RESEARCH SUMMARY

Catalytic Valorisation of biomass to chemical products using thermochemical conversion process.

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Harnessing the potentials of biomass in addressing the energy need of the world has become more desirable in view of the detrimental environmental effects of petroleum, the major energy source. With the growing interest in the production of fuels and chemicals from renewable resources, the new concept of biorefinery, where biomasses are processed to obtain valuable chemical and fuel products in an all-encompassing chemical process stream, similar to oil refinery, is now receiving a great attention.

When biomass is thermochemically and/or biochemically converted, various chemical products are obtained, including bio crude oil (BCO). BCO is a potential fuel that can replace many petroleum derived fuels in internal combustion engines. With the presence of over 200 chemicals, BCO is a viable replacement for many chemical feedstock presently obtained from petroleum (Czernik & Bridgwater 2004; Bridgwater, 2012). Numerous chemicals obtainable from biomass via thermochemical conversion process include furan, ketones, aldehydes, pyrans, anhydrosugars, phenols, etc.

The use of catalyst during the thermochemical conversion process or in the upgrading BCO can enhance the final chemical products. The application of catalysts in fast pyrolysis processes offers means of altering the highly oxygenated and acidic BCO. It offers practicable means of removing the unwanted oxygen contents in BCO (Carlson et al., 2009, French and Czernik, 2010). Various modified and unmodified zeolite have been employed in the catalytic conversion of lignocelluloses because of their activity and selectivity. Zeolites catalysts have tremendous effectiveness in the conversion of oxygenated compounds to hydrocarbons thereby improving the fuel and chemical properties of BCO. (Azeez et al., 2011, Carlson et al., 2010, Aho et al., 2008).

This research therefore focuses on the catalytic conversion of biomass to useful chemical products via fast pyrolysis, using metal-impregnated zeolites. The catalysts will be characterised using XRD, TPD, NMR and ICP-AES. The catalytic effects of the catalysts will be studied by converting simple biomass-derived chemicals such as levulinic acid, sorbitol and glucose to new chemical products using the new tandem pyrolysis gas chromatography - mass spectrometer (Py/GCMS). The conversion trial will be extended to main components from fractionated lignocellulose.

The outcome of this research will enhance understandings of optimal means of converting simple lignocellulose-derived chemical to higher chemical products. It will also help in developing conversion strategies for the catalytic processing of lignocellulose to useful chemicals in biorefinery.

References

Aho, A., Kumar, N., Eranen, K., Salmo, T., Hupa, M. & Murzin, D.Y. 2008. Catalytic pyrolysis of woody biomass in a fluidised bed reactor: Influence of the zeolite structure. *Fuel*, 87, 2493-2501.

Azeez, A.M., Meier, D., Odermatt, J. & Willner, T. 2011. Effects of zeolites on volatile products of beech wood using analytical pyrolysis. *Journal of Analytical and Applied Pyrolysis*, 91, 296–302.

Bridgwater, A.V. 2012. Review of fast pyrolysis of biomass and product upgrading. *Biomass and Bioenergy*, 38, 68-94.

Carlson, T., Tompsett, G., Conner, W. & Huber, G. 2009. Aromatic Production from Catalytic Fast Pyrolysis of Biomass-Derived Feedstocks. *Topics in Catalysis,* 52, 241-252.

Carlson, T. R., Jae, J., Lin, Y.-C., Tompsett, G.A. & Huber, G.W. 2010. Catalytic fast pyrolysis of glucose with HZSM-5: The combined homogeneous and heterogeneous reactions. *Journal of Catalysis*, 270, 110-124.

Czernik, S. & Bridgwater, A.V. 2004. Overview of applications of biomass fast pyrolysis oil. *Energy & Fuels*, 18, 590-598.

French, R. & Czernik, S. 2010. Catalytic pyrolysis of biomass for biofuels production. *Fuel Processing Technology*, 91, 25-32.

MEET THE RESEARCHER:

Akeem M. Azeez

AREA OF RESEARCH	Thermo-chemical/catalytic conversion of biomass to fuels and chemicals
HOME TOWN	Ado Ekiti, Ekiti State, Nigeria
INTERESTS OR HOBBIES	Playing badminton and football

Akeem graduated with a BSc (Hons) in chemistry from the University of Ado, Nigeria in 1997, followed by two post graduate degrees (PGD Chemical Engineering in 2000 and M.Eng. Environmental Engineering in 2003) from the University of Port Harcourt, Nigeria. In 2004, he secured a Nigerian government scholarship to study MSc Biogeochemistry at the University of Newcastle upon Tyne (UK) in 2004 and following his graduation, returned home to complete his M.Sc Inorganic Chemistry at the Premier University of Ibadan in 2006. Akeem returned back to Europe in 2007 to obtain his PhD in Wood Chemical Technology from the University of Hamburg, Germany. He was motivated to seek a post-doctoral research fellowship at UKZN/FFP following FFP's common research area of the catalytic conversion of biomass and biorefinery.

Akeem's various postgraduate degrees have given him a worthy insight into the world of science and its solutions for environmental challenges. "Green chemistry is an area of research where lesser attention has been given in my country [Nigeria] despite our huge renewable resources," Akeem explains. "The desire to contribute in solving evident environmental disaster occasioned by the use of petroleum is a motivating factor that has spurred me to my field of research."

Akeem was motivated to seek a post-doctoral fellowship in South Africa due to a lack of basic laboratory facilities back home in Nigeria, but has found his access to research equipment here just as limited, as FFP has only recently begun to expand its core focus from pulp and paper to biorefinery, he explains. Despite these challenges, Akeem has embraced the CSIR and UKZN libraries' wide range of electronic research resources and research seminars that have proved equally useful. "I have been able to carry out the preparation of catalysts I intend to use for biomass conversion at the UKZN Chemistry Department, and have been scouting for a laboratory that has the necessary equipment for my research within South Africa for possible collaboration."

Akeem hopes that his postdoctoral fellowship will provide the platform and opportunity to deepen his research ability, acquiring and mastering new skills on how research could be conducted in his area of interest.

Looking forward, Akeem believes that the paper industry's "upcoming global strategy to integrate biorefinery into the industry" will open up an array of research opportunities and will help to maintain its prosperity and attractiveness to researchers such as himself. Despite the decline in paper demand due to an increase in electronic media, Akeem feels that the "vital need for paper in our society" will always attract researchers to the pulp and paper industry. ■