



Review article

Challenges and opportunities of enhancing cold flow properties of biodiesel via heterogeneous catalysis



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HIGHLIGHTS

- Lipid derived biofuel is primarily being investigated in two forms: renewable diesel and biodiesel.
- The long straight chain fatty acid molecular composition found in naturally occurring oils produces fuel of a lesser quality.
- Cold flow properties and oxidative stability are the two major concerns in terms of quality.
- Hydroprocessing using heterogeneous catalysis is considered to be the most innovative solution.
- Dewaxing (hydrocracking and hydroisomerisation) offers the most enticing prospects.

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ABSTRACT

Concerns over climate change are necessitating the need for alternative greener fuel. Biodiesel is widely considered to be a key contributor to alleviating this concern. At present the biodiesel sector faces a number of challenges including technical challenges such as improving the quality of biodiesel to match that of crude oil derived diesel. One of the key challenges in the quality arena is improving the cold flow properties to enable wider geographic and seasonal operability. This review discusses in depth the various options which can be deployed to address this issue in an efficient and effective manner, with heterogeneous catalysis offering fascinating prospects.

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1. Introduction

The mass utilisation of biofuels from vegetable oil in internal combustion engines dates back to the early 20th century (1920–1930) in particular during WWII, with reported use from around the globe including Germany, Argentina, Japan, Belgium, Italy, France, the United Kingdom, Portugal, and China whom all tested and used various types of biofuels [5]. However the emergence of

low cost petroleum fuel production caused a decline in biofuel research and made investigation into the biofuel production infrastructures redundant. In recent times concern over the depletion of the finite fossil fuel reserves and with the transport sector now accounting for approximately 25% of the overall energy consumption and CO₂ equivalent emissions produced globally a resurgence is being witnessed in biofuel research and utilisation. Political, environmental and social factors, highlighted in Fig. 1, are the primary instigators for the increasing demand for biofuels. When it comes to the types of biofuel, numerous exist which can be produced from various feedstock using a variety of processes. The type of processing required is largely determined by the desired product as well as the composition of the feedstock, as shown in Fig. 2 below. Of the various types of biofuel, according to a recent study, ethanol from lignocellulosic waste, biodiesel from waste oil and palm oil are touted as the most economically competitive alternatives [6]. The overall price of biofuels usually take into consideration the costs associated with the feedstock, conversion process, fuel distribution and value of co-products; with Table 1 entailing some typical retail prices of international biofuels, courtesy of IEA [7]. The units of price are displayed in US dollars per litre of gasoline equivalent (USD/lge) due to the disparity in the energy content of biofuels in comparison to that of fossil fuels.

The focus of the proposed research is on biofuels produced from lipids which can be extracted from various forms of waste and crops [9,10]. Lipids are typically triglycerides composed of a series

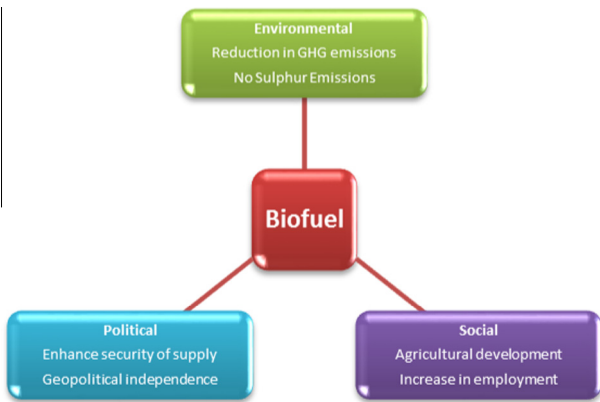


Fig. 1. Major drivers for the resurgence of biofuels. Adapted and modified from Azapagic et al. [8].

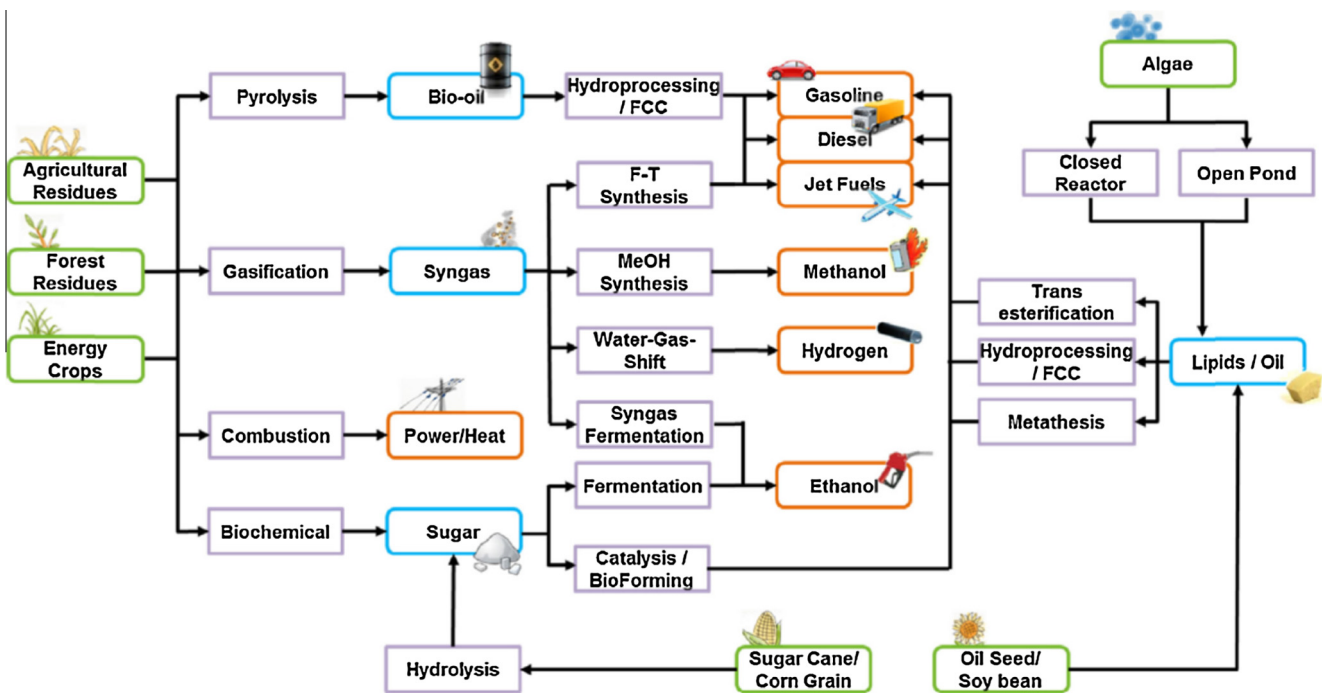


Fig. 2. Biofuel options based on different feedstock and processes. Adapted from Yue et al. [9].

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