Applied Energy 92 (2012) 109–132

Contents lists available at SciVerse ScienceDirect

Applied Energy

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

A review analyzing the industrial biodiesel production practice starting from vegetable oil refining

Giulio Santori [a,*], Giovanni Di Nicola [b], Matteo Moglie [b], Fabio Polonara [b]

[a] Università degli Studi e-Campus, via Isimbardi 10, 22060 Novedrate, Como, Italy
[b] Università Politecnica delle Marche, Dipartimento di Energetica, via Brecce Bianche, Polo Montedago, 60131 Ancona, Italy

ARTICLE INFO

Article history:
Received 29 June 2011
Received in revised form 4 October 2011
Accepted 16 October 2011
Available online 27 November 2011

Keywords:
Biodiesel
Production process
Industrial practice
Vegetable oil refining
Biodiesel refining
Transesterification

ABSTRACT

One of the most promising renewable fuels proposed as an alternative to fossil diesel is biodiesel. The competitive potential of biodiesel is limited by the price of vegetable oils, which strongly influences the final price of this biofuel. On the other hand, extensive use of vegetable oils may cause other significant problems such as starvation in developing countries. Appropriately planning and designing the whole production process, from the seed to the biodiesel end-product, is essential to contain the influence of energy inefficiencies on the high price of the end-product. The present study reviews the technologies currently used in the production of biodiesel. We first discuss the technologies for extracting the vegetable oil from the seed, and its subsequent refining and conversion into biodiesel. This study focuses on the characteristics of the production processes currently used in the sector, illustrating the technological options and emphasizing the drawbacks of certain practices and the best choices available. The vegetable oils tend to be processed using procedures that are well established, but oriented more towards obtaining products suitable for the foodstuffs industry, and that consequently use technologies that are sometimes excessive for energetic purposes. The processes for extracting the vegetable oil from the seed generally include a set of steps, the complexity of which depends on the raw material. Basically, the two extraction technologies involved rely on the use of pressure or solvents. In practice, the two systems are often combined. Using the vegetable oils as a source of energy makes some of these steps superfluous and enables technologies to be used that would be unsuitable for foodstuffs production. This study focuses on feasible technological improvements that would give rise to oil that is still suitable for use as a source of energy, but at a lower cost. The refined vegetable oil can subsequently be converted into biodiesel by means of a great variety of technologies, many of which are still not suitable for applications on an industrial scale. The solution that has met with the greatest favor is homogeneous alkaline transesterification with KOH and methanol. Even when dealing with this type of conversion alone, it is impossible to establish a universal schema to describe the conversion or purification stages because there are numerous possible different solutions. When we then look more closely at the state of the art in industrial biodiesel production plants, we encounter the potential problems introduced by the type and characteristics of the original raw material. Comparing some of the reference solutions that have inspired numerous installations, a sensitivity analysis is conducted on the main elements involved in the process, focusing on their behavior in different working conditions to obtain products with the characteristics required by the international standards (EN 14214:2008, ASTM D 6751 07b).

© 2011 Elsevier Ltd. All rights reserved.

Contents

* Corresponding author. Tel.: +39 071 2204636; fax: +39 071 2204770.
E-mail addresses: giulio.santori@uniecampus.it (G. Santori), g.dinicola@univpm.it (G. Di Nicola), m.moglie@univpm.it (M. Moglie), f.polonara@univpm.it (F. Polonara).

0306-2619/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.apenergy.2011.10.031

1. Introduction

Crude oil is a non-renewable resource that will eventually run out. In the meantime, the steady increase in its consumption, the depletion of the reserves and the uncertain political situation in some oil-producing countries are leading to a rapid increase in the cost of crude oil.

Alternatives to oil are renewable energy sources and, among these, vegetable oils and their energy derivatives [1,2] and biodiesel, in particular are regarded as the most promising. Biodiesel has the advantage of not being responsible for any emission of CO_2 connected with its use. As a matter of fact, the CO_2 released into the atmosphere by biofuel combustion is the same CO_2 that was absorbed by photosynthesis by the growing plant. In addition, the CO emissions are more limited than from fossil diesel, while a slightly higher level of NO_x emissions can be expected [3].

However renewable fuels cannot replace fossil fuels for the time being, they can only contribute to reduce the latter's consumption [4]. Even if all the animal and vegetable fats currently available on the market were to be converted into biofuel, this would still only cover a limited part of the demand for fuel [5].

Moreover, the chances of the price of biodiesel being able to compete with fossil diesel are limited by the price of vegetable oil, which accounts for about 80% [6–8] of the final price of the biofuel.

Although day-to-day variations in the commodities market can naturally change these considerations, Fig. 1 shows that the price of crude oil is still lower than that of refined vegetable oil [9–11] primarily due to the link between crude petroleum oil, vegetable oil refining process and speculation [12]. Actually the cost-effectiveness of using biodiesel relies entirely on its exemption from taxation [13]. An even more pressing problem, however, concerns the debate on the morality of using fertile land to grow biomass for conversion into energy instead of food crops, while so many people around the world go hungry [14].

Most of the vegetable oil currently used as biodiesel feedstock could also be used as edible oil, and this introduces a new variable in the food commodities market (which is already under strain), preventing any proper control over the prices of basic commodities intended for human nutrition. The most likely way to escape this dangerous contradiction is to completely separate the agro-energy business from the agro-food business [15,16]. This can feasibly be

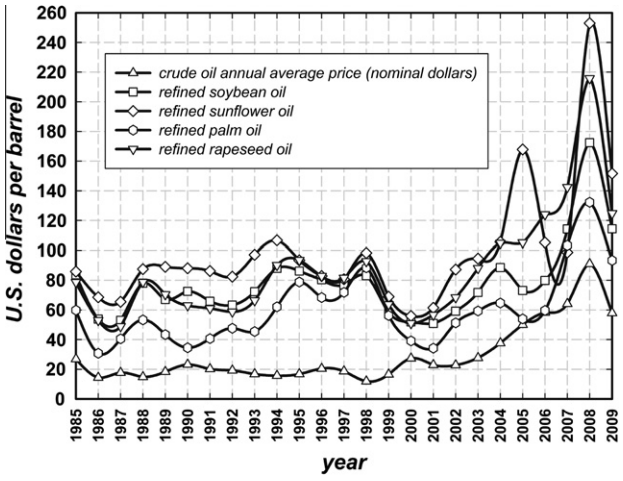

Fig. 1. Prices of some refined vegetable oil varieties.

Download English Version:

https://daneshyari.com/en/article/243587

Download Persian Version:

https://daneshyari.com/article/243587

Daneshyari.com