Performance Of Water-Based TiO_2 Nanofluid During The Minimum Quantity Lubrication Machining Of Aluminium Alloy, AA6061-T6

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ABSTRACT

The effects of cutting parameters on the wear mechanisms in the end milling of aluminium alloy AA6061 with minimum quantity lubrication (MQL) conditions using water-based TiO_2 nanofluid were investigated. Three different cutting speeds of 5200, 5400 and 5600 rpm were used. The MQL flow rates used were 0.65 ml/min and 1.0 ml/min, while the TiO_2 nanoparticles used were of different volume fractions in the aqueous solutions of 0.5, 2.5 and 4.5%. The results showed that the adhesion of the work material is the major tool damage phenomenon. In addition, abrasion was observed. The major benefit from the water-based nanofluid MQL was shown in the edge integrity i.e., edge chipping and edge fracture were seen in very few cases especially with a higher depth of cut higher. This is attributed to the cooling effect produced by the latent heat of vaporization of the water resulting in the lowering of temperature in the cutting zone. The volume fraction of 2.5% TiO_2 nanoparticles appeared more feasible in terms of tool damage. The effectiveness of the non-conventional nanofluid MQL was also discussed. A non-deterministic component of the sustainability index, for the milling process with the MQL, was calculated using fuzzy logic. The basic objective is to quantify the non-deterministic component of the sustainability index by using the fuzzy rule-based model for the performance analysis of machining with MQL. The results show the prospective utilization of water-based TiO_2 nanofluid as the MQL medium. Thus, it is beneficial for the higher cooling rates of water integrated with the lubrication characteristics of nanoparticles.

KEYWORDS: MQL; surface roughness; flank wear; TiO_2 nanofluid; sustainability index

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