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Advanced liquid biofuels from residue biomass by thermo-catalytic reforming

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Statement of the Problem: To meet the ambitious political targets regarding the future energy supply, advanced biofuels are needed to reduce the dependency and correlated emissions of fossil fuels. It has become apparent that the transportation sector still offers great potentials to facilitate a sustainable transition. Biogenic fuels that meet fossil fuel standards could therefore utilize in standard fossil fuel engines without market entry barriers. These fuels are only sustainable if the production is not competing for food security or is economically competitive. Methodology & Theoretical Orientation: The research focuses on the development of a new thermo-chemical process to convert biogenic carbon-based residues into valuable storable products. The Thermo-Catalytic Reforming (TCR®) is an intermediate pyrolysis process combined with a unique integrated catalytic reforming step. Various biogenic and industrial residues like sewage or digestate were utilized in a TCR®-plant with a capacity of 30kg/h. The purpose of this work was the production of renewable high-quality transport fuels from residual and waste biomass. To reach the high standards of common fuels like gasoline and diesel, the crude TCR®-oils were hydrotreated. Findings: The crude TCR®-oil was hydrotreated at a temperature of 350 °C and a pressure of 140 bar to remove sulfur, nitrogen and oxygen compounds. After hydrogenation, the oil was fractionated into common fuel fractions. The renewable gasoline and diesel were analyzed and showed the required properties to meet fossil fuel standards (EN 228; EN 590). These fractions were successfully tested in modern EURO-6 car engines. Conclusion & Significance: The TCR® of residue biomass and the upgrading of the oils by hydrogenation enable sustainable production of advanced liquid biofuels. The fuels meet fossil fuel standards, and corresponding engine tests demonstrated the ability of the biofuels to substitute fossil fuel without drawbacks like higher fuel consumption or higher emissions.

Recent Publications

1. Tilman, D., et al. (2009) Beneficial biofuels - The food, energy, and environment trilemma. Science, 325, 270-271.
2. Alonso, D.M., Bond, J.Q., Dumesic, J.A. (2010) Catalytic conversion of biomass to biofuels. Green Chem., 12, 1493-1513.
3. Mortensen, P.M., et al. (2011) A review of catalytic upgrading of bio-oil to engine fuels. Appl. Catal., A, 407, 1-19.
4. Conti, R., et. al. (2017) Thermocatalytic Reforming of Biomass Waste Streams. Energy Technol., 5, 104-110.
5. Neumann, J., et. al. (2016) Upgraded biofuel from residue biomass by Thermo-Catalytic Reforming and hydrodeoxygenation. Biomass Bioenerg., 89, 91-97.

Figure1: Crude TCR®-oil (left) and hydrotreated TCR®-oil (right)

Biography

Prof. Hornung is an expert in thermo-catalytic conversion of biomass and organic residues for sustainable fuels and chemical synthesis. He has over 25 years' experience in developing novel reactor systems for the conversion of biomass and has expertise in designing, building, and operating reactor units to achieve desired outcomes at all scales of operation. Prof. Hornung currently holds positions as Director of the Fraunhofer Institute, Sulzbach-Rosenberg, Germany. Furthermore, he keeps the Chair in Bioenergy at the University of Birmingham (UK) and is Professor in High-Temperature Process technologies at the Friedrich-Alexander Universität Erlangen-Nürnberg (Germany). He currently holds 21 patents and has published over 250 scientific papers.

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