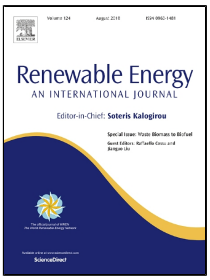
Accepted Manuscript



Methanation of Carbon Dioxide over Ru/Mn/Ce-Al_2O_3 Catalyst: In-Depth of Surface Optimization, Regeneration and Reactor Scale

Susilawati Toemen, Salmiah Jamal Mat Rosid, Wan Azelee Wan Abu Bakar, Rusmidah Ali, Siti Fadziana Sulaiman, Rahim Hasan

PII:	S0960-1481(18)30507-X
DOI:	10.1016/j.renene.2018.04.082
Reference:	RENE 10040
To appear in:	*Renewable Energy*
Received Date:	06 September 2017
Revised Date:	23 March 2018
Accepted Date:	27 April 2018

Please cite this article as: Susilawati Toemen, Salmiah Jamal Mat Rosid, Wan Azelee Wan Abu Bakar, Rusmidah Ali, Siti Fadziana Sulaiman, Rahim Hasan, Methanation of Carbon Dioxide over Ru/Mn/Ce-Al_2O_3 Catalyst: In-Depth of Surface Optimization, Regeneration and Reactor Scale, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.04.082

Methanation of Carbon Dioxide over Ru/Mn/Ce-Al_2O_3 Catalyst: In-Depth of Surface Optimization, Regeneration and Reactor Scale

Susilawati Toemen[a]*, Salmiah Jamal Mat Rosid[b], Wan Azelee Wan Abu Bakar[a]*, Rusmidah Ali[a], Siti Fadziana Sulaiman[a], and Rahim Hasan[c]

[a]*Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia.*

[b]*Unisza Science and Medicine Foundation Centre, Universiti Sultan Zainal Abidin, Kampus Gong Badak, 21300 Kuala Nerus, Terengganu, Malaysia.*

[c]*Research Department and Environmental, Tenaga Nasional Berhad, 41990 Klang, Selangor, Malaysia.*

*Corresponding Authors' E-mail: susilawatitoemen@utm.my; wazelee@kimia.fs.utm.my

Abstract

Converting the CO_2 gas *via* catalytic methanation technology has significant potential application in the power plant industry. Therefore, ceria based catalyst impregnated with Ru/Mn/Al_2O_3 was developed and from the experimental results, the optimum conditions over potential Ru/Mn/Ce(5:30:65)/Al_2O_3 catalyst was achieved with 65 wt% of Ce based loading calcined at 1000^{o}C gave 97.73% of CO_2 conversion with 91.31% of CH_4 at 200^{o}C of reaction temperature. 10 g of the potential catalyst was pre-reduced at 300^{o}C for 30 minutes in the presence of H_2 gas prior to the start of catalytic testing. The reliability, robustness, reproducibility and regeneration testing of this catalyst were further studied. The catalyst started to deactivate (spent catalyst) at sixth testing with only gave 41.17% CO_2 conversion. However, the catalyst can be regenerated in the presence of compressed air at 400^{o}C for 3 hours as it gave 92.85% of CO_2 conversion. From the characterization of spent catalyst, the factor for the catalyst deactivation in this reaction was the particle agglomeration due to the loss of RuO_2 and Mn_2O_3 species. When the catalyst was scale-up, the result showed that Ru/Mn/Ce(5:30:65)/Al_2O_3 catalyst able to convert 60% of CO_2 and 50.4% of methane formation at lower reaction temperature of 160^{o}C.

Keywords: methanation, scale-up, flue gases, carbon dioxide, catalyst, ceria