EcoMachining – Performance Assessment of Additive-Based Vegetable Oils as Cutting Fluids in Machining

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Abstract

This study investigates the performance of biodegradable cutting fluids formulated from coconut and sunflower oils with maize starch additives under Minimum Quantity Lubrication (MQL) during turning of EN8 steel. The work evaluates thermal conductivity, cutting temperature, tool wear, and surface roughness to compare eco-friendly formulations with conventional cutting fluids.

Experiment Overview

Work Material	EN8 Steel (080M40)
Machine	PSG-124 Lathe
Operation	Turning
Tool	CNMG120408NC6110 Carbide
Speed / Feed / DOC	560 rpm / 0.17 mm/rev / 0.5 mm
Lubrication	MQL @ 10 ml/min

Key Results

• Coconut Oil + 0.1g maize starch per 100ml showed the lowest cutting temperature and tool wear.
• Sunflower Oil variants achieved better surface finish due to superior lubricity.
• Thermal conductivity increased significantly with maize starch additives, enhancing heat dissipation.
• All bio-fluids demonstrated improved machining performance over dry or pure oil conditions.

Thermal Conductivity Results

Fluid	Thermal Conductivity (W/m·K)
CC PURE	0.121
CC + 0.1g	0.26
CC + 0.5g	0.245
SF + 0.1g	0.232
SF + 0.25g	0.241

Conclusion

Experimental investigations confirmed that maize starch additives improve the thermal and tribological properties of vegetable oil-based cutting fluids. The optimized formulation (Coconut Oil + 0.1g starch per 100ml) provides effective cooling, reduced tool wear, and better surface finish—making it a sustainable alternative to conventional mineral oils.

Sustainability Impact

This work aligns with sustainable manufacturing goals by reducing toxic emissions, operator health risks, and non-biodegradable waste. The study supports a shift toward renewable, plant-derived lubricants in precision machining applications.

Visual Summary