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Editorial

Catalysis for the Production of Sustainable Fuels and Chemicals

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The emission of green-house gases and environmental concerns have led to recent research in the use of renewable feedstocks derived from biomass, waste oils and fats as a source for fuels and chemicals. However, these feedstocks contain a large amount of oxygen functional groups. Processing these feedstocks generally requires esterification and transesterification, deoxygenation, hydrogenation, hydrogenolysis, aldol condensation and cracking reactions. The bio-oils produced through pyrolysis and hydrothermal treatment are treated through catalytic processes for producing clean fuels. In addition, syngas produced through the gasification of biomass is converted to liquid fuels. Petroleum crude oils contain large amounts of heteroatoms and contaminants. Due to the global mandate of cleaner fuels, these materials require severe processing with a large energy input, and hence require novel and advanced processes for creating environmentally friendly fuels for societal needs. The main focus of this issue was to solicit recent advances in the catalytic processing of renewable and non-renewable feedstocks for sustainable fuels and chemicals.

In this Special Issue of *Catalysts*, 15 high-quality papers, which are externally and thoroughly reviewed, are published, and the catalytic conversion of biomass and biomass-derived liquids and hydrocarbon-based fuels is focused on. The novelty and contributions of these papers are briefly highlighted below for the benefit of the readers. The performance of sulfided NiMo/γ-alumina for the hydrodeoxygenation (HDO) of a fatty acid to alkanes was performed in a batch reactor by Abdus-Salem et al. (2018), and the catalyst's deactivation was due to the blockage of active sites and pore blockage and largely contributed to product coke and the irreversible production of aluminum phosphate. The oxidative stability of hydrotreated vegetable oils as compared to fatty acid methyl ester and their suitability as fuels in a mixture with different transportation fuels is studied in detail by Zeman et al. (2019). The properties of fuel blend, such as viscosity, density, and cold filter plugging point, confirmed that the hydrotreated vegetable oil blend with fuel can meet the fuel standard for engines without modification. The hydrotreating of waste cooking oil to produce green diesel using unsupported and supported CoMoS on a mixed oxide was investigated by Wang et al. (2019). The support favored the metal dispersion and surface area of CoMoS, a decrease in reaction temperature for HDO, enhancement of hydrogenation capabilities and reduction in polymerization activities. A series of 25 wt.% Ni/KIT6 reduced at different temperatures (400−550 °C) was evaluated by Zhang et al. (2019) for the HDO of ethyl acetate to ethane and methane. The catalyst reduced at 450 °C was most suitable for higher product selectivity due to its optimum metal support interaction, Ni dispersion, crystallite size, and ability to adsorb and activate hydrogen. Ayandiran et al. (2019) investigated several Fe promoted Cu/SiO_2-Al_2O_3 catalysts for jet fuel production from oleic acid in an autoclave. The impact of support acidity by using ZSM-5 and HZSM-5 on the jet-fuel range hydrocarbons' yield and selectivity was investigated. These catalysts were extensively characterized and the higher yield and selectivity for Fe(3)-Cu(15)/SiO_2-Al_2O_3 was attributed to their excellent textural properties, high oxophilic iron content, high metal dispersion, and mild Bronsted acidity. The catalytic decomposition of oleic acid to organic liquid product (OLP) containing mostly alkenes and cyclo-alkenes was studied by Hu et al. (2019) using various acidic and basic catalysts. Lewis acidic catalysts were beneficial for deoxygenation and secondary cracking, whereas CaO, among all basic catalysts, favored dehydrogenation activity. The enhancement of the HDO activity of MoP on SiO_2 with a physical mixture with alumina or zeolites for methyl palmitate (MP) to palmitic acid was investigated by Shamanaev et al. (2020). Additional acid sites to MoP/SiO_2 enhanced HDO reaction, and isomerization and the cracking of alkanes were favored by the addition of zeolites. The catalytic pyrolysis of Chilean Oak to value-added chemicals and fuels was studied by Alejandro-Martin et al. (2019) using ammonium-modified Chilean Zeolite. Bronsted acidity was favorable for ketones, aldehydes and hydrocarbons, and for a decrease in esters, ethers and acids, and was responsible for upgraded bio-oil with lower oxygen content and higher value-added chemicals. The kinetics, isotope effect and mechanism of catalytic pyrolysis of aliphatic carboxylic acids into ketones over Ce-based catalysts were investigated by Kulik et al. (2020). The study showed that it is a sterically controlled reaction and demonstrated a method for studying the catalytic pyrolysis mechanism.

Liu et al. (2019) investigated the promotional effect of Ni on glycerol hydrogenolysis to 1,2- propanediol (1,2-PD) with in-situ hydrogen from methanol present in crude glycerol using a Cu/ZnO/Al_2O_3 catalyst. Ni contributed to the generation of in situ hydrogen with higher methanol conversion, reduced the conversion of glycerol, and improved the selectivity of 1,2-PD. Ni assisted in the slower dehydration of glycerol to acetol and higher hydrogenation activity of acetol to 1,2-PD. Hydroprocessing (HT) followed by oxidative desulfurization (ODS) and denitrogenation (ODN) of gas oils was investigated by Badoga et al. (2019). HT was performed using NiMo/γ-Al_2O_3, and alumina, alumina–titania supported Mo, P, Mn and W catalysts were tested for sustainable ODS and ODN of gas oils using tert–butyl hydroperoxide as an oxidant, followed by the adsorption of oxidized compounds on activated carbon. MnPMo/γ-Al_2O_3 was the most suitable for the HT process. This research showed that the combination of HT, ODS and ODN resulted in the most efficient removal of S and N compounds from gas oils.

A novel artificial intelligence modelling for the prediction of a CO-rich hydrogen production rate from methane dry reforming was successfully conducted by Ayodele et al. (2019). Light olefin selectivity with a higher O/P ratio via the Fischer Tropsch Synthesis (FTS) process was investigated by Tian et al. (2019) for a FeN catalyst supported on 10MnK-AC. Light olefin selectivity was improved due to the electronic donor effect of nitrogen and the suppression effect on the second hydrogenation over 10MnK-AC support. Microwave and conventional heating systems were used by Sharifvaghefi et al. (2019) for hydrogen production from the dry reforming of methane using Ni and Ni-MnO supported on activated carbon. Microwave heating improved the reactants' conversion and hydrogen selectivity, due to the enhancement of energy efficiency of the reaction as compared to conventional heating. The mechanism of methanol synthesis from CO_2 hydrogenation using Cu-ZnO-based catalysts was investigated by Gao et al. (2019) using a combination of strong electronic adsorption (SEA) and atomic layer deposition (ALD) techniques. These materials were extensively characterized. The catalyst with 5 wt.% Cu on one atomic layer of ZnO produced smaller and more Cu sites, and ZnO basic sites, and a stronger interaction between them, which possibly led to CO_2 activation and hydrogenation to form methanol.

In summary, many of these 15 publications deal with the production of sustainable fuels and chemicals and have a higher level of novelty related to an improved catalytic process and chemical product efficiency, catalytic reaction mechanism and process sustainability. The Guest Editors sincerely

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