

GHGT-10

CO₂ reduction potential of coal-to-liquids (CTL) process: Effect of gasification technology

Hari C. Mantripragada^{a1*} and Edward S. Rubin^a

^a Dept. of Engineering and Public Policy, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA 15213, USA

Abstract

Coal-to-liquids (CTL) is a process of producing synthetic transportation fuels from coal. The process involves gasification of coal to produce synthesis gas which is then catalytically converted to liquid fuels in a Fischer-Tropsch (FT) reactor. A major concern of CTL plants is their emissions of carbon dioxide (CO₂) produced as part of the process. A significant fraction of the plant-level CO₂ is produced in the gasification process, which needs to be separated before the syngas is fed into the FT reactor. In this paper, CTL processes using two different coal-feeding methods – slurry and dry – are studied for their effect on the performance, emissions and cost of a CTL plant. The slurry-fed and dry-fed systems are modeled based on the commercially available GE and Shell gasifier designs, respectively. Effect of implementing CCS or carbon constraints that impose a price or cost on CO₂ emissions is also studied. The potential of the co-production configuration to reduce the overall CO₂ emissions by displacing conventional pulverized coal power plants is also investigated.

It was found that the process using a dry-feed Shell gasification is more efficient, emits less CO₂ and has lower capital and product costs compared to a CTL plant using a slurry-feed GE gasifier. For both the cases, the costs of liquid product from both liquids-only and co-production plants are comparable to the crude oil prices seen in the past 2-3 years. Though co-production plants are much costlier than liquids-only configurations in terms of capital cost, because of the high electricity revenues, the cost of liquid product is lower than that of the liquids-only case, at market prices of electricity. Co-production is also much more efficient than the separate production of liquids and power and, the difference in efficiency increases with the addition of CCS.

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Keywords: Coal-to-liquids; Fischer-Tropsch; carbon capture and storage; co-production; cost of liquid product.

1. Introduction

Coal-to-liquids (CTL) is a process of producing synthetic transportation fuels from coal, to replace or supplement conventional supplies of diesel oil and gasoline derived largely from imported oil. In the most commonly used CTL technology, coal is first gasified to produce synthesis gas (or syngas) which is subsequently converted to liquid hydrocarbons like gasoline and diesel in a catalytic Fischer-Tropsch (FT) process [1]. These fuels are very clean in

* Corresponding author. Tel.: +1-412-268-5284; fax: +1-412-268-3757.
E-mail address: mharichandan@cmu.edu.