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Experimental investigation on tool wear reduction by nano- alumina particles enriched waste coconut oil nano-fluid for machining SAE 1045 shaft

R. Saravanan [a], G. Anbuchezhiyan [a], R. Pugazhenthi [b], Sreekanth Sura [c]

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Abstract

The performance of machining tool can be assessed in terms of tool wear. Increased tool wear has an impact on surface quality. The surface quality of the shaft is a major influence in fatigue load failures. The liquid waste of multiple times used coconut oil are disposed in open channel, which contaminates the soil and ground water and also harm to environment. This study looked into the impact of a Nano fluid containing Nano-alumina particles enriched waste coconut oil on tool wear. The samples in this study were divided into two groups: group I was the control group, and group II was the experimental group, in which the samples were machined (turned) on a heavy-duty lathe using the green machining process. The intervention group's sample was machined using a clean technology approach that included 0.3 percent Nano-alumina particles enriched waste coconut oil based wet machining. To validate the statistical model, the experimented observations were subjected to Taguchi analysis and subsequent examination by ANOVA. Based on the experimental findings, the proposed Nano-alumina particles enriched waste coconut oil based wet machining method was developed.

Introduction

One of the widely used steel for shaft manufacturing is SAE 1045 steel. It was examined steel of grade C45 which was machining with a cryo-treated M2 grade HSS tool in a dry machining environment [1], [2], [3], [4], [5]. Usually employed the L9 experimental plan and optimized parameters using Taguchi analysis outputs such as the signal to Nosie ratio and ANOVA results [6], [7], [8], [9]. The tool wear was compared to a tool that had not been treated [10]. It is discovered that the treated tool has a lower tool wear than the untreated tool [11], [12], [13], [14]. Some researchers evaluated the tool wear data with advanced optimization methods and produced a prediction model after testing the machining performance of hard materials like Inconel 625 samples [15], [16], [17], [18], [19]. The cutting characteristics for AISI10140 steel and concluded that at high tool wear and surface roughness must be monitored, thus coolant is required to prevent such deterioration. Based on sunflower oil with Nano crystalline Graphite enriched fluid in MQL form was recommended by the authors [20]. Another essential factor in orthogonal cutting is the tool profile [21]. As a result, a research looked into the effects of the Rack angle on machining Hardened Steel in the lathe with c-BN Tools. They used Digital Image Correlation to compare strain field to strain field. The tool wear model is based on the thickness of uncut microchips. It was discovered that the specific cutting energy and nose radius had a relationship.

The availability of alumina nanoparticles is high, and they can be made from aluminium waste scarps from the aluminium industry [22]. It was recommended that low concentration of alumina nanoparticles for pumped flow in heat exchangers [23]. Use of Nanofluid in Heat exchangers, suggested that along with the twisted tape the metallic Nano fluid performance was found appreciable the authors used water as base fluid and thermal performance factor achieved was 2.15 [24]. About Alumina Nanofluid performance it was reported that the heat transfer performance of alumina Nano fluid found 28% higher when compared to base fluid performance for double tube heat exchanger [25]. In this research the alumina Nano fluid prepared with waste (used) coconut oil for liquid lubricant for shaft machining.

Section snippets

Materials and methods

A heavy-duty, semiautomatic industrial class lathe is used in this research as shown in Fig. 1. The work material was chosen to be SAE1045 steel because it is often utilised in this technique and demands more inquiry for a better outcome. Coconut oils, which have been used in cooking for many years, were used as a basic fluid. Nano alumina particles were suspended for 120 min after being extensively mixed in an ultrasonication-type mixing process. After 48 h, there is no sedimentation in the…

Results and discussion

In Table 2, the observations of tool wear in a clean and green machining environment are compared. The findings are statistically confirmed using an independent samples test. The independent samples test (T-Test) output of group statistics is shown in Table 3. Green machining was used in Group 1 (control group) while clean machining was used in Group 2 (intervention group). Table 4 shows that the average tool wear encountered while machining Group 1 samples is 0.7528 m, whereas the proposed…

Conclusion

This study identified the possibilities machining SAE 1045 steel material with proposed Nanofluid, The Nanofluid coolant prepared from the waste of multiple time used coconut oil and supplemented with alumina Nanoparticles. The tool wear-based comparison was followed to investigate the machineability of SAE 1045 Steel material. The parameters optimized to minimum tool wear. The prediction model developed for predicting the responses for various un experimented trails or justifying the responses …

Declaration of Competing Interest

No funding is received by the authors for performing this research work…

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