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Eco-Conversion of Castor Oil to Trimethylolpropane Ester using Non-And Impregnated Chicken Egg Shells (N-ICES)

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EXTENDED ABSTRACT

Castor oil as non-edible vegetable feedstock has high viscosity, which is found and distributed widely around the earth, has been becoming interesting issues for its conversion to trimethylpropane (TMP)-ester. The eco-conversion of castor oil was conducted in a bath stirrer flask via two-steps catalytic transesterification. Reactions of castor oil methyl ester (COME) and trimethylolpropane (TMP) were run under non- and impregnated eggshell (N-ICES) catalysts. Effects of catalyst loading, ratio of COME and TMP, reaction time and temperature were also observed. The highest TMP-ester conversion (98.90%) with triester composition (71.4%) was found by the COME and TMP ratio of 1:4, time of 3 h, temperature of 110°*C and catalyst loading of 3 wt/wt%. Physico-chemical properties of resulted TMP-ester, mainly density of 924.70 kg/m*^{3} *and kinematic viscosity at 40°C of 65.77 mm*^{2}*/s are commensurable with another renewable sources, catalysts and proposed lubricant standards. The impregnated* chicken egg shell confers marvellous results compared non-impregnated shells performance, and the recyclable boths catalysts can be visualized for destiny lucrative engine oil.

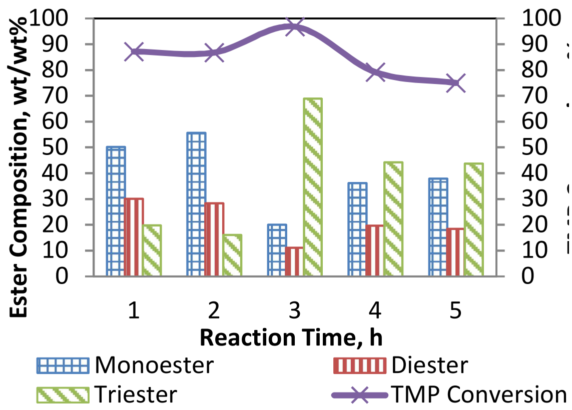

Fig. 1: Reaction time vs TMP-ester.

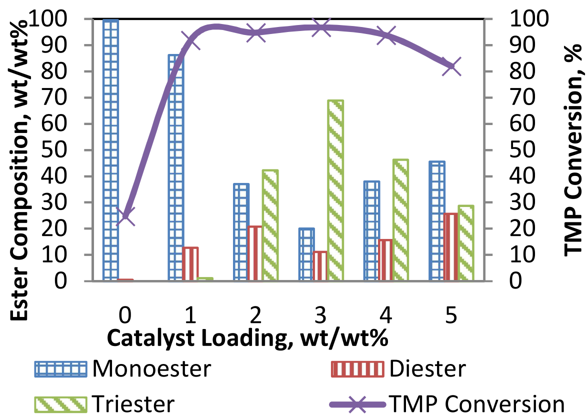

Fig. 2: Catalyst loading vs TMP-ester.

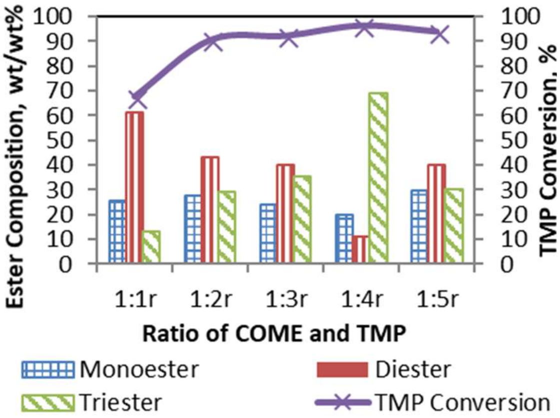

Fig. 3: COME and TMP ratio vs TMP-ester.

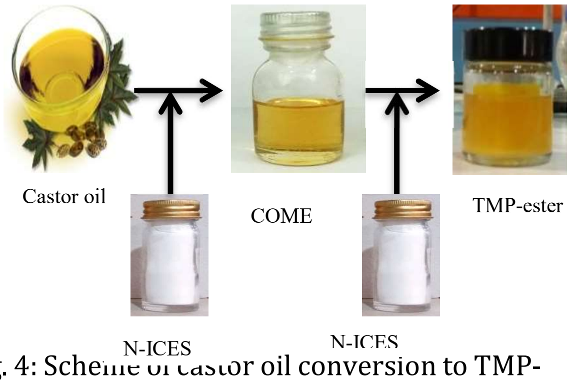

Fig. 4: Scheme of castor oil conversion to TMP-ester.

Trimethylpropane (TMP)-ester is a substance that is applied between two surfaces in motion to reduce the mechanical friction, ease heat transfer, liquid sealing and provide protection against corrosion. There are two major types TMP-ester according to their sources, namely mineral oil lubricants originating from crude oil sources and also the bio-lubricant [1]-[3]. Around 9 million metric tons per year of industrial and automotive lubricant market exists [4]. The crude oil compromises of 97.6% of the fossil fuel energy consumption in the transportation sector and over 60% of this lubricants are lost to the earth [5]. The industrial engine oil especially in food processing and water management industries are discouraged due to the increasing concerns over the discharge and accumulation of the lubricants in the aquatic and terrestrial ecosystem which resulted in serious hazards to health and environment [6]. Utilization of castor oil as non-edible vegetable feedstock has high viscosity, which is found and distributed widely around the earth, has been becoming interesting issues for its conversion to trimethylpropane (TMP)-ester. Only castor oil has a great oxidative stability compared to other vegetable oils which requires additives in order to increase their stability. Character of castor oil posseses low pour point and high viscosity. The viscosity index of castor oil is lowerer than other vegetable oils [7], [8]. Transesterification of non-edibles vegetable oils for TMP-ester in water base mud has been proved to have performance potentials due to inherent properties [9]. Next, a great challenge to find heterogeneous base catalyst for transesterification process under mild reaction conditions in shorter reaction time. Alkaline earth metal oxides with high basicity especially calcium oxide is one of the most promising heterogeneous base catalysts for methyl ester production [10]. Commonly, most of the eggshell wastes end in the landfill without any pre-treatment because it was traditionally useless. Recently, efforts have been done to develop eggshells as a possible bone substitute, starting material for preparing calcium phosphate bio-ceramics and low cost adsorbent for removal of ionic pollutant from the aqueous solution. The development of eggshell into active heterogeneous catalyst is possible due to its intrinsic pore structure in the calcined eggshells, high content of pure $CaCO_3$ and the abundance availability. Besides that, reuse of eggshells as catalysts is also looks promising as it is able to recycle, minimize the contaminants, and reducing the cost of production. Mainly chemical composition of eggshells were calcium carbonate, it could be converted to calcium oxide. This calcium oxide can be reused, high activity and low cost [11]. Furthermore, a lot of TMP-ester synthesis have been being done, but a lack of reports about the castor oil conversion using modified solid catalysts. Thus, this work aims to use non-and impregnated egsshell for conversion of treated castor oil to TMP-ester. The eco-conversion of castor oil was processed in a bath stirrer flask via two-steps catalytic transesterification. Reactions of castor oil methyl ester (COME) and trimethylolpropane (TMP) were examined under non- and impregnated eggshell (N-ICES) catalysts. Effects of catalyst loading, ratio of COME and TMP, reaction time and temperature were also observed. The scheme, converted castor oil to TMP-ester, process parameter effects can be shown in the Fig. 1, 2, 3 and 4.

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