ABSTRACT

SELECTED ISSUES OF THE HOLE DRILLING PROCESS IN AlSi10Mg(Cu) ALUMINIUM ALLOY UNDER MINIMUM QUANTITY LUBRICATION CONDITIONS WITH A TWO-CHANNEL SYSTEM OF CARBIDE DRILLS

The dissertation presents an analysis of the influence of aerosol formation parameters in the minimum quantity lubrication method and the variable rotational speed of the drill on selected machinability indicators during turning of AlSi10Mg(Cu) aluminium alloy. The studies were also conducted under dry cutting and compressed air cooling conditions.

This dissertation consists of six main chapters, divided into two main sections on the analysis of the state of the art and all the information related to the execution of the different experiments.

The most important aspects of the use of cutting fluids in machining are presented in Chapter 1. Detailed environmental information on the eco-friendly minimum quantity lubrication cooling method and its importance in the machining of holes is discussed. A detailed analysis of the literature revealed research gaps in the application of the MQL method in drilling of the AlSi10Mg(Cu) aluminium alloy, particularly with regard to aerosol formation parameters.

Based on the analysis, the cognitive and utilitarian aim of the dissertation, as well as the scope of the work, were defined and the following hypothesis was formulated: "The selection of proper aerosol formation parameters in the minimum quantity lubrication method will positively influence the jet behaviour and turbulence reduction during high-speed drilling when machining of AlSi10Mg(Cu) aluminium alloy, enabling the improvement of machinability indicators represented by the topography of the machined surface, the dimensional accuracy of the hole and the wear and vibration of the tool."

Chapter 3 focuses on simulation studies of the effects of the variable volume flow rates of both synthetic fluid and air, as well as varying rotational speed of the drill and the inclination of the channels at the tool outlet, which supply the active medium in the MQL method. The results of these tests enabled the determination of the influence of the variable aerosol formation parameter values and the design of the channels inside the drill on droplet diameter, jet turbulence and the area of cooling and lubrication in the cutting zone.

Methodology and conditions of the experimental studies carried out are presented in Chapter 4. The most relevant values of the cutting parameters, information on the cutting fluid, tool and workpiece material are given, and the test stand, aerosol forming device and measuring apparatus are characterised.

The results of the experimental studies on tool vibration and wear, topography of the machined surface and hole accuracy are presented in Chapter 5. The aerosol formation and tool speed parameters, at which a reduction in wear was found, and the mean-square values of vibration accelerations in the three considered directions were determined. It was found that the accuracy of the hole depends on the vibrations generated during drilling and that rotational speeds higher than 7000 rpm should not be used, as the tolerance exceeds 0.1 mm. According to the surface topography, air volume flow rate of 60 l/min and synthetic fluid volume flow rates of 25 ml/h up to 40 ml/h are recommended. For these active medium formation parameters in the MQL method, the highest quality of the machined surface was found in terms of the height, amplitude and volume parameters.

As a result of the analysis of both simulation and experimental studies, conclusions for further research directions have been developed. Chapter 6 also presents conclusions regarding cognitive and practical aspects, which provide guidance on the settings of the active medium formation parameters, rotational speed in the context of the drilling process of AlSi10Mg(Cu) aluminium alloy.