Bioresource Technology 120 (2012) 6–12

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Biofuel production from crude palm oil with supercritical alcohols: Comparative LCA studies

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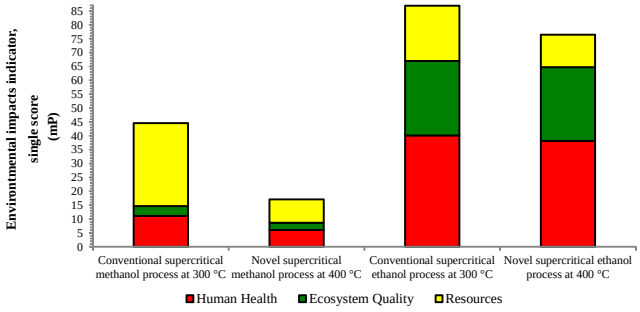
HIGHLIGHTS

- The novel process generates the lowest environmental impacts.
- The heavy environmental load in all cases comes mainly from the steam generation.
- The amount of alcohol plays an important role in energy consumption in all processes.
- The use of ethanol creates a higher environmental load than that with methanol.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 5 April 2012
Received in revised form 7 June 2012
Accepted 9 June 2012
Available online 16 June 2012

Keywords:
Biofuel
Biodiesel
Life cycle assessment
Supercritical alcohol
Vegetable oil

ABSTRACT

A recent life cycle assessment (LCA) reported that biodiesel production in supercritical alcohols (SCA) produces a higher environmental load than the homogeneous catalytic process because an enormous amount of energy is required to recover excess alcohol. However, the excess alcohol could be dramatically reduced by increasing the operating temperature to 400 °C; although the product would have to be considered as an alternative biofuel instead of biodiesel. A comparative LCA of the biodiesel production in two SCA at 300 °C (C-SCA) and novel biofuel production in the same two SCA at 400 °C (N-SCA) is presented. It was clear that the N-SCA process produces a dramatically reduced environmental load over that of the C-SCA process due to a lower amount of excess alcohol being used. The N-SCA process could be improved in terms of its environmental impact by changing from fossil fuel to biomass-based fuels for the steam generation.

1. Introduction

The concept of biofuels has been promoted worldwide due to the depletion of the non-renewable petroleum resources and the global warming problem. With respect to these two problems, the feasibility of biofuel production has been challenged in view of its associated environmental impact (Arvidsson et al., 2011; Cherubini and Stromman, 2011; Kim and Dale, 2005; Singh and Olsen, 2011; Sobrino et al., 2011). Biodiesel, principally produced from methanol as fatty acid methyl esters (FAME) or ethanol as fatty acid ethyl esters (FAEE), is the one of the biofuels that is produced from domestic oil-based biomasses. Nevertheless, the conventional biodiesel production process using homogeneous acidic and/or basic catalysts has some drawbacks, especially from the point of view of its lack of environmentally friendliness (Basha et al., 2009; Ma and Hanna, 1999; Meher et al., 2006). Novel biodiesel production processes have been developed in order to disentangle those systematic and environmental drawbacks of the conventional homogeneous catalytic process (Andrade et al., 2011; Refaat, 2010). For example, heterogeneous and enzymatic catalysts have been introduced to solve the problems of product separation and feedstock contamination,

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http://dx.doi.org/10.1016/j.biortech.2012.06.014