ELSEVIER

Fuel Processing Technology 86 (2005) 1097–1107

FUEL PROCESSING TECHNOLOGY

www.elsevier.com/locate/fuproc

Biodiesel processing and production

Jon Van Gerpen*

University of Idaho, Moscow, ID 83844, USA

Abstract

Biodiesel is an alternative diesel fuel that is produced from vegetable oils and animal fats. It consists of the monoalkyl esters formed by a catalyzed reaction of the triglycerides in the oil or fat with a simple monohydric alcohol. The reaction conditions generally involve a trade-off between reaction time and temperature as reaction completeness is the most critical fuel quality parameter. Much of the process complexity originates from contaminants in the feedstock, such as water and free fatty acids, or impurities in the final product, such as methanol, free glycerol, and soap. Processes have been developed to produce biodiesel from high free fatty acid feedstocks, such as recycled restaurant grease, animal fats, and soapstock.

Keyword: Biodiesel

1. Introduction

Biodiesel is an alternative fuel for diesel engines that is produced by chemically reacting a vegetable oil or animal fat with an alcohol such as methanol. The reaction requires a catalyst, usually a strong base, such as sodium or potassium hydroxide, and produces new chemical compounds called methyl esters. It is these esters that have come to be known as *biodiesel*.

* Tel.: +1 208 885 7891; fax: +1 208 885 7908.
E-mail address: jonvg@uidaho.edu.

0378-3820/$ - see front matter © 2004 Elsevier B.V. All rights reserved.
doi:10.1016/j.fuproc.2004.11.005

Because its primary feedstock is a vegetable oil or animal fat, biodiesel is generally considered to be renewable. Since the carbon in the oil or fat originated mostly from carbon dioxide in the air, biodiesel is considered to contribute much less to global warming than fossil fuels. Diesel engines operated on biodiesel have lower emissions of carbon monoxide, unburned hydrocarbons, particulate matter, and air toxics than when operated on petroleum-based diesel fuel.

The objective of this paper is to describe the processing and production of biodiesel. The emphasis will be on processing as it is conducted in the United States, where most biodiesel is produced by reacting soybean oil or used cooking oils with methanol.

2. Background

At current production levels, biodiesel requires a subsidy to compete directly with petroleum-based fuels. However, federal and state governments are providing incentives that encourage the rapid growth of the biodiesel industry. Current production levels are 20–25 million gallons/year, but achieving current European levels of 500 million to 1 billion gallons/year should be feasible.

The combined vegetable oil and animal fat production in the United States totals about 35.3 billion pounds per year [1]. This production could provide 4.6 billion gallons of biodiesel. However, the annual consumption of on-highway diesel fuel in the United States is about 33 billion gallons. If all of the vegetable oil and animal fat produced in the U.S. were available to produce biodiesel, it would only displace about 14% of the current demand for on-highway diesel fuel.

Although biodiesel cannot entirely replace petroleum-based diesel fuel, there are at least five reasons that justify its development.

1. It provides a market for excess production of vegetable oils and animal fats.
2. It decreases, although will not eliminate, the country's dependence on imported petroleum.
3. Biodiesel is renewable and does not contribute to global warming due to its closed carbon cycle. A life cycle analysis of biodiesel showed that overall CO_2 emissions were reduced by 78% compared with petroleum-based diesel fuel [2].
4. The exhaust emissions of carbon monoxide, unburned hydrocarbons, and particulate emissions from biodiesel are lower than with regular diesel fuel. Unfortunately, most emissions tests have shown a slight increase in oxides of nitrogen (NOx).
5. When added to regular diesel fuel in an amount equal to 1–2%, it can convert fuel with poor lubricating properties, such as modern ultra-low-sulfur diesel fuel, into an acceptable fuel.