Lignin pyrolysis in the presence of oxide particles embedded onto natural clinoptilolite and ZSM-5

Jelena Milovanović, Faculty of Technology and Metallurgy, Belgrade, Serbia; Nevenka Rajić, Faculty of Technology and Metallurgy, Belgrade, Serbia; Ruth Elisabeth Stensrød, SINTEF, Oslo, Norway; Elisabeth M. Myhrvold, SINTEF, Oslo, Norway; Roman Tschentscher, SINTEF, Oslo, Norway; Michael Stöcker, *SINTEF*, Oslo, Norway;

Introduction

A main objective of this work was to investigate and compare catalytic activity of the natural clinoptilolite (NZ) and ZSM-5 which are modified with several oxide species: NiO, Cu_2O, MgO and CaO in the pyrolysis of softwood and hardwood lignin. The lignocellulose as cheapest and most abundant source of biomass has attracted considerable attention as very promising substitute for fossil fuels.

Experimental

The catalysts were prepared by a wet impregnation of NZ and ZSM-5 with the corresponding metal salts and by subsequent calcination of the impregnated products at 600 °C. The pyrolysis of the lignins (supplied by Innventia AB) was examined in a fixed-bed reactor under nitrogen at 450, 500 and 550°C. The resulting liquid and gas phases were analyzed by using GS and GS/MS, respectively.

Results and Conclusions

NiO-, MgO- and CaO-modified zeolites exhibited a catalytic activity in lignin pyrolysis. All three catalysts gave a higher liquid yield with softwood lignin in comparison to hardwood one and showed that optimal temperature for the catalytic process is that at 500 ^oC. The liquid yields and content of desirable phenols and undesirable acids and carbonyls in the liquid phase differ mutually. NiO-ZSM-5 gave the highest liquid yield (42.4 wt%) whereas the highest phenol content (83.6 wt.%) in the liquid phase was obtained in the presence of CaO-ZSM-5. The catalysts did not increase significantly the content of PAHs (being ~1.2 wt%) and heavy compounds (~0.4 wt.%). The results indicate that metal oxide-modified ZSM-5 could be promising candidate for catalyst design for the catalytic lignin pyrolysis.

Acknowledgment

The authors gratefully acknowledge the financial support of BRISK (project No. 102002082-2) and express gratitude to Innventia AB for providing lignin samples.