Cairo University

BIODIESEL PRODUCTION FROM WASTE FRYING OIL AND WSTEWATER SEWAGE SLUDGE

By

Jemmy Carter Fouad Atta

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
Civil Engineering - Public Works

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TITLE OF THESIS:

BIODIESEL PRODUCTION FROM WASTE FRYING OIL AND WSTEWATER SEWAGE SLUDGE

Key Words: Fossil, Biodiesel, Transesterification, sunflower, Jatropha.

Summary:
The global continuous growth of energy demand poses urgent problem due to the fossil fuels depletion. Energy demand has led the world to discover new secure energy sources that are renewable, environment-friendly, affordable and above all sustainable. Biodiesel is a well known alternative fuel due to its different advantage resides. Transesterification of edible oil such as sunflower oil, non-edible oil as Jatropha oil, home waste cooking oil and chipcy cooking oil were carried out. The maximum bio-diesel obtained yields (g/g) of 97.23% ,96.54%, 95.37% and 96.38 % were achieved from sunflower oil , Jatropha oil, home waste cooking oil and chipcy cooking .

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Table of Content Page

List of Tables Page

List of Figures

Abstract

The global continuous growth of energy demand poses urgent problem due to the fossil fuels depletion, as they currently represent about 75% of all energy consumed worldwide. Energy demand has led the world to discover new secure energy sources that are renewable, environment-friendly, affordable and above all sustainable. From the point of view of protecting the global environment and concerns for long term energy security, it is necessary to develop alternative fuels with properties comparable to petroleum based fuels. Bio-diesel is a well known alternative fuel; its advantage resides in its ease of usage and integration with present engine models. The replacement of petroleum–derived diesel with bio-diesel reduces the green house gas emissions up to 40%. Bio-diesel is methyl or ethyl esters of fatty acid made from virgin oil, used vegetable oil and animal fat by transesterification reaction of triglycerides with methanol or ethanol in the presence of a catalyst. At present, the high cost of bio-diesel is the major obstacle for its commercialization. Approximately 75-80% of the total cost of bio-diesel production is attributed to raw feedstocks.

Transesterification of edible oil such as sunflower oil, non-edible oil as Jatropha oil, home waste cooking oil and chipcy cooking oil were carried out using two- steps process , Since vegetables oil contains high FFA, when a base homogeneous catalyst is used, FFA react with the catalyst to produce emulsified soap which inhibits bio-diesel production. If an acid catalyst is applied, despite the saponification phenomenon is avoided, the acid has a less catalytic effect on the transesterification. It is very slow and needs a very high methanol to oil molar ratio. Therefore, a two-step process, esterification pre-treatment using an acid catalyst to remove FFA followed by base transesterification, was employed for the production of bio-diesel from vegetables oil.

The maximum bio-diesel obtained yields (g/g) of 97.23% ,96.54%, 95.37% and 96.38 % were achieved from sunflower oil , Jatropha oil, home waste cooking oil and chipcy cooking oil respectively .

One of the contending candidates is the wastewater sewage sludge due to its numerous advantages over others bio-diesel obtained by different production processes , It was found the maximum bio-diesel yield from primary and secondary sludge were 11.82 % and 2.82 % respectively, under the optimum production conditions. Furthermore, in-situ transesterification or direct transesterification eliminates the extraction step which could lead to a reduction in overall production cost of bio-diesel.

During the two-step process, the esterification and transesterification parameters were optimized to achieve high conversion of feedstock into bio-diesel . The produced bio-diesel was characterized and the conversion was calculated by GC , Fatty acids composition of sludge was compared with common bio-diesel feedstock such as vegetable oil (sunflower-jatropha) and waste cooking oil (home -chipcy factory). From that it is observed that majority of fatty acids in sludge are same as fatty acids of vegetable oil and waste cooking oil such as palmitic acid, oleic acid, linoleic acid.

The fuel properties of obtained bio-diesel were examined as per national and international standards such as the American Standard Test Methods (ASTM D-65716) specifications and European Union , DIN EN (14214) , to assess potential of bio-diesel as an alternative fuel.

Hence the different production methods , acid-base transesterification and in-situ transesterification were found to be very efficient to produce bio-diesel from the different organic feedstock Thus, wastewater sewage sludge serve as a potential renewable raw-material for bio-diesel production.