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Searching for journal paper can be done by using the study keyword or the name of the journal. If you still don't know what your research keyword is, please talk to your supervisor.

Among the simple tips to get research keywords are as follows:

1. List the tools used to make the study. The tool can be a software name or an experimental device.

Deform

Ansys

FEA

Etc

Fourball tester

Universal testing machine

Crack test

Etc

2. Find out the name of the material you want to study.

Aluminium

Brass

Copper

Nano carbon tube

Nano particle

Graphene

Etc



DR. SYAHRULLAIL SAMION

3. The concept of your study.

Green technology

Electric car

Wind turbine

Metal forming

CFD

Simulation

Questionnaire

Etc

4. What is the use of your study.

Reduces the greenhouse effect

Increase efficiency

Increase speed

Smooth the surface

Heat the liquid

Etc

5. Make a search based on nouns synonymous with your study.

Palm oil lubricant = bio-lubricant = green lubricant, etc

Extrusion = Metal forming = forging, etc

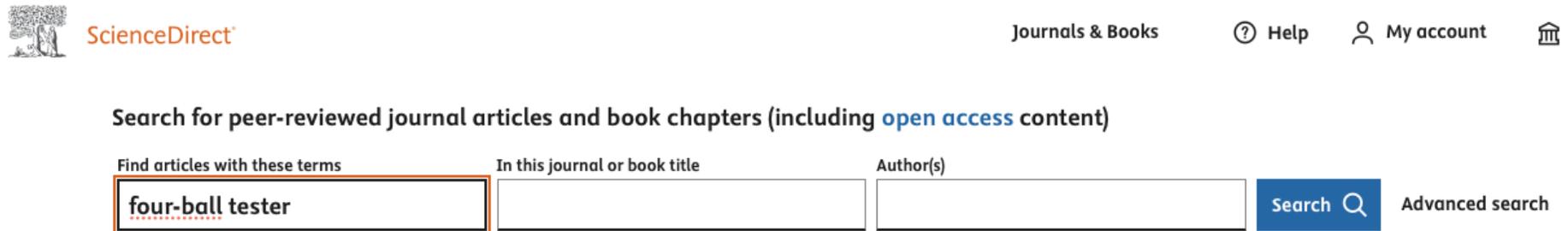
Wind turbine = energy harvesting, etc

Fourball tester = four ball tester = four-ball tester, etc

We may try another lubricant from same research theme like;

Rapeseed oil, jojoba oil, etc

For example, we enter the keyword "four-ball tester" in the ScienceDirect search box.



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Alexandria Engineering Journal, October 2021
M. A. Mujtaba, M. A. Kalam, ... Luqman Razzaq

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Materials Today: Proceedings, 2018
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W Piekoszewski, M Szczerek, W Tuszynski

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5 Wear as measured with a **four-ball wear tester** using fully flooded and vapor phase with condensation lubrication methods

Wear, 13 April 1993
E. E. Klaus, H. Li, ... J. L. Duda

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Wear, 29 July 2011
Mohsen Mosleh, Keron Bradshaw

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Tribology International 183 (2023) 108398



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2

3

Tribological performance of trimethylolpropane ester bio-lubricant enhanced by graphene oxide nanoparticles and oleic acid as a surfactant

P. Zulhanafi*, S. Syahrullail, Z.N. Faizin

Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, UTM Skudai, 81310 Johor, Malaysia



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ARTICLE INFO

Keywords:
 Trimethylolpropane
 Bio-based lubricant
 Nanoparticle
 Surfactant
 Tribology

ABSTRACT

One of the issues of nanoparticle additives is the tendency to agglomerate. The presence of a surfactant may help reduce this issue. In this study, trimethylolpropane (TMP) ester was used as a base lubricant, graphene oxide (GO) as a nanoparticle additive, and oleic acid (OA) as a surfactant. Tribological testing was carried out using a four-ball tribotester at various concentration ratios. The results showed that the TMP + GO + OA demonstrated increased dispersion stability compared to TMP + GO alone. Furthermore, the presence of OA reduced the coefficient of friction of the samples containing 0.05 wt%, 0.1 wt%, and 0.5 wt% GO by 22.9%, 21.1%, and 23.6%, respectively. Surface roughness and physical wear conditions were also observed and discussed.

1. Introduction

The rise in global environmental sustainability issues has prompted researchers to look for alternative lubricant oil resources. Because of its superior performance, mineral-based lubricant oil accounts for more than 70% of the world's supply. Mineral-based oils, on the other hand, are not environmentally friendly because they are toxic, non-biodegradable, and nearly impossible to dispose of naturally [1]. This compels researchers to focus their efforts on synthetic and bio-based lubricants. Although synthetic-based oil offers promising performance, it has high production costs. Meanwhile, bio-based oil is less expensive,

thermally stable, resulting in a higher VI, a high flash point, and a low pour point [4]. Fig. 1 depicts the chemical reactions that occur during the synthesis of palm oil-based TMP ester.

Many studies have been executed to evaluate the performance of TMP esters and most have shown promising results. Afifah et al. investigated the tribological performance of palm stearin methyl ester (PSME) and found that the coefficient of friction (COF) of PSME was reduced by 25.7% compared to SAE 40 engine oil. In terms of wear, mineral oils have been found to be superior to palm oil-based lubricants [5]. The same authors extended their research by using the same lubricant and observed that the wear scar diameter (WSD) that formed

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