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Keynote – Electrification of Gasification Processes by Plasma Integration

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The keynote will address the question of how renewable electricity can be integrated into gasification processes for converting low-grade, high-ash waste with the lowest possible intrinsic CO_2 generation, while maintaining high-quality syngas and stable operation [1].
The presentation will focus on the technical feasibility and performance potential of allothermal plasma-assisted gasification in two representative reactor concepts, using a fixed-bed gasifier equipped with a H_2O thermal torch and a fluidized-bed gasifier with internal electric arc as building blocks for electrified circular carbon technologies.
A technology survey [2] identified arc plasmas as being suitable for integration on a large scale into slagging and fluidized-bed systems. Based on this, two experimental platforms were realized. In the fixed-bed system, a non-transferred arc plasma using pure steam as the plasma gas is used for gasification of carbonaceous waste products (e.g. graphite, plastics, GFRP/CFRP and waste wood) at temperatures above 1300 °C. In the fluidized bed, a free-burning arc [3] was integrated into the internal circulation zone of a sewage sludge gasifier that was operated with steam and CO_2. Test campaigns assessed stationary operation, syngas yield and composition, arc stability, and electrode erosion under autothermal and allothermal conditions.
The results demonstrate that plasma-assisted gasification can consistently convert low-grade, high-ash feedstocks into high-quality syngas while directly integrating electrical power. In the fixed-bed concept, syngas production was governed by the water–gas shift and the Boudouard reaction. In the fluidized bed, the integrated arc maintained high internal temperatures, achieving high conversion rates, high gas quality and reducing slagging. Optimizing the power supply and electrode geometry enabled increased plasma powers and extended stable operation.
Overall, electrified, plasma-assisted gasification appears to be a promising key technology for circular carbon systems, enabling the highest possible carbon efficiency.

KEYWORDS
Circular Carbon Technology, Chemical Recycling, Gasification, Electrification, Plasma integration

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