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Embedding Methane Steam Reformer and Methanol Reactor into a Single Reactor

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Abstract

Non-incremental reductions in process plant size, cost reduction, safety, environment, and energy are some of the major objectives that currently drive the process industry towards intensifying the existing and future installations. In the present study, direct coupling of methane steam reformer and methanol reactor has been proposed. The synthesis gas produced in reformer was directly fed to methanol reactor skipping secondary reformer and shift convertors. A heterogeneous steam reformer model was developed and embedded with heterogeneous methanol reactor model. The set of differential algebraic equations was solved in MATLAB. Steady state and dynamic simulation results were validated against real plant data. The results showed gradual increase in the methanol mole fraction along the reactor length with a simultaneous decrease in CO and CO_2 levels. Although, the methanol yield achieved through this new reactor scheme remained unchanged, but the reduction in number of equipment and heat integration may help lower operational and capital cost and overall energy demand of the plant.
Keywords: Energy, Methanol, Modeling, Reactor Coupling, Synthesis gas

1. Introduction

Methanol is among few renewables which have the potential to replace or at least minimize dependency on fossil fuels. Commercially, methanol is produced in a three step process; Steam reforming, Methanol conversion, and Product separation. Like every other alternative fuel, the major constraint is end user product cost or market competency in terms of economic benefits. Basini [1] estimated that in most applications of synthesis gas such as methanol, about 60-70% of the cost of the overall process is associated with syngas generation, 20-25% for liquid fuel production and the rest of 5-15% for final product upgrading and purification.

Environmentally benign technical solutions, sustainability, efficient plant design, optimization of process schemes and development of new technologies are only few of the methods that may be adopted to hold decrease in the capital cost of any process in general [2; 3] and methanol in particular McGuire et al. [4]. In the present study, a new scheme is proposed that has the potential to not only save energy but can also help to considerably reduce capital investment. The main objective of this research is to model the novel idea of merging steam reformer and methanol convertor in a way to save on energy and capital investment.