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ENERGY MINIMIZATION OF HYDROGEN PRODUCTION VIA BUTANOL STEAM REFORMING

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Abstract

Steam reforming is currently the most common process for hydrogen production, but its use is mainly limited to fossil-based fuels such as natural gas. In an effort to diversify the hydrogen matrix, alternative sources have been considered, among which butanol appears as a potentially renewable source. The present study provides a detailed thermodynamic discussion about the operational parameters influencing hydrogen yield and heat consumption in an Aspen Plus® simulated cycle. The effect of key operational variables over hydrogen yield and heat duty was initially assessed through Response Surface Methodology (RSM) and later optimized with the Multi-Objective Lichtenberg Algorithm (MOLA). Results indicated that, for most of the operational range, reducing the steam/butanol molar ratio had a stronger influence on decreasing the heat duty required for optimal hydrogen production. The optimal temperature was kept at 800 °C even after the steam molar ratio reached lower values (4-4.5 mol/mol). At high temperatures and steam ratios, higher water gas shift temperatures were more efficient because they avoided unnecessary heat removal, despite losses in hydrogen production due to chemical equilibrium. The Pareto also presented a nearly vertical region, which indicated that hydrogen yield could not be significantly increased after 94.4%.

Keywords: butanol, hydrogen, meta-heuristics, steam reforming

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