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# A review on the role of nanoparticles in MQL machining

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## Abstract

The role of cutting fluid is significant for removing heat from machining zone, providing lubrication and chip removal process in the metal cutting operation. The green machining is achieved by using vegetable oil based minimum quantity lubrication (MQL) to reduce the environmental effect of cutting fluid. Adding nanoparticles on the base fluid of MQL system greatly improves the lubricating performance. In the current study, comprehensive review of various machining process under nanofluid MQL (NMQL) system has been discussed. To carry out the review, various studies on NMQL under four categories of machining process such as milling, grinding, turning and drilling in the recent four years have been considered. This article addresses the recent trends in the utilization of various nanoparticles and measuring the output performance parameters to the researchers on MQL system.

## Introduction

The process of cooling is the most challenging task for the machining sector. The generated heat from the cutting operation is exchanged by the conventional cutting fluid [1].The environmental and economic aspects are the main criteria for selecting the coolants and its applying techniques. Modern technologies have been developed to reduce the environmental impact by cutting fluid such as solid lubrication, oil on water, cryogenic machining and Minimum Quantity Lubrication (MQL) technique. Among these, the technique to reduce consumption of cutting oil and improve

the surface quality is MQL [2].In such a system the compressed air assisted minute droplets are sprayed by the nozzle on cutting zone to provide lubrication and cooling effect [3].The atomizer of the MQL system ejects the cutting oil by influence of high pressure air and the aerosol of lubricating particles are sprayed on the cutting zone [4].

The nanofluid is the combination of base fluid and nanoparticle and better heat transfer properties are identified this combination by various researchers. Furthermore, obtaining improvement in various thermo physical properties more than one nanoparticle are mixed and is called as hybrid nanofluid [5].The cost expense is one of the main drawbacks of nanofluid and it is compensated by minimum usage by using MQL technique [6]. The nanoparticles increase the retaining time of lubricating oil on the cutting zone and due to that the surface roughness, tool wear and cutting temperature are reduced [7]. The article deliberates the various recent studies conducted on NMQL technique milling, grinding, drilling and turning operations respectively. In each category of machining different input/output parameters used, details of nanoparticle and its influence on output performance have been discussed.

## Section snippets

### NMQL milling process

The multipoint cutter which can rotate and minimum amount of material are removed by each tooth at every spindle revolution on milling process. The relative motion of workpiece and cutter can be operated in various direction depends on surface orientation of workpiece [8]. A comparative table of various studies on NMQL milling is given in Table 1 including workpiece material, tool material, nanoparticle, base fluid and performance parameters. A comparative study carried out by Bai et al under…

## Conclusion

Implementing of MQL techniques in cutting operation has become more popular in the industrial sector. The existence of abundant benefits on nano technology attracts the researchers to incorporate the nanofluid in MQL cooling system. The summarization of recent researches on nanofluid MQL system at various machining operation have been detailed in this article. The concluded remarks of this comprehensive review have been listed below:

- The sustainable manufacturing is achieved by biodegradable…

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## CRediT authorship contribution statement

**Arumugam Balasuadhakar:** Investigation, Writing – original draft. **S. Thirumalai Kumaran:** Conceptualization, Methodology, Supervision, Visualization. **Farooq Ahmed:** Formal analysis, Writing – review & editing, Validation, Resources.…

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

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## References (44)

A. Ghadimi *et al.*
A review of nanofluid stability properties and characterization in stationary conditions
Int. J. Heat Mass Transf. (2011)

G. Singh *et al.*
Critical review on ecological, economical and technological aspects of minimum quantity lubrication towards sustainable machining
J. Clean. Prod. (2020)

A.K. Sharma *et al.*
Effects of Minimum Quantity Lubrication (MQL) in machining processes using conventional and nanofluid based cutting fluids: a comprehensive review
J. Clean. Prod. (2016)

J.A. Ranga Babu *et al.*
State-of-art review on hybrid nanofluids
Renew. Sustain. Energy Rev. (March 2017)

M. Hemmat Esfe *et al.*
Application of conventional and hybrid nanofluids in different machining processes: a critical review
Adv. Colloid Interface Sci. (2020)

N.N.N. Hamran *et al.*
A review on recent development of minimum quantity lubrication for sustainable machining
J. Clean. Prod. (2020)

R. Venkata Rao *et al.*
Parameter optimization of a multi-pass milling process using non-traditional optimization algorithms
Appl. Soft Comput. J. (2010)

H.B. Kulkarni *et al.*