Biomass Co-fed Advanced IGCC Plants with CCS and Co-production

OVERVIEW

Gasification of coal co-fed with biomass has been demonstrated to produce syngas which can be further utilized for the co-production of power along with hydrogen, fuels, and chemicals. However, preliminary and/or conceptual designs for integrated, economically viable co-production facilities and/or processes are lacking. In particular, conceptual designs incorporating advanced concepts (i.e., oxygen production, feed systems, warm gas cleanup, membrane separation, advanced turbines, etc.) have received minimal attention.

GOALS

The overall goal of the program is to develop design concepts incorporating advanced technologies for integrated and economically viable biomass-coal fed gasification facilities equipped with carbon capture and storage for the co-production of power along with:

- Hydrogen
- Fuels
- Petrochemicals
- Agricultural chemicals.

RESULTS

Co-production with 50% of the energy exported in the form of electricity, the electrical efficiency, as expected, is highest for hydrogen co-production while lowest for higher alcohols (ethanol) co-production. The electrical efficiencies for Fischer-Tropsch co-production are slightly higher than those for the methanol co-production but it should be noted that the methanol (as well as the higher alcohol) co-production cases produce the finished co-product while the Fischer-Tropsch co-production cases produce a co-product that requires further processing in a refinery. The cross comparison of the thermal performance between the various co-product cases is further complicated by the fact that the carbon footprint is not the same when carbon leaving with the co-product are accounted for. The economic analysis and demand for a particular co-product in the market place is a more meaningful comparison of the various co-production scenarios.

RESULTS (continued)

The first year cost of electricity calculated for a bituminous coal is $102.9/MWh while that for a lignite is $108.1/MWh. The calculated cost of hydrogen ranged from $1.42/kg to $2.77/kg depending on the feedstock, which is lower than the DOE announced hydrogen cost goal of $3.00/kg in July 14, 2005. Methanol cost ranged from $345/tonne to $617/tonne, while the market price is around $450/tonne. For Fischer-Tropsch liquids, the calculated cost ranged from $65/bbl to $112/bbl, which is comparable to the current market price of crude oil at around $100/bbl. It should be noted, however, that F-T liquids contain no sulfur and nitrogen compounds. The calculated cost of alcohol ranged from $4.37/gal to $5.43/gal, while it ranged from $2.20/gal to $3.70/gal in a DOE funded study conducted by Louisiana State University. The Louisiana State University study consisted of a significantly larger plant than our study and benefited from economies of scale. When the plant size in our study is scaled up to similar size as in the Louisiana State University study, cost of alcohol is then reduced to a range of $3.24/gal to $4.28/gal, which is comparable. Urea cost ranged from $307/tonne to $428/tonne, while the market price is around $480/tonne. These results show that the various co-products may be produced economically utilizing the advanced technologies identified in this study.

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