Syngas from palm oil mill effluent (POME) steam reforming over lanthanum cobaltite: Effects of net-basicity

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ABSTRACT

Steam reforming (SR) of palm oil mill effluent (POME) over net-basic $LaCoO_3$ was optimised for syngas production (FSyngas) and degradation efficacies (XP) by tuning temperature (T), POME flow rate ($V^{\cdot}$POME), catalyst weight (Wcat), and particle size (dcat). Net-basicity of $LaCoO_3$ facilitated the adsorption of Lewis acid CO_2, thereby assisted carbon removal via reverse Boudouard reaction. POME SR over $LaCoO_3$ was promoted by using (i) higher T (endothermicity), (ii) greater $V^{\cdot}$POME (larger partial pressure at constant weight-hourly-space-velocity and total feed rate), (iii) larger Wcat (longer residence time for POME vapour), and (iv) smaller dcat (higher surface area to volume ratio). Nevertheless, the catalytic activity of $LaCoO_3$ declined with (i) severe coking and sintering deactivation (T≥973 K), (ii) carbon-encapsulation ($V^{\cdot}$POME = 0.10 mL/min), (iii) agglomeration (Wcat>0.3 g), and (iv) pore occlusion (dcat<74 µm). Hence, the optimum conditions of POME SR over $LaCoO_3$ were T = 873 K, $V^{\cdot}$POME = 0.09 mL/min, Wcat = 0.3 g, and dcat = 74–105 µm. The optimised process able to produce syngas at a rate of 86.60 µmol/min whilst degrading POME to a less polluted liquid condensate (COD = 435 mg/L and BOD_5 = 62 mg/L).

KEYWORDS

Syngas generation; Palm oil mill effluent; Steam reforming; Wastewater valorisation

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