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CO₂ reduction potential of coal-to-liquids (CTL) plants

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Abstract

Coal-to-liquids (CTL) processes generate synthetic liquid fuels like gasoline and diesel fuel from coal. One main concern of coal liquids, however, is the large emissions of carbon dioxide (CO₂) from the CTL process. These emissions can be mitigated using carbon capture and sequestration (CCS) technology. A comprehensive techno-economic assessment model of liquids-only and poly-generation (producing liquid fuels plus electricity) CTL plants, capable of incorporating CCS is developed. To account for inherent uncertainties and variability, ranges and probability distributions are given to different cost parameters. Finally, the capability of a poly-generation CTL plant in mitigating CO₂ emissions by displacing conventional coal-fired power plants while producing liquid fuels is also investigated.

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1. Introduction

Depleting crude oil reserves and increasing oil prices have stimulated renewed interest in synthetic transportation fuels, such as those derived from coal, to replace or supplement conventional diesel and gasoline. In the most commonly used coal-to-liquids (CTL) technology, coal is first gasified to produce synthesis gas (or syngas) which, in turn, is catalytically treated in a Fischer-Tropsch (FT) process to produce different liquid fuels like gasoline and diesel [1]. These fuels are very clean in terms of criteria air pollutants like nitrogen and sulfur oxides and aromatic hydrocarbons.

Two general configurations of CTL plants are possible as shown in Fig 1. In a typical commercial CTL plant shown in Fig 1(a), the unconverted syngas from the FT reactor is recycled to the reactor to increase the productivity of the liquids. In this paper, such plants are called ‘liquids-only’ plants. Another configuration shown in Fig 1(b), though not yet commercial, is also possible in which the unconverted syngas from the FT reactor, instead of being recycled, is combusted in a gas turbine steam turbine combined cycle power plant to generate electricity. Plants with such a configuration are called ‘poly-generation’ plants in this paper. The by-product electricity can be sold to the