Characterization of Lignin Degradation and Repolymerization Products
Shelly Lu, Honzik Bílek, Anastasia Andrianoa, Alena Kubátová
Chemistry Department, University of North Dakota

Objectives
- Characterize lignin heteropolymer to better understand the composition of lignin for future renewable resource studies
- Observe lignin repolymerization to help understand and develop methods to prevent this phenomenon
- Quantify the amount of carbon by thermal carbon analysis (TCA) to evaluate contribution of monomers, oligomers, and elemental carbon.

Methods and Materials
- Lignin fractionation preparation using gel permeation chromatography (GPC)
- Fraction characterization by TCA
- Lignin visual analysis using transmission electron microscopy (TEM)
- Weekly evaluation of extent of lignin repolymerization by lyophilized samples using TCA

Background
Lignin is one of the most abundant biopolymers in the world; 50 million tons produced annually from plants.
- Lignin’s unique structure has the potential for the production of a new generation of renewable materials
- Lignin is a source of phenolic compounds, e.g., vanillin, phenol, guaiacol, and vanillic acid

Conclusions
- TCA confirmed that low MW fractions were rich in monomeric species, whereas higher MW fractions featured highly crosslinked polymers
- TCA corresponded with GPC and showed there is no lignin impurities which elute in GPC before high MW lignin species
- TEM results also suggested that the first eluted fraction in GPC was structurally different from lignin
- Lignin nanoparticles of uniform size were observed in narrow MW lignin fractions
- Repolymerization is occurring in concentrated lignin solutions over

Future Work
1. Measure lignin nanoparticle size in the solution by dynamic light scattering
2. Perform TD/pyr-GC/MS analysis of lignin MW fractions and GC-MS analysis of low MW fractions
3. Distinguish the predominant functionalities in different lignin MW fractions by means of NMR and FT-IR spectroscopy
4. Achieve the mass balance closure in lignin fractionation by MW

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