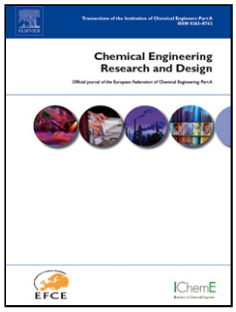

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Dynamic Simulation and Control of an Integrated Gasifier/Reformer System. Part I: Agile Case Design and Control

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ABSTRACT:

This two-part series investigates the feasibility of the operation and control of a novel gasifier cooling system which integrates steam methane reformer tubes into a gasifier radiant syngas cooler. This approach capitalizes on available exergy by producing valuable H_2-rich synthesis gas (syngas) for liquid fuel production. In Part I (this work), an 'agile' device design was developed for both counter-current and co-current flow configurations, wherein a PI control structure was designed to achieve performance objectives. Key trade-offs were found between the configurations: the counter-current design was more robust and effective in rejecting moderate and severe gasifier disturbances, while providing greater cooling duty and natural gas throughput, but at the expense of higher tube wall temperatures, which can greatly reduce tube lifetime. The co-current design operates in a safer temperature range and satisfactorily rejects moderate disturbances, but requires feedforward control to handle extreme gasifier upsets. Using the co-current design, the flexibility of the device to adjust natural gas throughput based on variations in downstream syngas demand was demonstrated.

Keywords: Steam methane reforming, gasification, dynamic simulation, polygeneration, control

Nomenclature

Abbreviations	
C-C	Cohen-Coon
COT	Coil Outlet Temperature
CV	Controlled Variable
DMC	Dynamic Matrix Control
DV	Disturbance Variable
FT	Fischer-Tropsch
GE	General Electric
IAE	Integral Absolute Error
IGCC	Integrated Gasification Combined Cycle
IMC	Internal Model Control
ITSE	Integral Time Squared Error
HPS	High Pressure Steam