1. INTRODUCTION

Since 1850's, pPetroleum has been the most significantmain fuel and energy supply since the 1850s, and accounts for nearlyource which is about 90% of the vehicle'sular fuel consumptions need are met by oil. In any case, there has been increasing concern about aAn energy crisis triggered by the imminent caused by potential petroleum depletion of since petroleum is non-renewable petroleum, has, however, become increasingly concerneding. Researchers have been driven to strive into seek alternative and sustainable energy sources to reduce their dependence upon petroleum, primarily because of their The need for increased energy security and their concern about the continuously rising cost ofhigh oil costs has driven researchers to seek for renewable and sustainable energy sources to overcome the reliance on petroleum. Besides, green and ecologically benign fuels also also have anthe effect onof fossil fuelgas emissions from fossil fuels and the environmental pollution. issues are also the important reasons for green and ecologically benign fuels. Biodiesel has become a very viable substitute for fossil diesel, with similar characteristics to fossil diesel, and has become world newsthe world's attention as one of a very promising alternative energies to substitute for fossil dieselsbecause it has similar properties to fossil diesels. Compared to conventional fossil fuels, The advantages of the biodiesel has more advantages:, some of which are:compared with the conventional fossil diesels are their renewability, biodegradability, non-toxicity and low exhaust emissions due to the free absence of sulfphur and aromatics in biodiesel (Hassan and Rahman, 2017). In this 21st century, bBiodiesel has seen a significant increase globally in the 21st century because of these due to the aforementioned experienced a major surge worldwide due to these advantages.

Technically, the term "biodiesel" refers to mixtures of fatty acid alkyl esters (FAAE) mixtures, produced by the transesterification of vegetable oils or animal fats with alcohol,s or through thevia esterification of free fatty acids (FFA) with alcohols. In this transesterification reaction, both Aacid and base catalysts can be used to increaseenhance the biodiesel production during transesterification reactions. Recently, much research has studied investigated the utilization ofbeen reported relating to the development of heterogeneous catalysts for the transesterification of various vegetable oils with methanol (Baskar and Aiswarya, 2016). Conventional biodiesel production hased used base-catalyzed homogeneous reactions, such as sodium hydroxide and potassium hydroxide, that which canould be dissolved into the vegetable oil or animal fat. Thus, aA large amount of water is required for washing purposes that led leads to the soap formation. which and This makes the process complicatedbecomes difficult, time-consuming, and expensive, and lowers the overall quality of biodiesel quality.

In the acid-catalyzed transesterification processUsually, strong acids such as hydrochloric acid and phosphoric acid usually serve asare used as catalysts in the acid-catalyzed transesterification process (Melero *et al.*, 2015). As the acid catalysts are more corrosive, it is not preferredable due to the highlarge operatingon costs in of the industrial process. The importance of sSolid base catalysts is are recognizedhas come to be known for their eco-nvironmentally friendly qualities. Typically, mMetal oxides are identified as the most commonlysignificant and extensively used as catalysts in this industry. A Sstrong basic metal oxide can be developedstrength can be formed after from a high-temperature treatment applied in order to obtain a carbonate-free metal oxide surface (Yacob *et al.*, 2014). In this research, zZinc oxide (,ZnO), which is inexpensive,cheap, re-usablereusable and stable, was used as a based catalyst for in this work. Besides, ZnO has been commonlyis generally used as for catalyst support and, when and it has been established that impregnatedion with alkaline metals,

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ZnO is considered to begives a good suitable basic and solid catalyst for the transesterification of vegetable oils (Alba-Rubio *et al.*, 2010). According to Dantas et al., (2017), the spinel-type of heterogeneous catalysts offergave more advantages because ofdue to their great cationic mobility. It This is attributedThis was due t to thetheir original crystalline structure, that which could make it easier to substituwhich might facilitate substitutioten of chemical elements with other elements of same structure in terms of electronegativity, valence and radius size, with other elements of the same structure.

As compared to other metals, thereforeThus, the doping with Cu significantly strengtheneds the properties of catalytic processes, provided significantly in contrast with to other metals improvement of properties in the catalytic processes. Ni catalysts, for example, were efficient in catalytic processes due to the high abundance of Ni, but Ni was found to have low corrosion resistance due to the acidity of bio-oil, which could potentially affect its activity and stability during the processFor example, Ni catalysts were efficient in catalytic processes due to the great abundance of Ni, however, it was found that Ni exhibited low corrosion resistance due to the acidity of the bio-oil, and this might affect its activity and stability during the process (Ambursa et al., 2016). The combination mixture of Cu and Zn was used to achieve high versatility in the properties of these materials. The catalytic activity of the binary catalyst, Cu/ZnO, has been reported to be several orders of magnitude greater than that of either metallic Cu or pure ZnO, thus thus indicatingsuggesting a synergetic interaction between of thethe two components (Kasatkin et al., 2007). A Strong strong interaction between the metal and the support has been known to caused a strain in the metal particles, which attributed to the improved overall catalytic performance. On the other hand, the addition of copper dopant into a single metal oxide canould increase the surface basic properties. It has been reported that supporting the metal oxides on high surface area materials, γ-Al_2O_3 is a promising approach to increase the stability of the resultant catalysts for supporting the metal oxides on high surface area materials. The high surface area of the supportinged material was is crucial for the dispersion of the catalytically active metal, and improvedbetter catalyst recovery after the reaction (Sulaiman *et al.*, 2017).

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