Title: Sulfur Profiling in Pine Residues and Its Impact on Thermochemical Conversion

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Objectives: The overall goal of this project is to establish sulfur profile database and correlate the form and fate of sulfur in pine feedstocks to thermochemical conversion performance and to develop effective feedstock preprocessing and sulfur mitigation strategies. To achieve this goal, five specific objectives will be pursued: 1) Define and characterize sulfur content/form in various sources of pine residues; 2) Determine the fate of sulfur during thermochemical conversion including both pyrolysis and gasification; 3) Develop and test the effectiveness of biomass preprocessing/sulfur mitigation strategies; and 4) Conduct feedstock logistics analysis and evaluate the techno-economic feasibility and environmental impacts of the strategies developed; 5) Develop and validate a predictive model that can guide the design and implementation of pyrolysis and gasification processes using biomass feedstocks with varying sulfur profiles.

Project Description: Variation in sulfur content and species represents an important concern to thermochemical conversion platforms in terms of deactivation to catalysts, equipment wear and air pollution. This proposed project specifically targets area of interest (AOI 2a) on relating biomass chemical characteristics to feedstock performance in conversion operations by addressing two topics under AOI 2a: 1) novel predictive models for relating plant tissue types in forest residues to biomass composition and 2) novel predictive models connecting chemical and physical characterization of biomass feedstocks with efficiencies in thermochemical conversions.

Methodology: An experienced team has been assembled to systematically investigate sulfur profiling and its fate during thermochemical conversion and develop TEA/LCA guided feedstock preprocessing/sulfur mitigation strategies. This project will use a combined experimental and modelling approach, the workplan being divided into 6 tasks: Task 1: Project initiation and validation; Task 2: Establish a sulfur profile library based on biomass sources; Task 3: Determine the fate of sulfur during thermochemical conversion; Task 4: Test effectiveness of sulfur removal/mitigation strategies; Task 5: Feedstock logistics and techno-economic (TEA) and life cycle analysis (LCA); Task 6: Predictive model setup and validation.

Potential Impact: The successful completion of this project will provide a thorough understanding of sulfur origin in relation to biomass feedstocks and its fate during thermochemical conversion and will improve the process efficiency for gasification by managing issues arising from the presence of sulfur. This project will lead to a detailed sulfur profile database along with other feedstock quality attributes, a suite of sulfur mitigation technologies and a predictive model that guide the design and implementation of thermochemical conversion of biomass feedstocks with varying sulfur profiles. Consequently, this will lead to sustainable domestic biofuel production, increased national energy security, and reduced greenhouse gas emission. EERE funding would advance biofuels and bioproducts research, help leverage resources and expertise across institutes and enable industry collaborators (including Red Rock Biofuels and others) to address the technical risks inherent in developing and scaling up thermochemical conversion technology.

Major Participants: University of Kentucky, Red Rock Biofuels, Kansas State University, Idaho National Laboratory, Mississippi State University