Experimental Investigation of Syngas Purification from Biogenic Residue Gasification

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Abstract

In the context of the energy transition, biogenic residues are becoming increasingly important as a renewable carbon source for the production of green base chemicals and synthetic fuels. Thermochemical gasification represents a promising technology for converting solid biogenic fuels into energy-rich synthesis gas. In addition to the desired main components – particularly hydrogen and carbon monoxide – this gas also contains a variety of undesired by-products such as particulates, chlorine compounds, ammonia, aromatic hydrocarbons, and acid gases like carbon dioxide and hydrogen sulfide. These impurities pose significant challenges for downstream processes, particularly for catalytic conversion routes to e-fuels or chemical intermediates.[1] To provide a purified synthesis gas suitable for further processing, a cost-efficient gas cleaning concept was experimentally investigated at pilot-scale at Technical University of Darmstadt as part of the BMWK-funded project VERENA.

The gas treatment plant is divided into six main process steps: Firstly, solid particles are separated by hot gas filtration, followed by a raw gas scrubber to cool the hot gas and remove halides and ammonia using water. The subsequent gas compression increases the operating pressure for the downstream processes. In the high-pressure hydrolysis stage, carbonyl sulfide (COS) and hydrogen cyanide (HCN) are converted into hydrogen sulphide (H_2S) and ammonia (NH_3). This is followed by the targeted removal of ammonia and BTEX compounds to prevent amine deactivation during acid gas removal. Finally, carbon dioxide and hydrogen sulphide are selectively removed using amine scrubbing.

The entire gas treatment system was tested in continuous operation with raw gas from biomass gasification. The results show a significant reduction in aromatic hydrocarbons, acid gases and other impurities. The cleaned gas therefore meets the requirements for downstream catalytic synthesis processes and contributes to the efficient utilization of biogenic residues in the context of a greenhouse gas-neutral energy system.

Reference

[1] Spliethoff, H., Fleck, S., Hartmann, D., & Weidner, E. (2024). Requirements on synthesis gas from gasification for material and energetic utilization. *Frontiers in Energy Research*, 12, Article 1382377. https://doi.org/10.3389/fenrg.2024.1382377