ABSTRACT

ANALYSIS OF ACTIVE MEDIUM FORMATION PARAMETERS IN THE MINIMUM QUANTITY LUBRICATION METHOD WITH NANOPARTICLES DURING MACHINING OF Ti6Al4V TITANIUM ALLOY

This dissertation includes an analysis of the effects of the influence of the active medium formation parameters and the size and mass concentration of nanoparticles on selected machinability indicators of Ti6Al4V titanium alloy turning under the conditions of the MQL method without nanoparticles and with copper and aluminium (III) oxide nanoparticles, as well as dry machining.

The current state of the art in terms of cooling methods based on the minimum amount of machining fluids, the classification and importance of aforementioned fluids, the parameters of the formation of the active medium in MQL and MQCL methods, and the additives used to improve the properties of cutting fluids were analysed in the dissertation. Based on this information, Chapter 1 was prepared and the theses, objectives, scope of work and research problems were defined, which are described in Chapter 2. Therefore, the theses of the present work were as follows: "There are values of the active medium formation parameters in the minimum quantity lubrication method that affect the cooling and lubrication of the cutting zone when machining the difficult-to-cut Ti6Al4V titanium alloy." and "Changing the size and mass concentration of nanoparticles added to the machining fluid affects selected machinability indicators by reducing tool vibration, cutting forces, cutting edge wear and changes in machined surface topography after turning of Ti6Al4V titanium alloy". The main cognitive objective of the study was the simulation analysis of the behaviour of droplets in the minimum quantity lubrication method delivered to the cutting edge−workpiece material−chip interface and of the physical phenomena occurring in the cutting zone during cooling with the MQL method with variable type, size and mass concentration of the nanoparticles as well as variable oil mist formation parameters.

Characterisation of the minimum quantity lubrication method based on the use of nanofluids including characteristics of the studied nanoparticles and the device that generates the active medium were described in Chapter 3. Simulation studies aimed at demonstrating the influence of active medium formation parameters on the diameter of droplets forming an oil mist are presented in Chapter 4. Test stand, research assumptions and steps required to develop the simulation as well as the obtained results were described. As a result of the simulation studies,

it was found that the volume flow rate of air had the greatest influence on the active medium output parameters.

Experimental studies carried out using nanofluids are described in Chapter 5. The main objective and the method used to conduct the research are highlighted, including the materials, the test stand, the measuring apparatus and the machining conditions. A further section of the Chapter presents the results of tool vibration, cutting forces, surface topography and cutting edge wear measurements. Their analyses are also included, on the basis of which the optimum parameters of the active medium formation were determined. As a result of the conducted simulation and experimental studies, conclusions were drawn with regard to directions for further research, as well as those of a cognitive, methodological and utilitarian nature, which describe recommendations in terms of active medium formation parameters, size and mass concentration of copper and aluminium (III) oxide nanoparticles in the context of turning the Ti6Al4V titanium alloy.