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Biodiesel Production from Macro Algae as a Green Fuel for Diesel Engine

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ABSTRACT

Plant oils or triglycerides are converted through the transesterification reaction with methanol and base catalyst to produce fatty acid methyl esters (FAME) or Biodiesel. Production of biodiesel from plant oil is a renewable, sustainable and alternative of petroleum based fuel. Algae oil from macroalgae has the potential to become a sustainable fuel source as biodiesel. Macroalgae are produced through photosynthesis by utilizing sunlight, carbon dioxide, water and other nutrients. The lipid contents or oil in algae, once extracted and purified, represent an excellent sustainable feedstock for biodiesel production. Three different species of macroalgae (*Spirogyra, Cladophora and Gracilaria*) were used for algal oil extraction in this study. The algal oil was extracted by physical and chemical extraction method. The transesterification reaction of algal oil with methanol and base catalyst was used for the production of biodiesel. In engine performance test, the algal biodiesel blends showed slight increase in specific fuel consumption but biodiesel blends showed higher brake power. The emission of carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxides (NO_x) reduced as biodiesel blend percentage increased over engine speed range.

1. INTRODUCTION

On the gradual reducing of fossil fuels, it is now more vital than ever to explore for fuels that can be used as alternatives to crude oil-based fuels such as gasoline and diesel fuel. The conversion of oils into chemicals is identified as long chain mono alkyl esters, or biodiesel. Biodiesel can be formed from a variety of fats and agricultural commodities which consist of oilseeds such as canola and soybeans, rendered animal fats, used restaurant cooking oil, and palm oil. It can also be made from biomass such as from algae blooms. Biodiesel can be utilized in internal combustion diesel engine in its pure form or in any concentration with conventional diesel. The use of its pure form (B100) may necessitate certain engine modifications to avoid maintenance and performance problems. However, it is most frequently found mixed at a ratio of 20% biodiesel to 80% normal diesel [1]. The use of biodiesel in a conventional diesel engine results in significant reduction of unburned hydrocarbons, carbon monoxide and particulate matter. Biodiesel has no sulfur or aromatics. In addition, biodiesel is non-toxic, readily biodegradable and increase lubricity of diesel fuels. This means biodiesel is compatible with the next generation of diesel engine pollution reduction appliances.

The recent investigation of the use of alternative, non-food related feedstock such as oil from algae is becoming popular. Algae have the capability to convert carbon dioxide to biomass that can further be processed downstream to produce biodiesel, fertilizer and other useful products [2]. The truth that algae grow in aqueous suspensions enables algae for more efficient access to water, carbon dioxide and other nutrients. This enables the potential for the making of more oil per unit area than other crops presently used [3]. Biodiesel manufacturers can decide to efficiently take care of wastewater while at the same time produce biodiesel. The chemical composition of algae differs based on species. Thus, algae have several characteristics that enable them to be a feasible biodiesel feedstock that deserves further research. Macroalgae are large multicellular plants that are similar to vascular plants but lack the complex array of tissues used for reproduction [4]. Macroalgae usually grow and attach to solid substrates such as coral skeletons, shells and rocks. They can be divided into three groupings: green algae- Division *Chlorophyta*, brown algae – Division *Phaeophyta* and red algae – Division *Rhodophyta*. Microalgae have high oil content but are hard to be cultivated and harvested in a cost-efficient way. On the other hand, macroalgae provide low-cost cultivation and harvesting potential [5].

Biodiesel, a nonpetroleum-based fuel defined as mono-alkyl esters of long chain fatty acid derived from vegetable oils or animal fats with alcohols of lower molecular weights

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