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Numerical Analysis of Internal Flow in Internally Cooled Cutting Tool

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Abstract

Metal cutting process often accompanied by heat generation at the contact area between cutting tool and the workpiece. Cutting fluid is used to remove the excessive heat generated and decrease the temperature of cutting tool. The benefits come with several drawbacks as cutting fluids are not environmentally friendly, high cost, and contain hazardous substance which may cause health issues to the workers. One of the green alternatives to conventional flood cooling is by using internal cooling channel embedded in the cutting tool. The aim of this study is to evaluate the flow regime of the cooling fluid in the cooling channel of 2 mm diameter, finding the friction factor, and to determine the pumping required to supply the fluid at each inlet velocity. Calculations has been done to determine the flow regime and the mapping of the velocity profile of the cooling fluid. The fluid is assumed to be Newtonian, incompressible, single-phase fluid. The result shows that the Reynolds number is in the range of 468 to 7027 where it is considered to be turbulent flow if the Reynolds number exceed 2300 and the fluid start behaving as turbulent flow at velocity of 1 m/s. In addition, with increasing Reynolds number, the friction factor decrease while on the other hand the pumping power required to overcome the pressure drop increase.

Keywords: Cutting tool; Fluid dynamics; Internally cooled cutting tool.