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Research Article

Electro-Catalysis System for Biodiesel Synthesis from Palm Oil over Dielectric-Barrier Discharge Plasma Reactor

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Abstract

Biodiesel synthesis reaction routes from palm oil using plasma electro-catalysis process over Dielectric-Barrier Discharge (DBD) plasma reactor were studied. The study was focused on finding possible reaction mechanism route during plasma electro-catalysis process. The prediction was performed based on the changes of Gas Chromatography Mass Spectrometer (GC-MS) and Fourier Transform Infra Red (FT-IR) analyses to the biodiesel products with respect to time length of plasma treatment. It was found that main reaction mechanism occurred in the plasma electro-catalysis system was non-thermal pyrolysis rather than transesterification. The main reactions within the plasma treatment were due to collision between high energetic electrons (supplied from high voltage power supply through high voltage electrode) and the reaction mixtures. The high energetic electrons affected the electrons pair of covalent bonding to be excited or dissociated even ionized at higher energy. Therefore, this plasma electro-catalysis system was promising for biodiesel synthesis from vegetable oils due to only very short time reaction was needed, even no need a catalyst, no soap formation, and no glycerol by-product. This system could produce fatty acid methyl ester yield of 75.65% at 120 seconds and other possible chemicals, such as alkynes, alkanes, esters, carboxylic acid, and aldehydes. However, during the plasma process, the reaction mechanisms were still difficult to be controlled due the action of available high energetic electrons. The advanced studies on how to control the reaction mechanism selectively in the plasma electro-catalysis will be published elsewhere.

Keywords: plasma reactor; electro-catalysis; biodiesel; transesterification; cracking; energetic electrons

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1. Introduction

Recent worldwide energy policies and increased environmental concerns are driving industry to come up with an alternative fuels, such as biodiesel. Biodiesel is an alternative fuel consisting of fatty acid methyl esters (FAME) produced by transesterification of triglycerides, the main constituent of various kinds of vegetable oil. This renewable fuel can be used in any compression ignition engine without major modifications. Biodiesel fuel is defined as the alkyl esters of long chain fatty acids, which fulfills certain standards. The biodiesel chemical is obtained by the transesterification or alcoholysis of natural tri-acylglycerols or triglyceride with short-chain alcohols, usually methanol or ethanol. The

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