Chemical Engineering Journal 220 (2013) 395–401

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

The potential of using cocoa pod husks as green solid base catalysts for the transesterification of soybean oil into biodiesel: Effects of biodiesel on engine performance

Cynthia Ofori-Boateng *, Keat Teong Lee

Lignocellulosic Research Group, School of Chemical Engineering, Universiti Sains Malaysia, 14300 Nibong Tebal, Pulau Pinang, Malaysia

HIGHLIGHTS

- A green heterogeneous base catalyst was prepared from cocoa pod husks (CPHs).
- Transesterified soybean oil with CPH potash catalyst gave 91.4% biodiesel yield.
- Transesterified soybean oil with CPH/MgO catalyst gave 98.7% biodiesel yield.
- Engine performance test showed that B40 had close characteristics of petro-diesel.

ARTICLE INFO

Article history:
Received 23 October 2012
Received in revised form 5 January 2013
Accepted 8 January 2013
Available online 4 February 2013

Keywords:
Potash
Biodiesel
Heterogeneous catalyst
Cocoa pod husk
Engine performance

ABSTRACT

In this study, the feasibility of using potash from cocoa pod husks (CPHs) in the transesterification of soybean oil into biodiesel was investigated. Both supported (CPH/MgO) and unsupported (CPH ash) catalysts of potash prepared from CPH were used as green heterogeneous catalysts for biodiesel production. Under optimum conditions for the CPH/MgO-catalyzed (oil/methanol ratio of 1:6, 60 °C, 60 min, 1 wt.% of MgO doped CPH ash catalyst) and the CPH-catalyzed (60 °C, oil/methanol ratio of 1:6, 120 min, 1 wt.% of CPH ash) transesterification reactions, biodiesel samples (98.7% and 91.4% yields for CPH/MgO and CPH ash catalysts respectively) with specifications falling within the limits of the European biodiesel quality standard (EN 14112) were obtained. Brake thermal efficiencies and torque were measured for each fuel sample at different loads. Engine test showed a better performance for all the fuel samples (B100 and B40) with B40 showing close characteristics of petroleum diesel. Thus, this first report on the utilization of CPH as catalyst for biodiesel shows a high feasibility of producing green heterogeneous base catalysts commercially from CPH for sustainable biodiesel production.

1. Introduction

Though biomass from agricultural wastes is highly convertible to value-added bio-products such as biofuels, and bio-chemicals, they are not appropriately utilized hence creating many environmental problems. Cocoa pod husks (CPHs) being major sources of potash, are a group of agricultural wastes in Ghana and most parts of the world where cocoa are produced. Potash from inorganic or mineral sources has been used as catalysts for biodiesel production and has proven to possess a high catalytic activity [1,2]. A carbonate content of 40–60% in the ashed cocoa pod husks and 3–9% in the dried pod husks have been reported [3–5]. This study investigates into the utilization of CPH ash for heterogeneous base catalyst for soybean oil transesterification. For the sake of comparison, the potash produced from CPH ash is loaded on magnesium oxide (CPH/MgO) and used as an alternative catalyst for the transesterification reaction.

Biodiesel is produced by the transesterification reaction of large branched triglycerides into smaller straight chain molecules of methyl esters, using an alkali or an acid as a catalyst. It has been estimated that the costs of catalyst and oil for biodiesel production form about 75% of the total biodiesel production cost [6]. This is because the catalysts are obtained from inorganic sources whose production processes are energy intensive. Thus, for sustainable biodiesel production, there is the need to opt for a cheap yet efficient and environmentally friendly source of catalyst. The technology for potash production from CPH on commercial basis is found to be cheaper compared to the conventional method [5].

Notwithstanding the current debate on the use of homogenous alkaline catalysts (e.g. NaOH, KOH and other similar alkoxides) for biodiesel production, almost all the industries involved in biodiesel

* Corresponding author. Tel.: +60 164302025.
E-mail address: cyndykote@yahoo.com (C. Ofori-Boateng).

1385-8947/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.cej.2013.01.046