



## Development of a Vegetable Oil-based Water-soluble Metal Working Fluid for End-milling Operation

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### Abstract

Metal Working Fluids (MWFs) have been used over the past 200 years for different metal cutting operations. They must provide a layer of lubricant to reduce friction, act as a coolant to reduce heat produced and prevent metal pick-ups by flushing away the chips. These functions will help to reduce wear on the tool, reduce energy requirement and to produce the desired surface quality on the work piece. MWFs can be categorized as straight cutting oils, water-soluble fluids and gases. Out of these categories water-soluble fluids are primarily used for high speed machining because they have better cooling capabilities. Most of the cutting fluids are mineral oil-based fluids but they pose significant health and environmental hazards throughout their life cycle. Therefore alternative solutions are highly expected by the modern industrials. Research on applicability of vegetable oil-based cutting fluids in machining metals has been undertaken in recent years and many of them are on testing the suitability of vegetable oils as straight cutting oils. Further water-soluble fluids were also developed using vegetable oils such as soy bean and sunflower oils. In this research a water-soluble MWF composed of 46.7% weight white coconut oil and a mixture of two emulsifiers was prepared. The pH value, viscosity and biodegradability of the newly developed cutting fluid were compared with a commercially available mineral oil-based soluble oil. It was found, BOD<sub>5</sub> (Biological Oxygen Demand in 5 days) of the commercial MWF is very higher than the developed white coconut oil base MWF. End milling machining experiments were conducted with mild steel, stainless steel and cast iron work pieces while applying this newly developed fluid and the selected mineral oil-based soluble oil. Surface quality and the temperature were measured and compared. The surface temperature was lower with the new MWF compared with the commercial soluble oil throughout the experiments during machining mild steel, stainless steel and cast iron. Surface roughness obtained was better with the white coconut oil based new MWF during machining mild steel and stainless steel for all selected spindle speeds. But this is different with cast iron as cast iron is somewhat of a special case with its own built-in lubricant.

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