Modelling and experimental analysis of the cooling liquid flow in ejector deep drilling processes

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ABSTRACT

The ejector deep drilling process is an effective approach for a large variety of drilling applications with length-to-diameter-ratios larger than $l/D > 3$ and high requirements in terms of roundness, diameter accuracy, and surface quality. The ejector method maintains the advantages of deep drilling, such as high material removal rate and high bore quality, on conventional machining centers since no complex cooling lubricant sealing is necessary [1]. Therefore, the understanding of this process is of enormous economic and ecological relevance. The crucial areas for an efficient execution of the drilling process are the cutting zone, the fluid feed area, and the supply zone. The fluid feed area provides the fluid to the cutting zone. The supply zone, where is also the ejector effect based on the Venturi principle, is responsible for the supply and drainage of cutting fluid to and from the system. Achieving a deeper understanding of flow effects and of all the process-specific peculiarities is fundamental. Since only a limited knowledge can be gained with the exclusive help of experimental and measurement methods, a simulation tool based on the mesh free Smoothed Particle Hydrodynamics method (SPH) [2,3] is developed. Together with the simulations, an experimental setup is used to perform in-process fluid pressure and flow measurements, which provides important input data for the improvement of the simulations and of the model generation, as well as validation criteria [3]. The improved understanding of the cooling lubricant behaviour during the evolution of the process, both in the cutting area and in the fluid feed areas, coming from the combined results of simulations and experimental investigations is fundamental for the achievement of new design strategies to improve the drilling efficiency in the industrial environment.

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