Supplementary Information

for

Optimizing the gasification performance of corn stover: regulation of the gasification temperature and the equivalent ratio in the lab-scale fixed-bed system

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Materials and methods

Characterization of feedstock

Proximate analysis of CS and its gasified bio-char was conducted according to the Chinese National Standard GB/T 28731-2012 (Methods for Proximate Analysis of Solid Biofuels). Ultimate analysis (C, H, N, S and O) was performed using an Elemental Analyzer (Vario EL, Elementar, Germany), with the oxygen content determined by difference. The calorific value was measured using a Bomb Calorimeter (ZDHW-300A, Hebi Keda Instrument Co., Ltd., China).

Characterization of gasified products

The composition of gasification gas was analyzed using a Gas Chromatograph (GC 9890B, Nanjing Renhua Chromatography Technology Co., China). The main detectable components included CO, H_2, CH_4, CO_2 and C_nH_m (e.g., C_2H_4, C_2H_6, C_3H_6, C_3H_8). The thermal conductivity detector (TCD) was operated at a column oven temperature of 85 °C and detector temperature of 95 °C, with high-purity argon (99.999%) as the carrier gas at a flow rate of 30–50 mL·min^{-1}. The flame ionization detector (FID) was set with an injector temperature of 150 °C and a detector temperature of 260 °C. The programmed heating procedure started with an initial hold of 13.9 min, followed by heating at 30 °C·min^{-1} to 180 °C, held for 17.94 min. The lower heating value (LHV, MJ·Nm^{-3}) of the product gas was calculated according to Equation S(1).

$$\mathrm{LHV} = 12.6V_{CO} + 10.8V_{H_2} + 35.9V_{CH_4} + 66.5V_{C_nH_m} \qquad \mathrm{S(1)}$$

Where V_{CO}, V_{H2}, V_{CH4} and V_{CnHm} denote the volume fractions (%) of the gas components.

Tar composition was determined by the Gas Chromatography–Mass Spectrometry (7890B–5977B, Agilent Technologies, USA). The tar was diluted with chromatographic-grade methanol, filtered through a 0.45 μm syringe filter, and injected for analysis. Separation was performed on an HP-5CS capillary column (30 m × 0.25 mm × 0.25 μm). The oven program was set at 40 °C for 3 min, then ramped at 10 °C·min^{-1} to 280 °C, held for 3 min. High-purity helium was used as the carrier gas at 1 mL·min^{-1}. The transfer line and injector were maintained at 300 °C, with injections in splitless mode. The mass spectrometer was operated in full-scan electron ionization mode with an ion source temperature of 230 °C, quadrupole temperature of 150 °C, scanning range of m/z 50–400, and a solvent delay of 7.5 min. The results for LHV and gas composition are based on the average values from three repeated experiments, with standard deviation shown as error bars in the figures.