

## 460f Autothermal Reforming of Jet Fuel for Sofc Apus

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### Introduction

Autothermal reforming (ATR) of Jet A and JP-8 is a promising process to deliver syn-gas streams to solid oxide fuel cells for use with jet fuels. Autothermal reforming combines exothermic partial oxidation with endothermic steam reforming, and is considered one of the most attractive options for on-board reforming of kerosene type fuels. The reaction temperatures of ATR tend to be lower than in partial oxidation. Compared to steam reforming, ATR requires less catalyst, less water, starts faster, and has better dynamic response to control actions or changes in feed conditions. Typical catalysts used for ATR of hydrocarbons include Ni, Pt, and Pt-Ni on  $\text{Al}_2\text{O}_3$  and  $\text{ZrO}_2\text{-Al}_2\text{O}_3$  supports.

Reforming of jet fuels requires catalysts that are flexible enough to process fuel of varying composition, as Jet-A and JP-8 formulations vary with geography, season, and refinery. Improved autothermal reforming catalyst formulations are required to address the need of required fuel flexibility, high activity, transient response, and resistance to coking and sulfur deactivation. Sulfur deactivation and coking are particularly relevant to JP-8 fuel processing because of its high sulfur and aromatic content.

Recently, catalyst supports with oxygen storage capacity and oxygen ion conductivity have attracted attention for their enhanced activity and coking resistance for reforming. Specifically, catalysts comprised of metals supported on doped mixed oxides of ceria. In this work supported nickel ceria-zirconia catalysts have been prepared and tested for autothermal reforming activity of jet fuel surrogates, with and without common fuel additives, commercial Jet A and JP-8. The effects of reaction temperature, space velocity, steam to carbon ratio, and oxygen to carbon ration have been investigated. The performance of nickel-ceria catalysts have been compared to more traditional nickel and platinum on alumina catalysts

### Materials and Methods

The ceria-zirconia ( $\text{CeZrO}_2$ ) supports were prepared by co-precipitation in aqueous solution of the corresponding metal salts by addition of 2M  $\text{NH}_4\text{OH}$ . For ceria-zirconia the salt precursors were:  $\text{Ce}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$  and  $\text{ZrOCl}_2 \cdot 8\text{H}_2\text{O}$ . The ceria-zirconia was prepared with a composition of  $\text{Ce}_{0.75}\text{Zr}_{0.25}\text{O}_2$ . After precipitation, the slurry is aged overnight and then dried overnight in air at 110 °C. Once dry, nickel is deposited on the support by wet impregnation with a solution of  $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  in ethanol or water. After wet impregnation the catalysts are dried in air at 110 °C and then calcined in air at 600 °C for one hour.

Catalytic reaction experiments were carried out using a flow reactor apparatus. Powder catalyst samples ranging from 500-1000 mg were loaded into ¼ inch quartz tubes and placed into a tube furnace. The flow of air was metered using mass flow controllers (MKS). Fuel and water were delivered using a combination peristaltic pumps (INSTECH) and a syringe pump (Isco). Jet fuel surrogates consisted of single component, and binary mixtures of n-dodecane, and tetralin. The characteristic fuel additives of JP-8, such as Stadis450 and di-ethylene glycol monomethyl ether, were added to single component feeds. Jet A and JP-8 samples were obtained from ChevronTexaco. The reactor effluent analysis was conducted using a gas chromatograph (Varian CP-3800) equipped with both thermal conductivity and flame ionization detectors.

## Significance

The development of stable active catalysts for jet fuel reforming is needed for the development of auxiliary power units.