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# Experimentally investigating cutting force reduction performance by nano-alumina particles enriched waste coconut oil Nano fluid in electric motor shaft manufacturing

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## Highlights

- Nano-alumina particles enriched waste coconut oil used to reduce cutting forces.
- Cutting force at clean and green machining environment was compared.
- Signal for the cutting velocity decreases with increase of cutting velocity.
- The variation of signals found less in the case of depth of cut.

## Abstract

Generally, coconut oil is used for healing cut and wounds, cooking, lubricating machine parts etc. Used coconut oils are considered as waste and disposed on open channel and that is against to eco-friendliest. This piece of research work aims to investigate the effect of Nano- alumina based Nanofluid in machining of steel work in the lathe machine. The novelty in this investigation is the used coconut oil is reused as base fluid for preparing the nanofluid. Cutting force response is used for optimizing the parameters of the metal removal process. For investigating the effects, the cutting speed varied as 40 to 190m/min, feed rate of the tool varied as 0.05 to 0.20mm/rev and the CVD coated tool with 4 different nose radiuses used such as 0.3mm, 0.6mm 0.9mm, and 1.2mm, L16 orthogonal array involved to form the minimum experimental combinations. The results compared with existing practice of dry machining. The new fluid based cutting out performed and its process parameters influences were studied, optimized and mathematical model developed for prediction.

## Introduction

Cutting force is prime importance factor to be considered in the field of machining. [1] investigated the C45 steel machining with cryo-treated HSS tool of M2 grade under dry machining condition. They used L9 experimental plan and optimized parameters with the outputs of Taguchi analysis like signal to Nosie ratio and ANOVA results. The cutting force existed were compared with un treated tool. Found that the treated tool experiences less cutting force than un treated tool. [2] tested the machining performance on Inconel 625 samples, and analysed the cutting force data with advance optimization algorithms and prediction model prepared. [3] analysed the cutting parameters for AISI10140 steel and insisted that at elevated temperature the tool wear and surface roughness are must be taking care so coolant is mandatory to avoid such deterioration and recommended Sunflower oil-based Nano crystalline Graphite enriched fluid in MQL form. The tool profile is another important thing in the orthogonal cutting So [4] analysed the Rack angle's consequences for machining the Hardened Steel with c-BN Tools in lathe. They compared with strain field with use of Digital Image Correlation. The cutting force model is created in terms of micro sized uncut chip thickness. The relationship between the specific cutting energy and nose radius were established. The alumina nano particles availability is high as well as it can be produced from the aluminium waste scarps from the aluminium industries [5], [6]. [7] recommends low concentration of alumina nanoparticles for pumped flow in heat exchangers. [8], [9], [10] suggested that along with the twisted tape the metallic nanofluid performance was found appreciable the authors used water as base fluid

and thermal performance factor achieved was 2.15. [11], [12], [13], [14], [15] reported that the heat transfer performance of alumina nanofluid found 28% higher when compared to base fluid performance for double tube heat exchanger. The novelty of this research is the Nanofluid prepared from multiple times used and waste coconut oil for machining coolant. The use of such Nanofluid in flood coolant will permits multiple time usage than MQL. This results also recommended a coolant for machining the steel. But the coolant was synthesized in the route of liquid waste, that is used coconut oil by suspending the alumina nanoparticles.



## Section snippets

## Materials and methods

The lathe of heavy duty and semiautomatic industrial class machine is employed in this research as shown in Fig. 1. The work material of steel of grade SAE1045 was preferred as it is widely involved in this process and needy research for better outcome. The multiple time used coconut oils for cooking was employed as base fluid. Nano alumina particles (less than 5 Nm sized particles) suspended by thorough mixing them for 12 h in the ultrasonication type mixing process [16], [17], [18], [19], [20]

## Results and discussion

Table 3 demonstrates the *t*-test first part of the result that mean of cutting forces on conventional method of machining is 286.4108 N and the same was in proposed machining method with nanofluid is 219.5314536 N. The same was presented graphically in Fig. 2.

Table 4 express that as significant value is less than 0.05 the cutting force observations are significantly varying between methods as 66.87913 N. That is mean of cutting force observations are significantly different [21], [22], [23], [24]

## Conclusion

The clean technology-based approach is followed to reduce the machining cost. That is Nanofluid coolant was prepared from the liquid waste of multiple times used coconut oil. That was supplied at machining interface for lubrication and cooling purpose at the metal cutting zone while machining the steel of grade SAE1045. The results were compared with conventional machining practices. As proposed method is outperformed, the same results were analysed with Taguchi analysis, ANOVA and optimized

## Declaration of Competing Interest

No funding was received for the current research work

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