Abstract

SOME INVESTIGATIONS ON MACHINING CHARACTERISTICS OF INCONEL 718 USING HYBRID ULTRASONIC VIBRATION AND MQL ASSISTED TURNING PROCESS AND PREDICTION OF CUTTING TEMPERATURE THROUGH 2D FE SIMULATION

Inconel 718 is renowned for its excellent mechanical, chemical and thermal properties. As a result of its chemical compositions, it possesses high strength, hardness, oxidation resistance, etc. The high strength and hardness lead to an increase in the cutting forces and high specific energy consumption. Further, the low thermal conductivity property of Inconel 718 hinders its machinability by resulting in excessive heat accumulation in the cutting zone. The heat which gets generated also lead to the formation of secondary precipitation hardening particles, which, in turn, shortens the tool life by causing catastrophic failure of the cutting edge. Also, the heat facilitates the formation of built-up edge (BUE) and deteriorates the surface finish of the machined workpiece.

In the present study, a hybrid ultrasonic vibration assisted turning, and minimum quantity lubrication (MQL) have been used to improve the machinability of Inconel 718. For the present study, experiments were conducted using an indigenously developed ultrasonic vibration assisted (UVAT) setup. The developed fixture consists of unique features like V- slot for cutting tool seat and rake angle adjuster.

Experiments have been conducted using a hybrid of UVAT and different lubri-cooling strategies. MQL (with sunflower vegetable and mineral oils) and flood environments are the lubri-cooling strategies that have been employed. Machining responses like cutting forces, surface finish, and tool wear and its mechanisms have been investigated. Results have been compared for conventional cutting (CT) and UVAT for each environment. In the case of hybrid turning, better machinability has been observed under lower machining parameters compared to CT for the same situation.

To study the relationship between surface roughness (Ra) and parameters like cutting speed, feed, amplitude, and flow rate, a regression-based surface roughness model has been developed. For reducing the number of experiments, a response surface methodology (RSM) design of experiment has been employed. Model adequacy has been validated using different statistical tools, and the developed model have been found to be adequate.

Finally, the distribution of cutting temperature at the cutting zone has been analyzed with a 2D finite element cutting simulation using a commercially available AdvantEdge® software. The simulations showed that in the case of UVAT, a lower average cutting temperature has been observed compared to CT.