Effect of flushing on debris and heat transport in Electrical-Discharge Machining using hierarchical Cartesian grids

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ABSTRACT

Electrical-discharge machining (EDM) is an accurate manufacturing process that removes material through melting and vaporization via high-frequency electrical discharges between an electrode and a workpiece both submerged in an insulating dielectric fluid. The thermal loads induced by the sparks heat the machining tool and the workpiece, while the removed material solidifies forming spherical particles that alter the insulating properties of the dielectricum. Subsequent discharges might remelt the debris worsening the surface quality of the workpiece, reducing the material removal rate of the process, and producing short-circuits on high-concentrations which will stop the manufacturing process. The efficient removal of the material debris and the cooling of the electrode and the workpiece are critical for the performance of the EDM manufacturing process and directly responsible for the material removal rate and the resulting surface quality of the workpiece [1].

In this study, the performance of the cooling and debris removal of dielectricum flushing in the die-sink EDM process is analyzed using Large-Eddy Simulations (LES). A massively-parallel, adaptive, finite-volume cut-cell method [2] on hierarchical Cartesian grids is used to simulate the multi-phase flow involving the fluid and the solid particles, which are described by a level-set method [3]. The flow around each particle is fully-resolved and the heat-conduction between the particles and the fluid is taken into account [4]. The performance of the flushing on the removal of the debris particles is evaluated, the cooling efficiency of the flushing mechanism is analyzed, and the effect of debris particles on the heat-transfer between the dielectric fluid and the workpiece is studied.

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