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Ex situ tar elimination during densified refuse-derived fuel (d-RDF) gasification.

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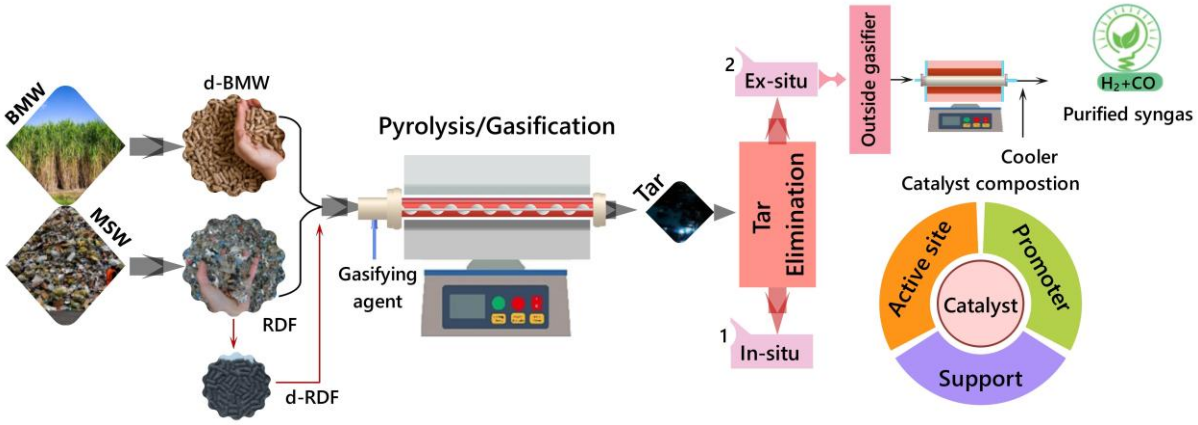
Graphical abstract



Abstract

The formation of tar presents a major obstacle to the advancement of densified refuse-derived fuel (d-RDF) pyrolysis/gasification technologies, highlighting the efficient tar conversion strategies critically important. Catalytic tar reforming has emerged as a prominent technique for improving the efficiency of d-RDF gasification. Using activated carbon (AC), with abundant pore structure, high surface area, and unique chemical properties demonstrated an efficient potential as a support in tar conversion, enhancing resource application and system efficiency. However, catalyst deactivation is a widespread issue that remains a key challenge in catalytic tar conversion, significantly limiting its industrial application. This paper investigates AC modification, activation, catalytic performance in tar reforming, deactivation mechanisms, and regeneration strategies. The ex-situ catalytic performance of the catalysts was evaluated at various reaction temperatures using a two-stage fixed-bed reactor. The Ni/AC catalyst, with a specific surface area of 925.06 m^2/g, demonstrated promising performance. As the catalyst loading increased from 0 to 18 g, the tar content was significantly reduced from 15 g/Nm^3 to 2.1 g/Nm^3, achieving a high tar conversion efficiency of 85 % at a catalytic reaction temperature of 800 °C. H_2 was the dominant gas in the product gas, likely due to the enhanced cracking and reforming reactions of tar facilitated by the catalysts. The total gas yield reached 53.5 %, with a lower heating value (LHV) of 12 MJ/Nm^3, H_2 yield of 13 mol/kg d-RDF, and a CO yield of 2.9 mol/kg d-RDF. In comparison to previous studies, the Ni/AC catalyst demonstrated competitive performance in terms of tar conversion efficiency. However, despite these advancements, sintering and coke deposition remain significant challenges in catalytic conversion of tar, necessitating improved modification strategies to enhance catalyst stability and activity.

Keywords: gasification, tar formation, catalyst, ex-situ tar conversion.