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A comprehensive review on biodiesel as an alternative energy resource and its characteristics

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ABSTRACT

As the fossil fuels are depleting day by day, there is a need to find out an alternative fuel to fulfill the energy demand of the world. Biodiesel is one of the best available resources that have come to the forefront recently. In this paper, a detailed review has been conducted to highlight different related aspects to biodiesel industry. These aspects include, biodiesel feedstocks, extraction and production methods, properties and qualities of biodiesel, problems and potential solutions of using vegetable oil, advantages and disadvantages of biodiesel, the economical viability and finally the future of biodiesel. The literature reviewed was selective and critical. Highly rated journals in scientific indexes were the preferred choice, although other non-indexed publications, such as Scientific Research and Essays or some internal reports from highly reputed organizations such as International Energy Agency (IEA), Energy Information Administration (EIA) and British Petroleum (BP) have also been cited. Based on the overview presented, it is clear that the search for beneficial biodiesel sources should focus on feedstocks that do not compete with food crops, do not lead to land-clearing and provide greenhouse-gas reductions. These feedstocks include non-edible oils such as *Jatropha curcas* and *Calophyllum inophyllum*, and more recently microalgae and genetically engineered plants such as poplar and switchgrass have emerged to be very promising feedstocks for biodiesel production.

It has been found that feedstock alone represents more than 75% of the overall biodiesel production cost. Therefore, selecting the best feedstock is vital to ensure low production cost. It has also been found that the continuity in transesterification process is another choice to minimize the production cost. Biodiesel is currently not economically feasible, and more research and technological development are needed. Thus supporting policies are important to promote biodiesel research and make their prices competitive with other conventional sources of energy. Currently, biodiesel can be more effective if used as a complement to other energy sources.

Contents

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1. Overview of global transportation sector consumption and emissions production

1.1. Global transportation sector energy consumption

Energy has become a crucial factor for humanity to continue the economic growth and maintain high standard of living especially after the inauguration of the industrial revolution in the late 18th and early 19th century. According to the International Energy Agency (IEA) report [1] and Shahid and Jamal [2], the world will need 50% more energy in 2030 than today, of which 45% will be accounted for by China and India. In the past 30 years, the transportation sector has experienced a steady growth especially due to the increasing numbers of cars around the world. It has been estimated that the global transportation energy use is expected to increase by an average of 1.8% per year from 2005 to 2035. Fig. 1 shows the total world, OECD (Organization for Economic Cooperation and Development) and non-OECD (Countries outside the Organization for Economic Cooperation and Development) transportation sector energy consumption between 2005 and 2035 [3]. Globally, the transportation sector is the second largest energy consuming sector after the industrial sector and accounts for 30% of the world's total delivered energy, of which 80% is road transport. It is believed that this sector is currently responsible for nearly 60% of world oil demand and will be the strongest growing energy demand sector in the future. Nearly all fossil fuel energy consumption in the transportation sector is from oil (97.6%), with a small amount from natural gas. Between 2006 and 2030, around three quarters of the projected increase in oil demand is expected to come from this sector [3–5]. Fig. 2 shows total world, transportation and other sectors oil consumption by end-use sector between 2007 and 2035 [3].

Fig. 3 shows the history of oil proved reserves between 1980 and 2009. Fig. 4 presents the trends of oil production and consumption between 1965 and 2009. Although oil is expected to remain the largest source of energy, the oil share of world marketed energy consumption is expected to decline from 35% in 2007 to 30% in 2035 as can be seen in Fig. 5 [3]. There is speculation about the peak oil production. A 2005 French Economics, Industry and Finance Ministry report suggested it may occur in 2013. However, few models predicted the peak year has already taken place in 2010, while other models predicted that it was in 2005. There are few other studies that reported the peak extraction will be occurred in 2020. The World Energy Forum has predicted that reserves will be exhausted in less than another 10 decades. Other believes that it will be depleted in fewer than 45 years if consumed at an increasing rate of 3% per annum [7–10].

1.2. Global transportation sector emissions production

It is believed that climate change is currently the most pressing global environmental problem. If the average global temperature increases by more than 2 °C, up to one million species could become extinct and hundreds of millions of people could lose their lives [9,11].

It is expected that about 4.1 billion metric tons of carbon dioxide will be released to the atmosphere from 2007 to 2020. Moreover, it is estimated that another additional 8.6 billion metric tons carbon dioxide will be released to the atmosphere from 2020 to 2035. This is estimated to be about 43% increase for the aforementioned projected period [3,12]. Fig. 6 shows the carbon dioxide emission trends for OECD, non-OECD countries and total world until 2035.

Globally, transportation sector accounted for about 23% and 22% of total world CO_2 emissions in 2007 and 2008 respectively [13,14]. Within this sector, road transport, accounting for 10% of global GHG emissions [15]. According to the United Nations'