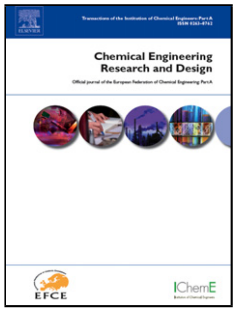

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Thermodynamic evaluation of chemical looping based nitric oxide and hydrogen production

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Abstract

A new chemical looping based process for the production of nitric oxide and hydrogen has been recently proposed and demonstrated for metal oxides such as CuO, Co_3O_4 and Fe_2O_3 (Thengane et al., 2016a). The present study extends the work and compares the conventional Ostwald process for nitric oxide production with this chemical looping based process. Two flowsheets are considered for the new process; the reduced metal oxide is re-oxidised using air (CLAO) and the reduced metal oxide is re-oxidised with water (CLHYD). Both processes are simulated in Aspen Plus and compared with the conventional steam methane reforming (SMR) flowsheet, which is also simulated. Both the energy and exergy efficiencies are calculated. The energy efficiency of the three processes; SMR, CLHYD and CLAO including the steam generation potential are 69.2 %, 81.2 % and 93.7 %, respectively. The exergy efficiency of the three processes; SMR, CLHYD and CLAO are 39.9 %, 63.3 % and 63.7 %, respectively. A hybrid case (CLHYD-AO) is also simulated to obtain the energy efficiency of 91.7 % and the highest exergy efficiency of 76.5 %. The exergy efficiency is particularly sensitive to NO conversion for the chemical looping processes, where the assumed conversion was 80% based on the experimental results. The chemical looping based processes therefore offer significant advantages such as operation at lower pressures,