

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

*Yoke Wang Cheng<sup>a,c</sup>, Chi Cheng Chong<sup>a,c</sup>, Soon Poh Lee<sup>b</sup>, Jun Wei Lim<sup>c</sup>, Ta Yeong Wu<sup>d</sup>, Chin Kui Cheng<sup>a</sup>*

<sup>a</sup> Faculty of Chemical & Natural Resources Engineering, Lebuhraya Tun Razak, Universiti Malaysia Pahang, 26300, Gambang, Kuantan, Pahang, Malaysia

<sup>b</sup> Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang, Gambang, 26300, Kuantan, Malaysia

<sup>c</sup> Centre for Biofuel and Biochemical Research, Institute of Self-Sustainable Building, Universiti Teknologi PETRONAS, 32610, Seri Iskandar, Perak, Malaysia

<sup>d</sup> Chemical Engineering Discipline, School of Engineering, Monash University, Jalan Lagoon Selatan, 47500, Bandar Sunway, Selangor Darul Ehsan, Malaysia

## ABSTRACT

Steam reforming (SR) of palm oil mill effluent (POME) over net-basic  $\text{LaCoO}_3$  was optimised for syngas production (FSyngas) and degradation efficacies (XP) by tuning temperature (T), POME flow rate ( $V_{\text{POME}}$ ), catalyst weight ( $W_{\text{cat}}$ ), and particle size ( $d_{\text{cat}}$ ). Net-basicity of  $\text{LaCoO}_3$  facilitated the adsorption of Lewis acid  $\text{CO}_2$ , thereby assisted carbon removal via reverse Boudouard reaction. POME SR over  $\text{LaCoO}_3$  was promoted by using (i) higher T (endothermicity), (ii) greater  $V_{\text{POME}}$  (larger partial pressure at constant weight-hourly-space-velocity and total feed rate), (iii) larger  $W_{\text{cat}}$  (longer residence time for POME vapour), and (iv) smaller  $d_{\text{cat}}$  (higher surface area to volume ratio). Nevertheless, the catalytic activity of  $\text{LaCoO}_3$  declined with (i) severe coking and sintering deactivation ( $T \geq 973 \text{ K}$ ), (ii) carbon-encapsulation ( $V_{\text{POME}} = 0.10 \text{ mL/min}$ ), (iii) agglomeration ( $W_{\text{cat}} > 0.3 \text{ g}$ ), and (iv) pore occlusion ( $d_{\text{cat}} < 74 \mu\text{m}$ ). Hence, the optimum conditions of POME SR over  $\text{LaCoO}_3$  were  $T = 873 \text{ K}$ ,  $V_{\text{POME}} = 0.09 \text{ mL/min}$ ,  $W_{\text{cat}} = 0.3 \text{ g}$ , and  $d_{\text{cat}} = 74\text{--}105 \mu\text{m}$ . The optimised process able to produce syngas at a rate of  $86.60 \mu\text{mol/min}$  whilst degrading POME to a less polluted liquid condensate ( $\text{COD} = 435 \text{ mg/L}$  and  $\text{BOD}_5 = 62 \text{ mg/L}$ ).

## KEYWORDS

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

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