



Prospects of Plant-Based Trimethylolpropane Esters in the Biolubricant Formulation for Various Applications: A Review

Nurliyana A. Raof¹, Hamidah Abd Hamid¹, Nur Atiqah Mohamad Aziz² and Robiah Yunus^{2*}

¹Institute of Plantation Studies, Universiti Putra Malaysia, Selangor, Malaysia, ²Department of Chemical and Environmental Engineering, Faculty of Engineering, Universiti Putra Malaysia, Selangor, Malaysia

OPEN ACCESS

Edited by:

Nurin Wahidah Mohd Zulkifli,
University of Malaya, Malaysia

Reviewed by:

Jitendra Kumar Katiyar,
SRM Institute of Science and
Technology, India
Arslan Ahmed,
COMSATS University Islamabad,
Pakistan

*Correspondence:

Robiah Yunus
robiah@upm.edu.my

Specialty section:

This article was submitted to
Tribology,
a section of the journal
Frontiers in Mechanical Engineering

Received: 11 December 2021

Accepted: 27 January 2022

Published: 28 February 2022

Citation:

Raof NA, Hamid HA,
Mohamad Aziz NA and Yunus R (2022)
Prospects of Plant-Based
Trimethylolpropane Esters in the
Biolubricant Formulation for Various
Applications: A Review.
Front. Mech. Eng 8:833438.
doi: 10.3389/fmech.2022.833438

Biodegradable lubricants from renewable feedstocks have been successfully developed to meet the demands of new machines with stringent requirements of the global standards, which address sustainability and environmental policy. Trimethylolpropane ester (TMPE) has been extensively evaluated as a biolubricant base stock and occasionally used as an additive, due to their low toxicity and excellent biodegradability. The formulation of high-performance TMPE-based lubricants involves addition of surface additives, multifunctional additives, and solid nano particles. This review focuses on the development of plant-based TMPE formulation for various applications, namely food-grade lubricant, engine oil, drilling fluid, insulating fluid, metal working fluid, hydraulic and heat transfer fluids. Even though plant-based TMPE lubricants have huge advantages over mineral oils, they have other challenging issues such as limited load-bearing capacity, hygroscopic properties, and high risk of toxic emission owing to additives selection. The details on the performance characteristics of TMPE as base stocks and additives are discussed, including the current prospects and challenges in the respective areas. This review concludes with a brief discussion on suggestions and recommendations for future advancement in the usage of TMPE and the remaining issues that must be overcome to allow for its full potential to be realized.

Keywords: biolubricants, trimethylolpropane ester, environmentally friendly lubrication, formulation, additives

INTRODUCTION

Formulations of lubricants by using a conventional mineral oil and additives have raised crucial drawbacks, such as global scarcities due to a rapid exploitation of fossil oil resources, high toxicity, and non-biodegradability. The usage of mineral oil-based lubricants as the end products could adversely affect the environment due to an accidental loss, spillage, or a poor lubricant handling or management. In this case, due to its renewable, low eco-toxicity, biodegradable, and safer attributes, biolubricants derived from plant oil have become a great interest. While plant-based oils have long been used as lubricants, they were rapidly overshadowed in the 20th century by mineral oils, which are significantly cheaper. However, with the present increase in plant-based chemistry and skyrocketing petroleum crude oil prices, biolubricants are regaining popularity. The performance of biolubricants, however, particularly in terms of friction, wear prevention, and lubricity, remains debatable. One of the main attributes for an excellent lubrication is high affinity toward metal