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U.S. Department
of Transportation



Project Title: Critical analysis of syngas fermentation reactors for biological alcohol production

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Project Goal:

- The goal of this research is to expand our understanding of reactors used in hybrid gasification-syngas fermentation technology.
- To achieve this, we measured and compared the mass transfer coefficients ($k_L a/V_L$) of trickle-bed reactor (TBR), various types of hollow fiber reactor (HFR), and continuous stirred tank reactor (CSTR). The effect of agitation speed, gas and liquid flow rates on the mass transfer capabilities of the three reactors was studied.

Project Outcomes:

- Evaluation of the enhancement of mass transfer and associated alcohol productivity in various types and modifications of reactor designs. The three reactor designs are trickle-bed reactor (TBR), continuous stirred tank reactor (CSTR), and hollow fiber membrane reactor (HFR). Five different types of HFRs were examined. We found that the reactor geometry, material of construction, volume, and operating conditions affect the mass transfer and associated gas utilization and biofuel productivity. These findings are critical in designing reactors for efficient biofuels and chemicals production from syngas.
- Development of a novel method to sustain culture activity, gas uptake and improve selectivity for ethanol production during syngas fermentation in the CSTR. This method produced 26 times the ethanol concentration compared to the standard method.
- Development of a new technique to measure the mass transfer coefficients for H_2 and CO using gas chromatography and gas flow rate measurements. A mass transfer model was derived and found to be in very good agreement with the experimental data for CO and H_2 .



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Funded: \$ 374,999.00

Start Date: 12/1/2009

End Date: 11/30/2013

Other Sources of

Funding: Oklahoma State University and Brigham Young University respectively covered the cost sharing portion of this award.