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Development of Online Tar Detection and Separation Technologies for Biomass Pyrolysis Gas

Biomass pyrolysis technology offers a renewable energy conversion pathway by transforming organic solid wastes such as agricultural residues and forestry by-products into valuable products including pyrolysis gas, biochar, and tar. Pyrolysis gas is a combustible mixture widely used for heat generation and synthesis of fuels. However, the presence of tar compounds—complex, viscous hydrocarbons—in the pyrolysis gas poses significant challenges. Tar tends to condense and deposit on pipelines and equipment surfaces, causing blockages, corrosion, and operational instability, thereby reducing system efficiency and increasing maintenance costs.

Efficient online detection and separation of tar in biomass pyrolysis gas are crucial for optimizing system performance and enabling real-time process control. Conventional tar detection methods rely on offline sampling and laboratory analysis, which are time-consuming and unable to provide continuous monitoring of tar concentration dynamics during pyrolysis. Existing separation techniques, such as condensation, adsorption, and filtration, often suffer from low efficiency, high energy consumption, and complex equipment requirements.

This research focuses on developing an integrated technology for online tar detection and separation tailored to biomass pyrolysis gas. High-sensitivity spectroscopic instruments will be employed for real-time quantitative analysis of tar components, combined with innovative separation devices such as advanced cyclone separators and membrane filtration systems to enable continuous tar capture and removal. System design and operating parameters will be optimized based on pyrolysis gas flow characteristics and tar particle size distribution to enhance detection sensitivity and separation efficiency.

The technology will be validated through laboratory-scale experiments and pilot-scale field tests to ensure stability and applicability. Successful deployment is expected to significantly improve the purification of biomass pyrolysis gas, reduce equipment downtime, and advance the clean and efficient utilization of biomass energy.