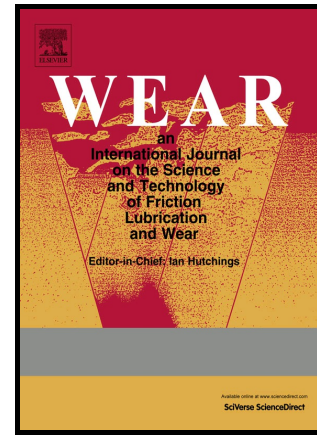


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TOOL WEAR CHARACTERIZATIONS IN FINISH TURNING OF AISI 1045 CARBON STEEL FOR MQCL CONDITIONS

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Abstract

This study presents analysis of tool wear of P25 cemented carbide inserts in finish turning of AISI 1045 carbon steel for different cooling conditions: dry cutting, minimum quantity cooling-lubrication (MQCL) and MQCL with phosphate ester-based EP/AW additive. It was proven that the wear of the inserts using MQCL + EP/AW method is reduced by about 40% compared to dry cutting and about 25% compared with MQCL. The improvement was proved to be a consequence of phosphate ester-based tribofilm formation. Additionally, SEM analysis revealed that active compounds contained in this tribofilm reduce the rate of adhesion and diffusion of tool wear processes. Further, analyzed is also the droplet diameter which has turned out to also have significant impact on wear. It was shown that droplet diameter has the greatest effect on the wear rate. Smaller droplets provide the better penetration into the cutting zone, especially for micro-machining applications. Thus, this work shows that MQCL medium as well as its proper application via generation of controllable mist can provide significant improvements in cutting tool wear rate and/or productivity of cutting tool.

Keywords

Minimum quantity cooling-lubrication, Tool wear, Droplet size and distribution, Additives EP/AW, Tribofilm

Nomenclature

a_p	Depth of cut (mm)
$A_{tot,drop,surf}$	Relative total wetting area on the surface by all droplets per 1 mm ² (%)
AW	Anti-wear
D_{avg}	Avg. droplets dia. on the contact surface (μm)
D	Droplet diameter on the contact surface (μm)
EP	Extreme pressure
E	Mass flow of active medium (g/h)
f	Feed rate (mm/rev)
v_E	Speed of the jet at the nozzle outlet (m/s)
KB	Distance from the cutting edge to the back crater contour (mm)
KE	Radial displacement of the tool corner (mm)
l	Distance of the nozzle from the cutting zone (m)
MRV	Material removed volume (mm ³)
KT	Crater depth (μm)
SQL	Minimum quantity lubrication
SQL	Minimum quantity cooling lubrication
P	Air volumetric flow (l/min)
n	Number of active medium droplets in the SQL spray jet per unit of surface area (no./mm ²)
v_c	Cutting speed (m/min)

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