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Hydrogenation of rapeseed oil for production of liquid bio-chemicals

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ABSTRACT

The main objective of rapeseed oil hydrogenation tests was the production of liquid bio-chemicals to be used as renewable raw material for the production of several chemicals and in chemical synthesis to substitute petroleum derived stuff. As, hydrogenation of vegetable oils is already applied for the production of biofuels, the work done focused in producing aromatic compounds, due to their economic value. The effect of experimental conditions on rapeseed oil hydrogenation was studied, namely, reaction temperature and time with the aim of selecting the most favourable conditions to convert rapeseed oil into liquid valuable bio-chemicals. Rapeseed oil was hydrogenated at a hydrogen initial pressure of 1.10 MPa. Reaction temperature varied in the range from 200 °C to 400 °C, while reaction times between 6 and 180 min were tested. The performance of a commercial cobalt and molybdenum catalyst was also studied. The highest hydrocarbons yields were obtained at the highest temperature and reaction times tested. At a temperature of 400 °C and at the reaction time of 120 min hydrocarbons yield was about 92% in catalyst presence, while in the absence of the catalyst this value decreased to 85%. Hydrocarbons yield was even higher when the reaction time of 180 min was used in the presence of catalyst, as the yield of 97% was observed. At these conditions hydrocarbons formed had a high content of aromatic compounds, around 50%. For this reason, the viscosity values of hydrogenated oils were lower than that established by EN590, which together with hydrogenated liquids composition prevented its use as direct liquid fuel to substitute fossil gas oil for transport sector. However, hydrocarbons analysis showed the presence of several valuable compounds that encourages their use as a raw material for the production of several chemicals and in chemical synthesis.

1. Introduction

Nowadays, modern society relies heavily on energy consumption using mostly solid, liquid or gaseous fuels from fossil sources. Combustion of such fuels has led to increasing CO_2 emissions, this together with the depletion of existing reserves, makes crucial the development of alternatives fuels. European Union wishes to increase the share of renewable sources in energy production, including the production of biofuels for the transportation sector and consequently research and development activities have been encouraged and supported. Fatty acid methyl esters (FAMEs), or biodiesel, is produced by transesterification of vegetable oils with methanol. Many fats contain triglycerides, which can be transesterified to produce FAME, however, in Europe are usually used rapeseed oil, soybean oil, sunflower oil and palm oil.

FAME has been used as diesel fuel for many years in Europe, blended with petroleum derived diesel fuel, at amounts lower than 10%, because of FAME different chemical compositions. Some motor manufacturers defend that during combustion some problems may arise that damage combustion devices or lowers their performance, however, it has been claimed that FAME use as a pure component, without blending, does not affect combustion devices. Hydrogenated Vegetal Oil (HVO) is another option to use vegetable oils as biofuels. HVO is produced by catalytic hydrogenation and its composition is similar to petroleum derived fuels, thus allowing its use in conventional motors without legal limitations. HVO is still a first generation fuel, but it may present several advantages in relation to FAME, namely: superior cold weather properties, higher heating value, higher cetane number, and the process by-product, propane, has better options than glycerol by-product. On the other hand, they may be used in conventional motors without the need of blending with conventional fuels.

Rapeseed oil has been widely studied for the production of bio-fuels via hydrogenation [1–6] with the aim of producing liquid biofuels with the right properties to be used in conventional transportation vehicles. Hydrogenation of rapeseed oil may convert fatty acid triglycerides into hydrocarbons. During triglycerides hydrogenation some chemical bonds are broken done, thus they may be converted into monoglycerides, diglycerides and carboxylic acids, which may be converted into alkanes by three different

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