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Topic of Research: Development of non-edible oil based cutting fluid and design of delivery system for machining

Findings

Cutting fluids have been used for centuries to cool and lubricate metalworking tools. Early forms of cutting fluids were simple mixtures of water and oil, but as metalworking technology advanced, so did the development of cutting fluids. In the 19th century, mineral oil-based cutting fluids were developed, which were used in the manufacturing of machinery and other metal products. Today, cutting fluids are available in a variety of formulations, including water-soluble, oil-soluble, and synthetic fluids, each with specific properties and applications in metalworking. The use of cutting fluids in metalworking becomes more widespread with the Industrial Revolution, mineral oil-based cutting fluids were developed and used in the manufacturing of machinery and other metal products. The 20th century saw a significant development in the field of cutting fluids with the introduction of synthetic cutting fluids. Synthetic cutting fluids were developed to meet the demands of high-speed and high-temperature machining. These fluids were more stable and had longer life spans than mineral oil-based fluids. These fluids were more stable and had longer life spans than mineral oil-based fluids, thus they could withstand high-speed and high-temperature machining. Today, cutting fluids are an essential component of metalworking and are used in a wide range of industries such as aerospace and automotive.

The research on development of water-soluble cutting fluids using non-edible oils as a base is important because it addresses several key issues in the metalworking industry. One of the main issues is the environmental impact of traditional mineral oil-based cutting fluids. The use of cutting fluids pose a serious health hazard to workers, including skin irritation, respiratory issues and cancer. The constituents of conventional cutting fluids are mineral oil and petroleum

products and their derivatives which make them a potential carcinogen. The use of cutting fluids can have negative impacts on the environment if it is not properly disposed \and can contribute to water pollution. Additionally, the increasing demand for sustainable products and processes has led to a need for alternative cutting fluids that are more environmentally friendly. The research on development of cutting fluids using non-edible oils as a base address the needs of the metalworking industry for more effective cooling and lubrication during metal cutting operations. Additionally, it has been reported in literature that the flood method of cutting fluid delivery is unable to provide effective lubrication in comparison to the MQL method. But, the MQL method suffers from temperature related problems which are sufficiently addressed by flood method. Hence, a novel hybrid delivery system was developed and the performance was compared with the MQL method and the flood method.

The present research has been conducted on the development of water-soluble cutting fluids using non-edible oils as a base oil. The main objective of the research is to develop sustainable cutting fluid solutions for metalworking industry that can provide effective cooling and lubrication during cutting operations while minimizing environmental impact. Four different cutting fluids have been developed from different oils viz neem oil, karanja oil, jatropha oil and castor oil. Emulsion stability of the developed emulsion was the criteria for achieving the highest stability of the cutting fluids. A surfactant is a chemical which has two moieties – one which attaches itself to water and the other attaches itself to the oil and thus helps in producing oil-in water emulsion.

The research has resulted in the development of water-soluble cutting fluids using non-edible oils as a base, with improved emulsion stability achieved through the use of specific surfactant mixtures and composition. The performance of these cutting fluids was found to be comparable or superior to traditional mineral oil-based cutting fluids in terms of thermal stability, lubrication, and cooling properties. From the experimental observations it was observed that the non-edible oil based cutting fluids were able to reduce the cutting force, surface roughness and tool wear in comparison to traditionally used mineral oil based cutting fluid. It was found that there was a maximum reduction of 7.9 % in cutting force, 17.54 % reduction in surface roughness and 16.84 % reduction in tool wear with the neem oil based cutting fluid in comparison to traditionally used mineral oil based cutting fluid. Similarly, Karanja oil caused a reduction the cutting force, surface roughness and tool wear by 11.2 %, 15.04 % and 22.77 % respectively and Jatropha oil based cutting fluid reduced the cutting force, surface roughness and tool wear by 8.78 %, 17.54 % and 23.52 % respectively in comparison

to the traditionally used cutting fluid. However, the traditionally used cutting fluid performed better than the castor oil based cutting fluid. The mineral oil based cutting fluid reduced the cutting force, surface roughness and tool wear by 6.85 %, 7.9 % and 25.85 % respectively in comparison to the castor oil based cutting fluid.

The use of a hybrid delivery system was also found to be effective in providing cooling and lubrication during cutting. It was observed that the MQL method began losing its performance beyond a certain machining parameter in comparison to the flood method. However, the hybrid method proved to the effective than both the MQL method and the flood method throughout the experiments. The hybrid delivery method the reduction in cutting forces, surface roughness and tool wear is 6.9%, 14.51% and 15.81 % respectively in comparison with flood method. In comparison to the MQL method, the hybrid method reduced cutting force, roughness, and flank wear by 4%, 15.99%, and 13.57%, respectively.

Overall, the research includes formulation development, testing, and analysis. The results of this research point positively towards the feasibility of non-edible oil based cutting fluids as an environment friendly alternate to the traditionally used cutting fluids. The findings of the research will aid in the development of sustainable cutting fluid solutions for metalworking industry which can reduce the environmental impact of the cutting process and also pave the way for future research in this field.