Syngas from catalytic steam reforming of palm oil mill effluent: An optimization study

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ABSTRACT

In this work, the syngas production rate (FSyngas) of LaNiO3-catalysed steam reforming of palm oil mill effluent (POME) was optimized with respect to POME flow rate (_VPOME), catalyst weight (Wcat), and particle size (dcat). With a net acidity, the synthesized LaNiO3 catalysed POME steam reforming by cracking the bulky compounds and valorising simpler intermediates into syngas. The degradation efficiencies (XP) were also evaluated by assessing wastewater parameters, viz. pH, chemical oxygen demand (COD), biochemical oxygen demand (BOD5), total suspended solids (TSS), and colour intensity (A). After steam reforming at 873 K, the liquid condensate has neutral pH and zero TSS. The parallel trend of FSyngas and XP verified syngas generation from degradation of POME's organics. At higher_V POME (0.05e0.09 mL/min), greater POME partial pressure promoted its steam reforming and water gas shift, which enhanced catalytic performance. Beyond optimum _VPOME (0.09 mL/min), coke-forming Boudouard reaction deteriorated catalytic activity. Catalytic performance was boosted for a longer residence time at higher Wcat (0.1e0.3 g); nonetheless, it was reduced by agglomerated catalyst when Wcat > 0.3 g. Finer LaNiO3 (dcat > 74 mm) with greater surface area to volume ratio exhibited better performance; however, ultrafine LaNiO3 (dcat < 74 mm) had poor performance because of occluded pores. Remarkably, optimized POME steam reforming over LaNiO3 (T ¼ 873 K, _VPOME ¼ 0.09 mL/min,Wcat ¼ 0.3 g, dcat ¼ 74e105 mm) has generated 132.47 mmoL/min of H2-rich syngas, whilst achieved 99.53% XCOD, 99.88% XA, 99.75% XBOD5, and 100% XTSS.

KEYWORDS: Palm oil mill effluent; Wastewater remediation; Steam reforming; Syngas production