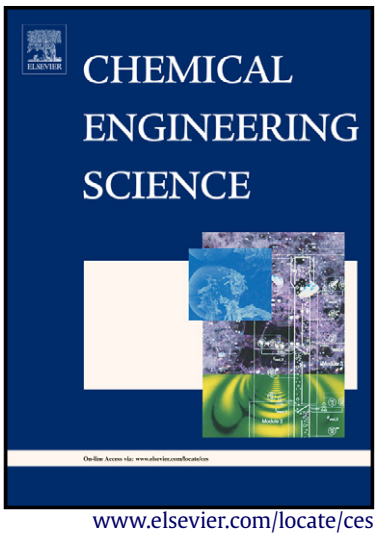

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A NEW SLURRY BUBBLE COLUMN REACTOR FOR DIESEL FUEL

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Abstract

Multiphase CFD simulations have shown how to design reactors using Fischer-Tropsch chemistry. The new design uses large catalyst particles to eliminate large bubbles, has no cooling tube bundles and produces up to 50,000 bbl/day of Diesel fuel in a 7 meter diameter, 12 meter high reactor at a pressure of 3 MPa and a temperature of 530 K.

Key Words

Fluidization, Computation fluid dynamics, Fischer-Tropsch reactor, Diesel fuel, Fracking, Natural gas.

Highlights

- A multiphase CFD model was used to design a new Fisher-Tropsch reactor.
- Catalyst, liquid and gas volume fractions agree qualitatively with experiments.
- The new reactor has no cooling tubes and is therefore less expensive.
- The use of large catalyst particles leads to greatly increased Diesel fuel production.
- Multiple jet inlets allow operation in the turbulent flow regime.

Introduction

The availability of gas from fracking makes it economical to produce liquid fuels using Fisher- Tropsch technology. In this process, the gas, primarily methane is reacted with steam to produce hydrogen rich synthesis gas, as shown below.

$$CH_4 + H_2O \rightarrow CO + 3H_2 \qquad \Delta H = 206 KJ/mol \qquad (1)$$

A recent ACS symposium, "Ultraclean Transportation Fuels" edited by Olayinka. I. Ogunsola and Isaac K. Gamwo(2007), and perspective "The Impact of Shale Gas in the Chemical Industry" by Jeffrey J. Siirola (2014), gave excellent reviews of the subject. The National Renewable Energy Laboratory Spath and Dayton(2003) provides estimates of costs needed to construct reactors for such synthesis.

Step one is the synthesis gas production as shown above. Basically water is split to produce hydrogen, requiring energy supplied by burning extra methane. The second step is a catalytic reaction of carbon monoxide and hydrogen to produce water and Diesel fuel (CH_2), as shown below.

$$CO + 2H_2 \rightarrow CH_2 + 2H_2O \qquad \Delta H = -165 KJ/mol \qquad (2)$$