Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 142 (2017) 413–418

Energy Procedia

www.elsevier.com/locate/procedia

9th International Conference on Applied Energy, ICAE2017, 21-24 August 2017, Cardiff, UK

Effect of Non-Edible Biodiesel Physical and Chemical Properties as Microturbine Fuel

E.S. Tan[a]*, Kumaran P. [a], T.M. Indra[a], K.Yoshikawa[b]

[a]*Universiti Tenaga Nasional, Jalan Ikram-Uniten, 43000, Malaysia*
[b]*Tokyo Institute of Technology, Japan*

Abstract

The world is facing critical energy concern, in view of depleting fossil fuel reserves and increasing environment pollution. Biodiesel can potentially substitute fossil fuel, and is produced through the transesterification of vegetable oils. This paper will emphasize on the transition from first generation derived from waste cooking oil, to second generation biodiesel derived from calophyllum inophyllum, which is a non-edible plant. The objective of this paper is to optimize the performance of biodiesel blends with diesel in a 30 kW microturbine. The characterization of chemical fuel properties of distillate and biodiesel blends will be conducted to determine if it meets international standards for power generation. Temperature profiles, pressure, and flame imaging will be closely monitored to detect possible problems in operability of the combustor caused by the differences in fuel characteristics. The findings may provide useful information towards optimization of microturbine performance, considering the wide range of biodiesel feedstock that exist. The paper outcome will show the potential of non-edible biodiesel blends to be used as alternative fuel in microturbines for power generation.

Peer-review under responsibility of the scientific committee of the 9th International Conference on Applied Energy.

Keywords: "Biodiesel, Microturbine, physicochemical, Calophyllum Inophyllum"

1. Introduction

The dependence on fossil fuel for energy has caused major effects of global warming, particularly due to the greenhouse gas emission from power producing plants, which is a major source of fossil fuel consumption. There is a need to find a renewable and sustainable energy. Among many renewable energy sources, biodiesel is regarded as the most promising fuel because of its sustainability and availability of raw materials worldwide. However, the current biodiesel produced from edible plants, have become a controversial problem, where the food

Peer-review under responsibility of the scientific committee of the 9th International Conference on Applied Energy.
10.1016/j.egypro.2017.12.065

chain is compromised. Therefore, research is focused on the non-edible plants, particularly calophyllum inophyllum which is known to have a high yield. There is potential for biodiesel derived from the inedible plant of calophyllum inophyllum to be blended with diesel and used in power generation, particularly for microturbine. This application of biodiesel is a new research area that have not been previously explored. Biodiesel is derived from renewable sources such as plants; therefore the emission from the combustion of biodiesel blends will be able to produce less greenhouse gas emissions, particularly CO_2 gas. The combustion efficiency of the microturbine could be increased, as both these fuels are oxygenated fuels, in which they are able to aid the completion of combustion in the microturbine system [1]. Blending biodiesel and diesel could widen their field of applications as an alternative green fuel. A blend could allow for mixtures to be created with improved properties to enable matching of the blend to the requirements of the application, such as desired viscosity of a target minimum heating value [2]. The main advantages of these liquid biofuels when compared to raw (solid) biomass are its higher energy density and availability on demand, which makes it easier for storage and transportation.

Microturbine systems have many claimed advantages over traditional reciprocating engine generators, such as higher power-to-weight ratio, low emissions, and less moving parts. There is a need to undertake studies on the technical feasibility of calophyllum inophyllum biodiesel blends for microturbine power generation. Various fuel samples will be tested experimentally in a 30 kW microturbine to study the combustion characteristics such as temperature profiles, efficiency and emissions.

Nomenclature

ASTM	American Society of Testing Methods
HI	heat input
LHV	lower heating value
SH	sensible heat
W	work

2. Research Methodology

There is potential for biodiesel to be blended and used in power generation, particularly for microturbine. In order to mitigate these problems, creating blends of biodiesel with diesel could be a viable short-term alternative to utilize an important fraction of these fuels in microturbine. Biodiesel is a renewable fuel derived from vegetable oils and animal fats through a process called transesterification. However, biodiesel produced from edible oils raised concerns of feedstock competing with food supply, therefore, non-edible oils such as calophyllum innophyllum becomes a possible source. Blending biodiesel with diesel could widen their field of applications as an alternative green fuel. A blend could allow for mixtures to be created with improved properties to enable matching of the blend to the requirements of the application, such as desired viscosity of a target minimum heating value. The main advantages of these liquid biofuels when compared to raw (solid) biomass are its higher energy density and availability on demand, which makes it easier for storage and transportation. Although the most successful use of liquid biofuels has been proven in the transport sector, recently there has also been a growing interest in the industrial sector.

A potential market for this type of fuels is related to microturbine, which are becoming more popular due to characteristics such as small size, fuel flexibility, low maintenance costs and low emissions. Figure 1 shows the microturbine schematic diagram. A pump is placed on the fuel tank to channel the fuel into the combustion chamber. There is a mass flow meter attached to the fuel tanks to obtain data for the mass flow rate. The real-time data are available for the fuel flow, the combustion efficiency, the temperatures, the pressures, the high heating value or the calorific value, the combustion efficiency, the generated power output, the speed and the torque. These parameters are logged in via the data acquisition system. Microturbines are compact electricity generators with rated capacities in the 25–300 kW range and have become widespread in distributed power and combined heat and power (CHP) applications. Microturbine systems have many claimed advantages over traditional reciprocating engine generators, such as higher power-to-weight ratio, low emissions, and less moving parts. Research have shown that thermal efficiency and the combustion efficiency showed the peak values at 20% biodiesel blend with distillate, despite biodiesel having lower calorific value and higher fuel consumption [3]. Meanwhile, other researchers have reported