

**PERFORMANCE EVALUATION OF WHITE COCONUT  
OIL BASED METAL WORKING FLUID**

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Degree of Master of Engineering

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Thesis submitted in partial fulfillment of the requirements for the  
Master of Engineering in Manufacturing Systems Engineering

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## DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

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## DEDICATION

To the most courageous two persons who guided me to great achievements: my beloved father *Sri Lal Daneial Wickramasinghe* and mother *Pearl Wickramasinghe*

## **ACKNOWLEDGEMENT**

As a graduate student of the Faculty of Engineering, University of Moratuwa, I have to complete a research project for the partial fulfillment of the requirements for the MEng. in Manufacturing Systems Engineering. For that, I selected the topic “Performance Evaluation of White Coconut oil-based Metal Working Fluid”. I am highly indebted to University of Moratuwa for the opportunity. Exclusively I would like to express my gratitude towards Dr. G.I.P Perera, Dr. Himan KG Punchihewa and Mr.S.W.M.A.I Senavirathne for their guidance and constant supervision as well as for providing necessary information regarding the project and for their support in completing the research project. Their kind co-operation and encouragement inspired me in completion of this project. Further, I acknowledge Mr. R.K.P.S Ranaweera for his valuable comments on my research. I would like to express my special gratitude and thanks to University of Ruhuna for giving me such information, time and engineering workshop facilities. My thanks and appreciation go to my colleagues in developing the project and people who have willingly helped me out with their abilities.

## ABSTRACT

Metal Working Fluids (MWFs) play a significant role in metal machining operations and vastly used in aerospace, automotive and marine industries to produce high tech components. The main purpose of using MWF during cutting operation is to facilitate a layer of lubricant between work tool interfaces to abate friction and heat. In the present context, industries practice to use mineral-based MWFs as of its good functional performance. However, health and environmental legislations have bounded the usage due to its carcinogenic behavior and adverse effects to the environment. Therefore, the requirement of ecological and user-friendly cutting fluid has raised substantially in manufacturing industries. Researchers have taken much effort to find an alternative for mineral oils and concluded the importance of vegetable oils as a substitute to use for the MWF. However, neat vegetable oil express poor cooling capability during machining due to its low oxidation stability. The authors have formulated a white coconut oil-based water soluble MWF to overcome the poor cooling ability by using water and permitted food grade surfactants. The main intention of the research is to assess the industrial applicability of the formulated fluid in term of functional performance while ensuring health and safety of the operators and environmental impact. The surface quality, chip curl radius, chip formation of 0.2% C and AISI 304 steels while using formulated novel white coconut oil based MWF, mineral oil based MWF in flood cooling and dry machining configurations have investigated for the conventional turning operation. The machining parameters were selected according to the recommended specifications of the work materials and tool manufacturers. Coated carbide indexable inserts have been used for the turning operation and surface quality of each set of cutting parameters were measured. Further, tool wear was investigated using scanning electron microscope (SEM). Work tool interface temperature was simulated using the DEFORM platform. The invented novel white coconut oil based MWF expressed better values for almost all the set of machining parameters when compared to the other cooling configurations and proven its industrial applicability for the sustainable machining. The performance of the formulated white coconut oil based MWF can be enhanced by adding nanoparticles and it is worthwhile to conduct the machining operations for hard to cut materials for further confirmation of the industrial applicability.

**Keywords:** Metalworking Fluid, Surface Quality, Turning, Tool Wear, Vegetable oil

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## LIST OF ABBREVIATIONS

<b>Abbreviation</b>	<b>Description</b>
AISI	American Iron and Steel Institute
BOD	Biological Oxygen Demand
BUE	Built Up Edge
COD	Chemical Oxygen Demand
CM	Chip Morphology
CNC	Computer Numerical Control
CR	Curl Radius
DoC	Depth of Cut
HLB	Hydrophilic Lithophilic Balance
IARC	International Agency for Research on Cancer
MSDS	Materials Safety Data Sheet
MR	Mean Roughness
MWF	Metal Working Fluid
SD	Standard Deviation