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The Effect of Karanja based Soluble Cutting Fluid on Chips Formation in Orthogonal Cutting Process of AISI 1045 Steel

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Abstract

The use of metal working fluids widespread with the industrial revolution in the late century. Petroleum based cutting fluid were being extensively used in the machining area causing health and ecological-related issues. The present work tried to elaborate the performance of eco-friendly and user-friendly karanja oil in water based cutting fluid during orthogonal cutting of AISI 1045 steel. Further attempt has been made to identify influence of developed and conventional cutting fluid on chip formation. Based on the findings of the study, a great reduction of 11% was observed in chips thickness which significantly increases tool life.

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Keywords: Karanja; Cutting fluid; Chip formation; Ecological; Tool life;

1. Introduction

The metalworking fluids improve the production efficiency of machining operations in terms of increased tool wear, reduced surface roughness, and improved tolerance and reduced components of cutting force and vibrations. Nearly 85% of cutting fluids being used around the world are derived from mineral oils. Excessive use of these oils has leads to hazardous environmental and health-related consequences e.g. skin diseases. Therefore, different studies

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have been conducted on different vegetable-based cutting fluids which have shown positive findings. In one study, Mohamed et al. evaluate the performance of castor oil as cutting fluid using minimum quantity lubrication technique. It was found that using small amount of lubricant of 50 ml/h during the particular turning process produces better results compared to dry cutting, in terms of longer tool life. Surface roughness and cutting forces were also enhanced [1-3].At higher cutting speeds, the heat generated in cutting zone is carried away along with chip making the use cutting fluid redundant. The absence of cutting fluid creates problems in chip formation and causes an increase of tool workpiece and tool-chip friction which affect the tool life and quality of machined surface [4]. Srikant and Ramana are making an attempt to replace both the mineral oil and petroleum-based emulsifier with vegetable-based alternatives i.e. sesame oil and coconut based emulsifier and produces a new class of sustainable cutting fluids. The findings show that the formulated fluid with 10% vegetable emulsifier content exhibits a performance similar to the regular cutting fluid in terms of cutting temperatures, tool wear and surface roughness. The major contribution of the work is the replacement of regular petroleum-based emulsifier with an eco-friendly alternative, in addition to using vegetable oil [5].

Although, metal working fluids are more beneficial in manufacturing companies, in today's market their uses become more prevalent around the globe due environmental consciousness enhanced laws and regulations [6]. The machinability of difficult to cut alloy with application of low cutting fluid (water and emulsion) volumes to the cutting area in the form of a precision-metered droplets mist show that, as far as tool life is concerned, the use of an emulsion mist is an advantageous strategy in comparison to MQL and dry cutting [7]. Debnath et al. studied the effect of various cutting fluid levels and cutting parameters on surface roughness and tool wear. The effect of feed rate contributing 34.3% to surface roughness of the work-piece and the flow rate of the cutting fluid also showed a significant contribution of 33.1%. On the other hand, cutting speed 43.1% and depth of cut 35.8% were the dominant factors influencing tool wear [8].]. Padmini et al. verify the performance of vegetable oil based nanofluids during turning of AISI1040 steel through minimum quantity lubrication (MQL) technique. Different samples of nanofluids are formulated using dispersions in coconut, sesame and canola oils at varying nanoparticle inclusions and examined for machining parameter. The results obtained by her study shows cutting forces, temperatures, tool wear and surface roughness reduced by 37%, 21%, 44% and 39% respectively by using 0.5% nanoparticle inclusion compared to dry machining [9]..Noordin et al. evaluates the performance of coated carbide cutting tools in term of tool life under MQL with flow rate of 50 ml/h using castor oil as the cutting fluid. The workpiece is hardened AISI 420 stainless steel with 47 – 48HRC hardness. The performance evaluation was done under different cutting speeds and feeds. It was found that tool life is inversely proportional to both cutting speed and feed, with the effect of cutting speed is more significant than feed [10 The performance of a new cooling technique integrated with a developed cutting fluid applied with MQL method is elaborated by Yousef et al. It seems that the proposed combined cooling method may potentially enhance the productivity of cutting operations in terms of machining quality, costs, operator health and environmental protection [11]. Alberto et al. in his study collect data on the aluminium alloy 7050-T7451 machinability for manufacturing of aeronautical structures, using the combination of the jatropha vegetable-base soluble cutting oil with relation to the canola vegetable and semi synthetic mineral oils and application of cutting fluid by flood in relation to the Minimum Quantity Lubrication (MQL). It was observed that the jatropha vegetable cutting oil represented the best results in terms of, superficial mean roughness [12].Xavior and Adithan determine the influence of cutting fluids on tool wear and surface roughness during turning of AISI 304 with carbide tool. The performance of coconut oil is compared with other two cutting fluids namely an emulsion and a neat cutting oil. The results indicated that in general, coconut oil performed better than the other two cutting fluids in reducing the tool wear and improving the surface finish [13]. Lawal et al. study the effect of formulated cutting fluids on surface roughness and cutting force in turning AISI 4340 steel with coated carbide using Taguchi method. Results show that cutting speed 64.64% and feed rate 32.19% have significant influence on the surface roughness and depth of cut 33.1% and type of cutting fluids 51.1% have significant influence on the cutting force [14].

From the literature reviewed, it has been observed that very few studies are reported on chip formation using vegetable based cutting fluid. Many researchers carried out experimentation using castor oil, coconut oil, sesame oil etc and the results shows great promise to exploit the potential of these oils in many applications. To the best of our knowledge, however, no reports on the use of karanja seed oil in water have been made and its effect on chips formation is observed. It is well-known that in present context to Indian scenario, karanja seed oil is available