematic systems.

The research was preceded by an analysis of the state of knowledge in the field of the deep hole drilling process. Previous achievements in this field were presented. A research methodology for the drilling process was developed. In addition, in the research work, theoretical and experimental models were developed for various materials to predict surface roughness, deviation of cylindricity, straightness, roundness, diameter error, height and width of the burr formed at the exit of the hole. The models were characterized by high values of determination coefficients (more than 70%).

The characteristics of: the three kinematic systems of the drilling process, the tools, the toolholder, the machines, the materials, the fixtures, the shape, and the coding of the specimens used in the study are presented.

The results of studies on the analysis of the dimensional-shape accuracy of holes (deviations of cylindricity, straightness, roundness and hole diameter error) were developed. The kinematic system was crucial in many parameters of dimensional-shape accuracy of holes (depending on the material). ANOVA statistical analysis was used, and selected created mathematical models predicting the values of the output parameters were simulated. The analyses show that the choice of kinematic system depends on the material used.

The geometric structures of the surfaces of the drilled holes described by three selected parameters (Ra, Rz, Rt) were analyzed. The smallest values of the selected surface roughness parameters were obtained using the second kinematic system for 40HM+QT tempered steel. In contrast, the smallest values of Ra, Rz and Rt parameters were obtained using the first kinematic system for C45 steel, MO58 brass alloy and Inconel 718.

The rest of the paper presents an analysis of the burrs at the hole exit against two parameters of the width and height of the burrs at the hole exit. In this case, only MO58 brass alloy obtained the single most favorable kinematic system (the third).

Each subsection of the paper includes statistical analysis, construction and simulation of mathematical models. A detailed analysis of cylindricity deviation versus centerline distortion is presented. Case analysis of roundness deviations using Fourier analysis was performed. In C45 steel and 40HM+QT tempered steel, three-roundness was dominant in every part of the hole, regardless of the kinematic system used. A multi-criteria optimization - Grey Relational Analysis - was performed. Based on it, the most favorable kinematic system and the values of technological parameters for which the smallest values of output parameters were obtained were selected.