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Fuel from waste animal fats

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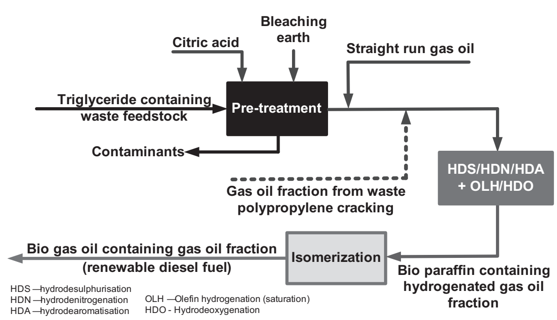
HIGHLIGHTS

- Purification of waste brown grease from rendering facilities.
- Feedstock component with practically zero iLUC (indirect land use change) value.
- Coprocessing of waste lard and gas oil fraction.
- Gas oil fraction from waste polyolefin cracking.
- Bioparaffin containing high quality diesel fuel.

GRAPHICAL ABSTRACT



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ABSTRACT

The hunger of the modern human society for energy is tremendous, which is increasing with the increasing population and with the pursuit of higher standards of living. A significant proportion of this energy demand is made up by the different fuels which ensure mobility. Based on environmental and energetic considerations, a larger proportion of this energy is trying to be covered with renewable energy sources on the whole world. Recently mankind utilised the first generation of biofuels for the transportation sector (bioethanol and biodiesel), but the development has not stopped. Today, the second generation is on the border of utilisation (2nd gen. bioethanol and bio gas oil – mixture of iso and normal paraffins). In this article, we are focusing on the topic of 2nd generation bio derived Diesel fuel, the so-called bio gas oil. We are investigating the possibilities of the utilisation of a new, waste feedstock, namely the brown greases which are the products of rendering facilities, in co-process with high sulphur containing heavy gas oil (1.2% sulphur content). During our experiments we produced bio gas oil containing gas oil fraction via the most favourable process parameters of hydrogenation (T: 330–340 °C, p: 50 bar, LHSV: 1.0 h^{-1}) and isomerisation (T: 340 °C, p: 50 bar, 1.0 h^{-1}) of waste lard containing gas oil stream. We determined that these kinds of waste fatty materials can be appropriate feedstocks for the production of renewable diesel–fuel components. In addition, these materials are cheap, and their iLUC (indirect land use change) value is practically zero. The properties (cetane number: ⩾54, CFPP: −10 to −20 °C, yield: >91%) of the product obtained after the two consecutive process steps met the valid standard for diesel fuel, thus we proved that this kind of waste feedstock can be an option for bio derived engine fuel production.

1. Introduction

One of the greatest challenges of the modern transportation sector is to ensure the supply for the increasing energy demand of the mobility, while bearing in mind the environmental issues, too [1,2]. Because of energetic and environmental demands mankind has begun to utilise bio derived fuels to replace part of the fossil energy source of the mobility. The steady development of bio derived fuels resulted in a wide range of options, which can be divided into multiple generations on the basis of feedstocks and of technologies [3]. Nowadays, mankind apply the first generation

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biofuels in the transportation sector (bioethanol and biodiesel), but the development has not stopped. Today, ones belonging to the second generation are on the border of utilisation (2nd gen. bioethanol and bio gas oil) [3].

1.1. Bio derived diesel–fuels

In case of diesel-engines, the most widely used bio derived fuel is the biodiesel, but due to its disadvantages [4] a product of a new chemical structure, the bio gas oil has been developed and applied in some extent. During the production of the bio gas oil, natural triglyceride (fatty acid) containing feedstock is converted via heterogeneous catalytic hydrogenation mainly to a mixture of iso and normal paraffins [5] (Fig. 1), which are the most important and best quality components of conventional diesel fuels, too [3–4,6–8]. At first, the aim of the triglyceride hydrogenation was to produce a cetane booster additive [9], but later on it became a widely researched area for bio derived diesel fuel production [3–8,10–20].

The production of bio gas oil can be made in itself [9–12] or as a co-process quality improvement process if the triglyceride is mixed with gas oil stream [7,13–16]. Almost without exceptions, the triglyceride feedstocks of these processes are some kind of vegetable oil with low impurity content, so pre-treatment is not necessary or only a slight cleaning is needed before the hydrogenation step. When the feedstock is a so-called waste oil or fat, it usually means slightly contaminated feedstocks, like used cooking oils [14,15,17]. Nevertheless the commercial price of this kind of feedstocks can be high and in some cases they may have high iLUC (indirect land use change) value as well (Fig. 2) [2]. The solution can be the processing of various triglyceride (fatty acid) containing waste materials.

1.2. Waste feedstocks for bio derived diesel fuel production

This type of material is the waste cooking oil, which does not require high degree of purification either, but its large scale collection has not been solved (apart from some experimental systems [16]) yet. However, a relatively high amount of triglyceride and free fatty acid containing fatty materials are formed everywhere in the rendering facilities (Fig. 3), which can be used as feedstock for bio gas oil production [19]. In these plants various fatty materials, meals, fodders are made from the waste of slaughterhouses and carcasses of livestock.

A high amount product of these rendering plants is the technical grade brown lard, which should not be used for animal feeding. However, after proper pre-treating this material can be a cheap feedstock for bio gas oil production. The biggest problem with these materials is that their solid contaminant as well as metal and phosphorous contents (Fig. 4) can be considerably high, therefore pre-treatment/cleaning is required, otherwise the high

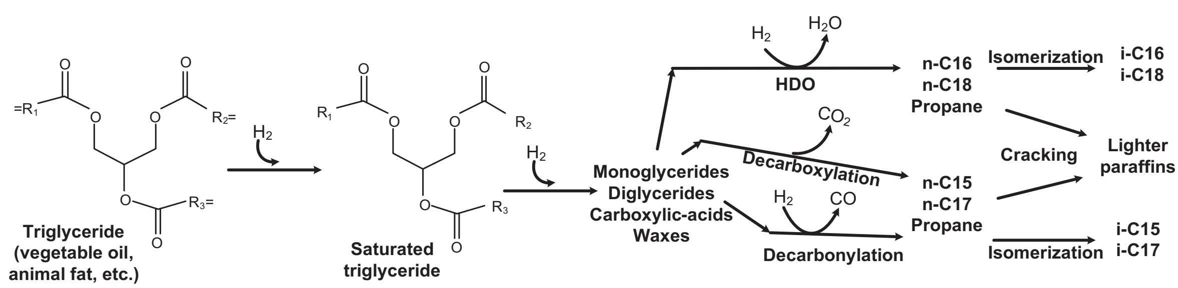

Fig. 1. Reaction pathway of the bio gas oil production [7]. (R_1, R_2, R_3: carbon chains with C_{11}–C_{23} carbon number) (examples are for C_{15} and C_{17} carbon chains.)

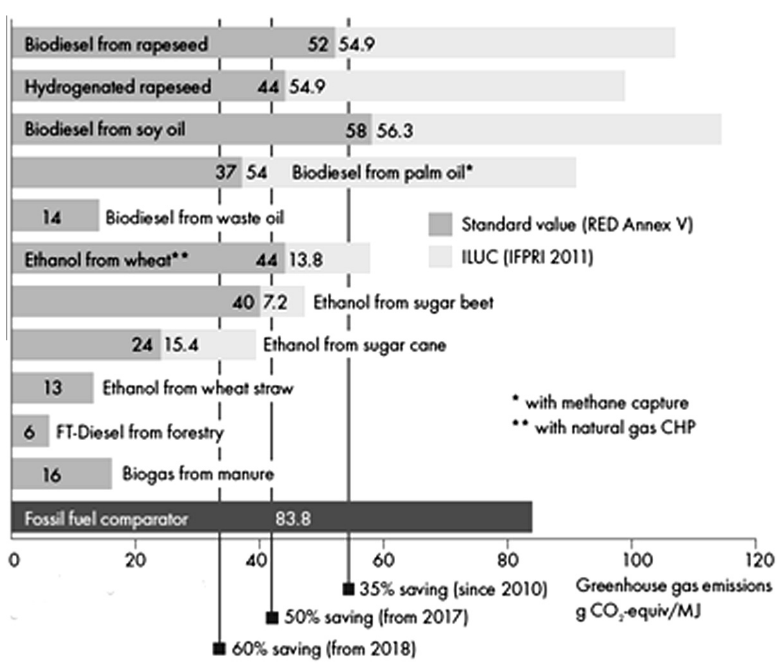

Fig. 2. iLUC values of some typical bio derived diesel fuel compared to conventional diesel gas oil [2].