

# A Systematic Review on Promising Development of Palm Oil and its Nanofluid as a Biodegradable Oil Insulation Alternative

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## ABSTRACT

This review is conducted following a systematic approach by adopting Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline and using reliable and trustworthy databases, namely IEEE Xplore, Science Direct, and Scopus, with Google Scholar as an additional database. This review paper has divided into three subsections. The first subsection shows the major publications searching for palm oil-based as an alternative to biodegradable oil insulation. The second subsection discusses the research trends on palm oil replacing mineral oil. Finally, the third subsection discusses the development and progress of palm oil-based nanofluid as a future substitute for biodegradable oil insulation, as well as the types of analyzes conducted in the studies. This part contains eleven sub-subsections, namely (i) types of palm oil used, (ii) tests of palm oil as insulating liquid, (iii) properties of palm oil as insulating liquid, (iv) thermal aging, (v) water content, (vi) dissolved gas analysis (vii) selection of nanoparticles, (viii) preparation of palm oil-based nanofluids, (ix) characterization and stability of palm oil-based nanofluids, (x) analysis of electrical, physical and chemical properties, and (xi) current status of palm oil-based insulating liquid in Malaysia. This article highlights palm oil's development, trends, and status and its nanofluid as a liquid insulating alternative in transformers. The properties and performance of the liquid are also reported in this article. The promising results, shortcomings, and imbalances between palm oil and other types of natural ester oils are discussed, and suggestions are made for future work worth exploring.

**Index Terms** — biodegradable oil insulation, nanofluids, natural esters, palm oil, systematic literature review

## 1 INTRODUCTION

**GROWING** environment awareness has stimulated the blossoming of biodegradable and renewable resources as a replacement to mineral oil (MO) as oil insulation in transformers.

Most research in biodegradable oils for transformer applications has focused on natural ester oils (NEOs), beginning with the introduction of BIOTEMP® in 1999, developed by ABB, which derived from sunflower oil [1]. It is followed by Envirotemp FR3® derived from soybean oil by Cooper Industries Inc. in 2000.

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