Wear Analysis when Machining AISI 304 with ethylene glycol/TIO2 Nanoparticle-based Coolant

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ABSTRACT

This paper discuss the tool life and wear mechanism in the end-milling of AISI304 stainless steel using a TiN-coated carbide insert with water-soluble coolant and nanoparticle-based coolant (TiO_2/EG). The cutting variables are cutting speed, feed rate, and axial depth. The end-milling operation using nanoparticle-based coolant (TiO_2/EG) obtains a high tool life compared with the end-milling operation using water-soluble coolant. In general, the tool failure when milling with water-soluble coolant was flank wear, cracking, chipping, and fracture at a cutting distance of 720 mm, but the milling process with nanoparticle-based coolant (TiO_2/EG) showed chipping and fracture at a cutting distance of 1200 mm. According to ISO 8688-2-1989 (E), the wear criterion for milling with water-soluble coolant is reached at an average cutting distance of 800 mm, but milling with nanoparticle-based coolant (TiO_2/EG) reached the ISO 8688-2-1989 (E) wear criterion at a cutting distance of 1300 mm. The SEM and EDX spectra show that there are nanolayers of Ti nanoparticles from the nanofluid embedded in and filling the holes in the insert, forming a layer which acts as a thermal bridge for the cutting insert. Attrition and oxidation at the cutting edge were the main tool wear mechanisms present during the end-milling operation with nanoparticle-based coolant (TiO_2/EG). An oxide layer formed during the oxidation wear which shielded the cutting tool from impact during the milling process.

KEYWORDS: Nanoparticle, Coolant, Wear, Tool life

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