Introduction:
The Northwest Advanced Renewables Alliance (NARA) is an organization that aims to create a sustainable aviation biofuels production industry in the Northwest United States. One of NARA's goals is to develop a production process with fewer environmental burdens than conventional petroleum-fuels production processes. This research aims to determine the atmospheric emissions and emission sources that may be released from proposed NARA biofuels production processes. One of the critical steps for biological conversion of lignocellulosic biomass to biofuels is the pretreatment operation. Pretreatment is aimed at decreasing the chemical recalcitrance of lignocellulose, and effective pretreatment results in an improved accessibility of the carbohydrate polymers for hydrolysis to fermentable sugars. One of the key pretreatment processes currently under study is Sulfite Pretreatment to Overcome Recalcitrance of Lignocellulose (SPORL), a process modeled after the bisulfite pulping process. In order to develop initial air emissions estimates, historical emissions testing data from the Georgia Pacific sulfite pulp mill after the bisulfite pulping process. In order to develop initial air emissions estimates, historical emissions testing data from the Georgia Pacific sulfite pulp mill after the bisulfite pulping process. This research aims to determine the atmospheric emissions from these sources are formaldehyde, acetaldehyde, acetone, methanol, benzene, diethyl ether, and chloroform and other chlorinated organics. Results of laboratory-scale SPORL experiments indicated that furfural, methanol, ethanol, DMS/ethanethiol, 2-methylfuran, \( \text{C}_{10}\text{H}_{16} \), and diacetyl sulfide were most likely part of the off-gas.

Methods:
Emissions data from the Georgia Pacific sulfite pulp mill were used to form the Georgia Pacific mill and the SPORL process, and the existence of an existing representative of what emissions might be from a biofuels production facility due to the similarities between the pulping process used at existing representative of what emissions might be from a biofuels production facility. This data is the closest existing representative of what emissions might be from a biofuels production facility due to the similarities between the pulping process used at the Georgia Pacific mill and the SPORL process, and the existence of an alcohol production plant at the mill.

Experimental Apparatus:

Procedure: 8g of ~0.5" shredded wood chips at 100% saturation were added to ~4 mL of 2% w/w \( \text{Na}_2\text{SO}_3 \). The mixture was placed into a 100mL Parr reactor, stirred, and heated to 180°C. The mixture was held at 180°C for 10 minutes, then allowed to cool to room temperature. \( \text{N}_2 \) was flushed through the reactor and slurry at ~200cc/min, pushing the off-gas into a ~10L Teflon bag, as well as diluting it. When the bag was full, scans of the contents were taken on the PTR-MS and GC-MS. Due to the high concentration of the bag sample, \( \text{N}_2 \) was used to further dilute the sample by a factor of ~300. The data from both mass spectrometers was compared to find compounds that were likely present in the off-gas (see PTR-MS Mass Spectrum of SPORL Reaction Headspace).

Results:
When examining the emission inventory data from the Georgia Pacific mill, the main emission sources were determined to be: (1) the steam production tower and scrubbers, and (5) aerated stabilization basin. Compilation of these data sets indicated that the primary emissions from these sources are formaldehyde, acetaldehyde, acetone, methanol, benzene, diethyl ether, and chloroform and other chlorinated organics. Results of laboratory-scale SPORL experiments indicated that furfural, methanol, ethanol, DMS/ethanethiol, 2-methylfuran, \( \text{C}_{10}\text{H}_{16} \), and diacetyl sulfide were most likely part of the off-gas.

Future Work:
Future experiments will include comparisons of SPORL emissions under different conditions (temperature and pH differences), as well as more detailed identification and quantification of SPORL off-gases. Similar testing will take place for analyzing the off-gas from saccharification and fermentation experiments.

References:


