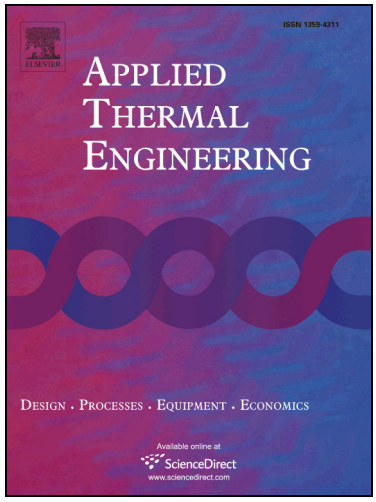

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PII: S1359-4311(16)30478-1
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.03.170
Reference: ATE 8038

To appear in: *Applied Thermal Engineering*

Received Date: 25 February 2016
Accepted Date: 31 March 2016

Please cite this article as: H. Kong, Y. Hao, H. Wang, A Solar Thermochemical Fuel Production System Integrated with Fossil Fuels, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.03.170

A Solar Thermochemical Fuel Production System Integrated with Fossil Fuels

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Abstract:

Thermochemical cycling (TC) is a promising means of converting solar energy into chemical fuels. Isothermal solar TC has the potential of achieving high solar-to-fuel efficiencies contingent on effective gas-phase heat recovery at high temperatures. We propose an approach of simultaneously recovering waste heat and unreacted gas species (e.g. H_2O or CO_2) downstream the isothermal TC reactor by taking advantage of endothermic reactions of certain fossil fuels (e.g. CH_4). Such comprehensive utilization and the syngas produced enable the establishment of a polygeneration system for simultaneous power and methanol production with the possibility of eliminating the self-generation power-plant that is conventionally needed for methanol production. A scheme is conceptually proposed based on the type of splitting reaction in isothermal TC, and optimization of the polygeneration system is discussed with solar conversion efficiency as the objective. Fossil fuel consumption for the production of a unit mass of methanol is about 22GJ/ton, lower than typical values in current industrial processes. Compared with direct solar reforming or direct combustion of the same fossil fuels, this new approach features lower carbon emissions per unit calorific value of fuel obtained due to the incorporation of the isothermal TC upstream.

Keywords:

Isothermal, Polygeneration, Solar Fuel, Syngas, Thermochemical Cycling, Methanol.