II.B.5 Hydrogen Production for Fuel Cells via Reformation of Coal-Derived Methanol

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Objectives

- Establish and prove a hydrogen production pathway from coal-derived methanol for fuel cell applications.
- Demonstrate hydrogen production from a coal-derived fuel.
- Test the resulting hydrogen gas, if of sufficient quality, in an existing proton exchange membrane (PEM) fuel cell stack.

Introduction

A viable method of creating methanol from high-sulfur coal was established in 1997. Recent interest in hydrogen fuel cells and fuel cell vehicles has prompted the question of using this coal-derived methanol as a primary source for hydrogen production. Initial testing has indicated that hydrogen can be derived from this coal-based fuel but impurities were seen as problematic, especially for utilization in fuel cells. The coal-derived methanol has since been further refined and distilled, yet no full analysis of reforming this high-grade coal-derived methanol using the latest reforming methods has yet taken place.

Eastman Chemicals of Kingsport, Tennessee has agreed to supply the University of California, Davis with sufficient quantity of plant-produced coal-derived methanol for use in this investigation. Baseline investigations and comparisons will take place with reference to high-grade methanol used in fuel cell vehicles supplied by Methanex.

Approach

The approach employed in this project is to conduct research in the following six areas:

1. Autothermal catalyst degradation due to start-up and shut-down
2. High pressure reformation system
3. Hydrogen separation system
4. Initial fuel cell testing
5. Fuel cell load bank system
6. Hydrogen storage

Results

High purity hydrogen from coal-derived methanol has been produced and initial tests on a Nexa system (PEM Ballard fuel cell) have been completed.

Autothermal reformation holds great promise for those interested in using coal-derived methanol for fuel cell applications, because no noticeable degradation occurred for the coal-derived methanol. Autothermal reformation continues to show promise for extended use.

Accomplishments

An autothermal catalyst degradation test composed of 30 separate cold start-up and full shut-down cycles was completed using coal-derived methanol. The total reformer operation was 100 hours. In this study, fuel lean start-up and lean shut-down processes have been chosen due to the higher temperatures experienced during start-up and shut-down. The experimental results show no significant change in catalyst activity based on temperature in both start-up and shut-down procedures, as well as in steady-state operation. Autothermal reformation degradation was significantly less than steam reformation degradation of coal-derived methanol. A hydrogen separation system was installed to separate the hydrogen from the reformate exiting the reformer since PEM fuel cells require high quality hydrogen for fuel. Preliminary gas analyses show satisfactory hydrogen purity when compared to the hydrogen produced from electrolyzing water.

Future Directions

Current research in the Hydrogen Production and Utilization Laboratory is one step away from achieving the main objectives of this project: to establish and prove a hydrogen production pathway from coal-derived methanol for fuel cell applications. This will be demonstrated by the integrated operation of the autothermal reformer with a PEM fuel cell. A palladium membrane reactor has been purchased and will be integrated into a hydrogen separation system with the goal of producing 99.95% pure hydrogen from coal-derived methanol.

FY 2006 Publications/Presentations

1. Results from the coal derived methanol using autothermal reformation will be presented at the coal conference at Pittsburg in September 2006.

References

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