0.5 wt% Ru/γ-Al_2O_3 is a highly active and stable catalyst for direct conversion of biogas into renewable natural gas

Yichen Zhuang[1] and David Simakov[1]

[1]University of Waterloo

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Abstract

Landfill gas is a source of CH_4 emission, also rich in CO_2 (up to 50 vol%). It can be upgraded to renewable natural gas (RNG) by separating CO_2 and impurities. Alternatively, the CO_2 contained in biogas can be converted into CH_4 via the Sabatier reaction, using H_2 generated by water electrolysis. For industrial applications, it is beneficial to eliminate the energy intensive CO_2 separation step, converting biogas to RNG directly. In this work, a series of 0.02-1 wt% Ru/γ-Al_2O_3 catalysts were prepared by wet impregnation and evaluated for a single-pass conversion of CO_2-CH_4 mixtures. Through the catalytic performance evaluation and characterization studies, the optimal Ru loading was identified as 0.1-0.5 wt%. For these catalysts, CO2 conversion of 80-87% was achieved at 450 °C and 90,000 mL/(g h), maintaining 95-99% selectivity to CH_4 production. These catalysts also showed excellent stability over 100 h on stream, while maintaining 99-100% CH_4 selectivity.

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