Popular science summary of scientific project

Methods of minimum quantity cooling and lubricating are currently being widely applied in the machining technology to produce the parts made of stainless and structural steels, as well as the hard-to-cut materials as: nickel and titanium alloys which are usually employed in aerospace, automotive and biomedical industries. In relation to constantly growing cutting temperatures appearing in a many of machining operations, the demand for cutting fluids, which efficiently dissipate the large amounts of heat from cutting zone still grows. Nowadays, the scientists are conducting the researches on searching the novel cutting liquids with better lubricating properties and higher level of heat dissipation from the cutting zone in order to improve the total process' performance and tool life. One of methods employed for the improvement of cutting liquids' efficiency is mixing the base liquids with the nanoparticles. However, there is lack of researches which regard the mixing of nanoparticles with the emulsion mist employed as the active medium in MQCL method. The emulsion which is mixed with the nanoparticles can improve the properties of the cutting medium, including the efficiency of heat dissipation. In addition, the nanoparticles contained in emulsion's microdroplets, may prevent the formation and rupture of adhesive joints – appearing in dry cutting (fig. 1a) and moreover contribute to the formation of tribofilm in the cutting tool-workpiece interface (fig. 1b, c). The tribofilm causes i.a. the reduction of friction in the cutting zone.

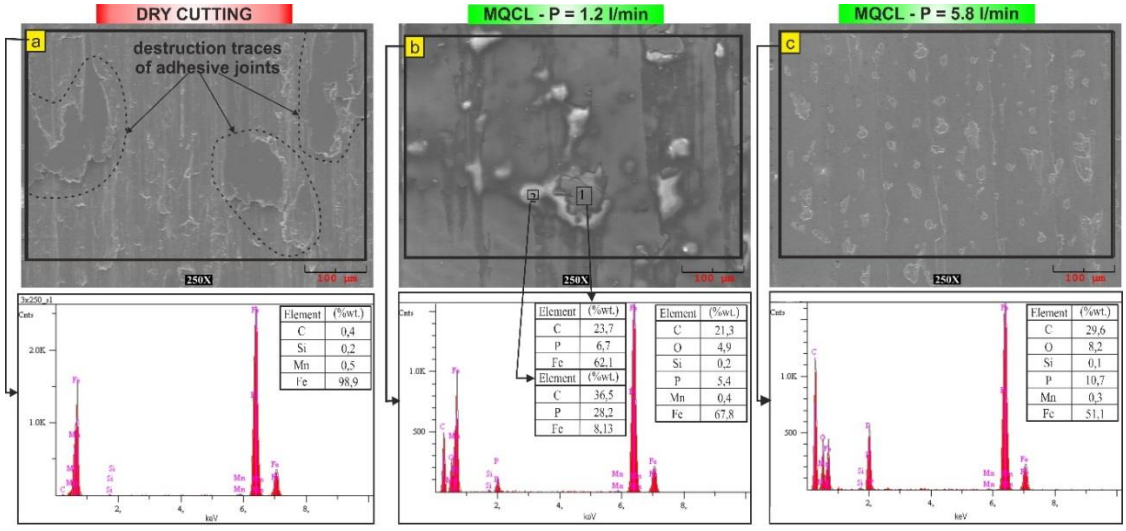

Fig. 1. The SEM analysis of C45 steel's surfaces after turning in a various cooling conditions: a) dry cutting; b) MQCL method for P = 1.2 l/min; c) MQCL method for P = 5.8 l/min.

In order to evaluate the quality of active medium's spraying by the outer nozzle, the numerical model will be applied. The modeling will be executed with the use of the Volume of Fluid (VOF) and the Discrete Phase Model (DPM). The VOF model applies the Euler-Eulerian approach to the investigation of two or more non-miscible liquids by the solution of singular sets of momentum equations and observing the active medium in a whole volume. The developed 2D model intended to investigation of flows disintegration in a vicinity of nozzle's output will be applied to the evaluation of preliminary droplets' diameter, which are consequently required as the input data to the DPM model. The models of active medium formation process proposed in this project will consider all important input parameters (air flow rate, active medium flow rate, size and type of nanoparticles, distance of nozzle from the cutting zone) and will determine the output parameters (number and diameter of droplets, tribofilm thickness, total machined surface wettability, heat transmittance coefficient), and therefore they will allow to solve some problems occurring during machining (vibrations of the cutting tool related to the tribofilm formation, cutting forces, tool wear mechanisms and machined surface quality), which have not been simultaneously considered in a previous researches related to the machining in the minimum quantity cooling lubrication conditions with the use of active medium containing the nanoparticles. All of these aspects allow to formulate the thesis regarding the pioneering character of a project.

The formulation of the project's subject has been dictated by the knowledge extension concerning the role of nanoparticles in an active medium during the MQCL machining, as well as the improvement of surface finish and growth of tool life. Ultimately, the effects can constitute the important basis for popularization of cooling methods based on minimum quantity of coolants and lubricants MQCL as a modern cooling technique and expansion of its practical application during manufacturing of parts with complex shapes intended to biomedical, automotive and aerospace industries.