7th International Conference on
GREEN CHEMISTRY & TECHNOLOGY
June 18-20, 2018 | Dublin, Ireland
Jakob Köchermann et al., J Ind Environ Chem 2018, Volume 2 | DOI: 10.4066/2591-7331-C1-002

PRODUCTION OF FURFURAL FROM D-XYLOSE AND ORGANOSOLV HEMICELLULOSE IN WATER/ETHANOL MIXTURES

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In recent years the production of furfural from D-xylose and hemicellulose rich streams from the pulp and paper industry were extensively discussed. However, one problem that has always been described was the formation of insoluble humins by self- and cross-polymerization of furfural. Due to these side reactions the product yield and selectivity decreases. Therefore, the use of biphasic systems or ionic liquids was investigated to avoid this issue. Promising results have been shown but such systems could by costly due to expensive solvents and the subsequently recovery processes. Another approach to suppress polymerization of furfural is the usage of alcohol/water mixtures as reaction medium. The alcohol can react with the sugars and stabilize the reactive intermediates. For our exploration as reaction medium ethanol/water with different mass ratios were tested. Xylose was used as model compound for organosolv hemicellulose and sulphuric acid as homogeneous catalyst. The experiments were conducted in a thermostatically heated 500 mL stirred batch reactor at three temperatures (180, 200 and 220°C). To avoid the heating phase, the xylose was dissolved in water and transferred in a liquid charging pipette made of stainless steel. The educt solution was added to the ethanol/water mixture only after reaching the reaction temperature. Immediately after addition, a first sample was taken by a liquid sample valve with dip tube. Five more samples followed after 5, 15, 30, 60 and 180 min. Afterwards the reactor was cooled down to ambient by the thermostat as fast as possible. Subsequently the insoluble humins were separated from the reaction medium by vacuum filtration. The process liquor samples were analysed by liquid chromatography (HPLC-DAD) and the humins were quantified by weighing. Since ethanol is used as solvent for the organosolv process, the hemicellulose stream after the digestion contains residues of that alcohol. Therefore, we were interested on furfural polymerization suppress capacity of different ethanol/water mixtures. This approach has an interesting benefit since after furfural separation ethanol/water stream can be reused for the organosolv process. Preliminary results show a correlation between the ethanol/water ratio and the amount of formed humins. The ethanol content has also a strong influence and leads to an increase of furfural yield (Fig.1). Furthermore, reference experiments with pure water were conducted. The results are promise for further explorations with real organosolv hemicellulose hat should be carried out in the next step.

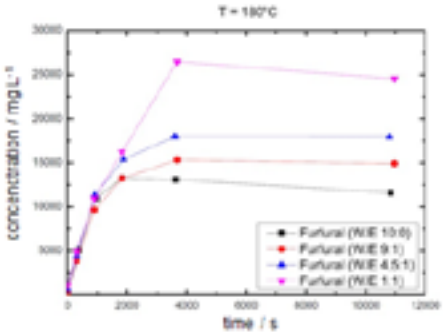

Figure: Furfural concentration at various water/ethanol mass ratios and a reaction temperature of 180°C

BIOGRAPHY

Jakob Köchermann studied chemical engineering at the Karlsruhe Institute of Technology (KIT) and Technical University of Dresden (TUD). He received his diploma (equiv. to MSc) in 2014 at TUD. In 2015 he joined German Biomass Research Center, where he worked until 2016 as research fellow, focusing on hydrothermal conversion of lignocellulosic biomass. Since 2016 he is PhD fellow at German Biomass Research Center. Within the framework of his PhD thesis, Jakob Köchermann works on hydrothermal conversion of organosolv hemicellulose and xylose to furfural.

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