

Abstract

IMPACT OF BIO- COMPONENT OBTAINED BY THE
"CO-PROCESSING" VARIANT ON PROPERTIES OF DIESEL FUEL

The presented work includes topics in a comprehensive manner of all aspects relating to both the production of bio-components in the process of hydro-conversion of a mixture of rapeseed oil and naphtha, and the application of the product obtained in the form of the final component or motor fuel. The novelty of this work is to include in the study a broad area of issues, including especially the impact of bio-components on the three main grades of diesel fuels available on the domestic market. Also, the study of the aging process of bio-components possesses an innovative character. The study considered the role of additives with special emphasis to the low-temperature properties of the product, due to the chemical nature of the bio-component as well. The aim of the study was to show that rapeseed oil hydro-conversion process, in the co-processing variant can be implemented in the domestic refinery industry, using the existing technical infrastructure. Hence, in addition to the wide range impact of the hydro-conversion process parameters on product characteristics, focus was also placed on the process conditions (pressure, temperature, catalysts), typical for existing installations for hydro-desulfurization of diesel oil components.

The scope of the research included:

1. Selection of a catalyst for the hydro-conversion process of rapeseed oil and hydrocarbon fraction mixture (naphtha fraction).
2. Determination of the effect of process parameters on the product properties and chemical composition originated from the hydro-conversion of raw materials containing rapeseed oil.
3. Vulnerability assessment of hydro-treating products on additives (foaming tendency, anti-corrosion properties, lubricity, susceptibility to microbial contamination).
4. The evaluation of the stability, low temperature characteristics and the susceptibility to depressants on hydro-conversion crude products containing rapeseed oil.
5. Determination of the effect of the hydro-isomerization process on the low temperature properties of hydro-converted crude products containing rapeseed oil.
6. Compatibility testing of hydro-converted crude products containing rapeseed oil with different classes of engine oils.

7. The possibility assessment of the co-processed products application, containing rapeseed oil as a component of diesel fuel or as a final fuel.

In conditions typical for industrial low-pressure hydrodesulphurization process of diesel fuel components, the total conversion of rapeseed oil (OR) in a mixture of petroleum fractions was obtained using the NiMo/Al₂O₃ catalyst. The catalysts CoMo/Al₂O₃ proved to be ineffective. The catalyst NiMo-1 ensures complete conversion of rapeseed oil at lower temperatures rather than the NiMo-2 catalyst. The chosen hydro-conversion level of rapeseed oil (OR content max. 10 mg/kg, iodine value max. 0,11 gJ/100g) on the NiMo-1 catalyst, for crude containing 10% (V/V) OR, was obtained for the following parameters: 300°C, 3,2 MPa, 3 h⁻¹, 150 Nm³/m³. In the case of crude containing 20 % (V/V) OR it was necessary to increase the ratio of H₂/crude to 250 Nm³/m³. The temperature increase of the hydro-conversion process (3,2 MPa), of crude containing 20 % (V/V) OR 300 to 320°C resulted in a significant increase from 48 to 61% of decarboxylation reactions contribution. A significant reduction of the mentioned reactions (from 55 to 16 %) could be obtained by the pressure increase from 3.2 MPa to 9,0 MPa (310°C).

Studies have shown, that regarding the impact of additives, on storage stability, susceptibility to contamination and compatibility with engine oils (synthetic, semi-synthetic and mineral), the product of hydro-conversion of a mixture of rapeseed oil and the fraction A-3 and prepared fuel with its participation, is characterized by comparable properties as refinery diesel oil (without FAME). These products are not susceptible for depressant additives, currently used by the refining industry.

Subjecting the product resulting from the hydro-conversion of crude, containing 20% (V/V) of rapeseed oil, to the hydro-isomerization process, results in significant improvement of low temperature properties, which expands the scope of its application. Depending on the temperature and pressure of the hydro-isomerization processes, a diesel fuel component can be obtained, with cloud point of -13°C, which is susceptible to the depressants application (310°C, 4,0 MPa, 1,0 h⁻¹, 200 Nm³/m³) or a component with very good low-temperature properties (320°C, 6,0 MPa, 1,0 h⁻¹, 200 Nm³/m³), characterized by a cloud point temperature of -23°C, which does not require the application of depressants. The component produced in both cases, can be successfully applied in the production of winter diesel fuel. Bio-component obtained by the hydro-conversion of rapeseed oil and naphtha may be an alternative to the currently used bio-components (FAME). Replacement of FAME with a bio-

component obtained from catalytic hydro-conversion of vegetable oils, characterized by a high cetane number and good oxidation stability, should increase the quality of commercial gas oil. The product of hydro-isomerization (320°C and 6,0 MPa, 1,0 h⁻¹, 200 Nm³/m³) of resulting bio-component in the variant of "co-processing" from crude containing 20 % (V/V) OR meets all quality requirements for diesel oil "with improved low-temperature properties" ,that are specified in PN-EN 590: 2013-12 (class 2 arctic climate). This product can be used as a standalone fuel for vehicles equipped with diesel engines, it can also be used as a component for the production of grade F diesel. Therefore the possibility of methods diversification for diesel fuels production complies with the requirements of EN-590: 2013-12 is achieved.