



Rocky Mountain AICHE News

November 2004

Volume 14 Number 3

November Section Meeting: Solid Oxide Fuel Cells

Fuel cell technology has the potential to increase energy efficiency and minimize detrimental environmental impacts compared to conventional combustion. Solid-oxide fuel cells (SOFC), in particular, offer a very promising method for direct production of electrical energy from currently available fossil fuels, thus postponing the need to build a hydrogen delivery infrastructure. Hybrid SOFCs, coupled with a heat recovery system such as a gas turbine generator, have the potential for fuel-to-electricity efficiencies approaching 75 – 80%. An added advantage of SOFC operation is the ability to use CO as a fuel, unlike Polymer Electrolyte Membrane (PEM) fuel cells where even trace amounts of CO can poison the cell. Thus SOFC units are particularly suited for running on syn gas, which can be produced from either coal or biomass.

However, SOFC operation has substantial challenges, especially in regard to formation of deposits within the anode channel and within the anode itself. In this presentation we will discuss our approach to the analysis of SOFC operation as a coupled kinetics/transport problem. The nominal SOFC operating temperatures of 600-800°C results in substantial conversion of the hydrocarbon fuel as it flows through the anode channels (gas-phase chemistry) and the porous anode (catalytic chemistry) before reaching the three-phase region where the electrochemistry occurs. We have explored this chemistry by using plug-flow models that are modified to accommodate the effects of oxygen ion flux through the electrode-electrolyte assembly. The gas-phase and catalytic kinetics are

November Section Meeting

- Speaker:** Dr. Anthony M. Dean
Professor of Chemical Engineering,
Colorado School of Mines
- Topic:** Solid Oxide Fuel Cells
- Date:** Tuesday, November 16th
- Time:** 6:00 Social Hour/Cash Bar
6:45 Dinner
7:30 Presentation
- Location:** Westminster DoubleTree
8733 Yates Dr., Westminster
- Menu:** Black bean & corn salad
Tossed Garden Salad
Make-your-own fajitas beef/chicken
Refried beans
Santa Fe Rice
Sopapillas
- Cost:** Members: \$20
Non-Members: \$25
Students & Unemployed: \$10

Please RSVP by **Friday, November 12th** (early RSVPs are greatly appreciated!). Indicate your name, phone number, and number of attendees by e-mailing Tom Wellborn at rockyaiche@yahoo.com. Alternatively, you may leave a voice mail for Tom at 303-933-0533.

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described in terms of elementary reactions. This analysis allows us to predict which species are actually available for electrochemical oxidation and also to explore approaches to minimize deposit formation.

Anthony M. Dean is the William K. Coors Distinguished Professor of Chemical Engineering at the Colorado School of Mines. He did his undergraduate work at Spring Hill College and received his Ph.D. in Physical Chemistry from Harvard University. He taught at the University of Missouri-Columbia for 9 years. He then spent 21 years in the Corporate Research Labs at Exxon Research and Engineering, where his efforts focused on the quantitative kinetic characterization of gas-phase reaction systems. The resulting insights were used to develop improved-fuel/advanced-engine concepts to improve efficiency and decrease emissions of internal combustion engines. This research led to 11 patents and numerous publications. He joined the CSM faculty in 2000, where his research activities have been extended to include high-temperature fuel cells that can run on fossil fuels.

NEW MEXICO CORNER

New Mexico members are getting active and organized. If interested in participating, please contact Kerri Pratt at PrattKL@cdm.com for more information.

Overnight Trip to Tour Sandia National Laboratory

Rocky Mountain AIChE is considering a trip to Sandia National Laboratory on the weekend of March 5th or 12th of 2005. Estimated cost per person would be \$150 (including meals and accommodations) and would entail leaving at 3 pm on Friday, staying overnight in Santa Fe, touring Sandia on Saturday from 9 am to 1 pm, and returning to Denver about 11 pm Saturday night. For an additional \$100 (due to 2nd overnight & meals) a visit to the nuclear test site of Los Alamos (from 3p to 6pm Sat & 2nd night in Santa Fe) could be included, returning 3 pm Sunday. Email Tom Wellborn with your level of interest and cost limitations at rockyaiche@yahoo.com.

November Puzzler: Can you find a solution?

Problem: A world scale (14,400 bpd) methanol unit suffered a full unit trip (shutdown) when the water/carbon molar ratio fell below 3 prior to steam-methane reforming, the first of two reaction steps in methanol production. A full unit trip required at least a day to restart and bring the product to specification, and the costs amounted to \$150M, including \$75M/day in lost production. A water/carbon ratio less than 3 would cause an irreversible coating of the reformer catalyst with carbon, requiring 3 weeks for catalyst replacement. About a third of the water requirement was provided by saturating the natural gas feedstock in a water saturator, prior to injecting saturated steam to bring the ratio to an optimal target above 3. The saturator circulation pump and its backup were powered by electric motors, and any power interruption virtually eliminated the water pickup in the saturator. In such an event, the steam valve was to immediately open to keep the steam-to-carbon ratio at a minimum of 3. However, the same steam valve in normal operation was to control the ratio to an optimal 3.15 ± 0.01 (saving approximately \$5M/day), and the valve control parameters could not be set to adequately serve both requirements. Brief, even momentary power interruptions occurred approximately four times per year, generally due to lightning strikes or high winds, but occasionally grid supply disruptions as well.

Diagnosis: The original (approved for construction) design for the saturator included a steam turbine driver for the water saturator pump with an electric backup, but the turbine had been cut from the as-built design to save approximately \$300M in capital costs. However, the capacitance (due to momentum) of a steam driven turbine would have allowed the valve control parameters to function under both tight trim and saturator pump failure requirements, thereby allowing the unit to avoid shutdown due the latter event.

Solution: Check the web-site at <http://www.aiche-rm.org> for the solution to this problem. If you don't have access to the web, keep reading, you may find the solution in this issue.

WHAT HAVE I MISSED?

SEPTEMBER AIChE Meeting - Golden

Approximately 32 AIChE members heard John Tobin, Executive Director of the Energy Literacy Project, give an interesting presentation on "The Need to Have an Energy Literate Public and Consumer Base". Formulating energy policy in the US has been very difficult due to the high degree of fragmentation among industry segments, including coal, oil & gas, electric power generation, and transportation companies. Compounding the complexity are local, national, and international politics, and special interest groups developing and promoting renewable sources. For instance, there are seventeen different and independent programs among multiple governmental agencies including departments of energy, defense, education, bureau of land management, the minerals management service, and the EPA. Education is the key to begin weaving these programs and their agencies into a unified and coherent energy policy for Americans, and members of organizations like AIChE should individually assist in educating the public on such topics.



OCTOBER AIChE Pub Crawl - Fort Collins

New Belgium Brewery

Thirty-eight AIChE members and guests were treated to generous samples of Fat Tire (Amber Ale), Sunshine (Wheat), Blue Paddle (Pilsner-Lager), 1554 (Brussels Style Black Ale), Abbey and Tripple (Belgian Styles), which are manufactured at New Belgium and distributed in the western United States. They toured the marvel-of-the-industry brewing facility which was built in 1995. Highlights included two quality assurance labs, a highly automated brew house, a unique yeast propagator and 6 miles of stainless steel piping. The brewing facility is a nationally recognized paradigm of environmental efficiency. From the steam condenser on kettle reusing hot water to sun tubes providing daytime lighting, attendees witnessed conservation and recycling throughout many functions of the building. The brewery is an environmental pioneer, as in 1998 it became the first wind powered brewery in America.



O'Dell Brewing Company

O'Dell's makes the enormously popular 90 Shilling and Easy Street Wheat ales, representing approximately 85% of their production. AIChE members also sampled Cutthroat Porter, Cutthroat Pale, Levity, Isolation, and the unfiltered Bobby. The Odell Brewing Company was founded in 1989 and was the second microbrewery in Colorado to open, making only draft kegs. In 1994, the current 50-barrel brewhouse was built and in 1995 a 10,500 square foot expansion was added. The brewery began bottling its beer in 1996, and in 1997 a pilot system for new beer development was introduced. The brewery currently produces at an annual rate of over 26,000 barrels. They try to make lagers, even though it takes more time - so their scale of production is significantly less than New Belgium. Odell beers are available in Colorado, Wyoming, South Dakota, Kansas, New Mexico, Nebraska, and Missouri.



AIChE Meetings

2004

Nov 7-12 2004 Annual Mtg.
Austin, TX

2005

Apr 10-14 2005 Spring Nat'l
Atlanta, GA

Apr 11-13 20th CCPS Int'l
Atlanta, GA

May 2-5 Offshore Tech
Houston, TX

Sept 26-29 Safety in
Ammonia Plants
Toronto, Ontario

Oct 30-Nov 4 2005 Annual Mtg.
Cincinnati, OH

Nov 2-4 AIChE/ACS Mgmt
Cincinnati, OH

For further information, contact
National AIChE.

National AIChE Contact Info

AIChExpress Service Center:

(US/Canada): 1-800-AIChemE

(1-800-242-4363)

(International): 212/591-8100

Fax: 212/591-8888

E-mail: xpress@aiiche.org

Member Services: 212/591-7981

Career Services: 212/591-7670

Govt. Relations: 202/962-8690

Govt. Relations Fax: 202/962-8699

Web Page: <http://www.aiiche.org>

Rocky Mountain AIChE Officers

Glenn Sprenger Director & Membership 303/938-6642

Glenn.Sprenger@VECO.com

Kevin Milliman Chair 303/804-2374

Kevin.Milliman@earthtech.com

Tom Wellborn Vice-Chair / Program 303/933-0533

wellborns@mindspring.com

Curtis Dominicak Secretary 303/969-9416

Cldominicak@comcast.net

Craig Wildemuth Treasurer 303/791-6307

Craig.Wildemuth@grace.com

Martin Vorum Employment Info 303/789-0848

Mvorum@chisp.net

Collin Greenwell Student Chptr. Liaison 720/497-2133

Collin.greenwell@xcelenergy.com

Kerrie Pratt New Mexico Liaison 505/243-3200

PrattKL@cdm.com

Laura Moes Editor 303/770-2432

Mmoes@ekiconsult.com

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The objectives of AIChE are to advance chemical engineering in theory and practice, to maintain a high professional standard among its members, and to serve society, particularly where chemical, engineering can contribute to the public interest.

UPCOMING MEETINGS IN 2005

January 18: Reservoir Engineering by James R. Gilman of Ireservoir

February 15: Nanotechnology by Tapesh Yoder of Nanoproducts Corp

March 12: To be determined

April 19: Ammonia Plant Tour in Cheyenne, WY

May 17: National Oceanographic and Atmospheric Administration in Boulder, CO

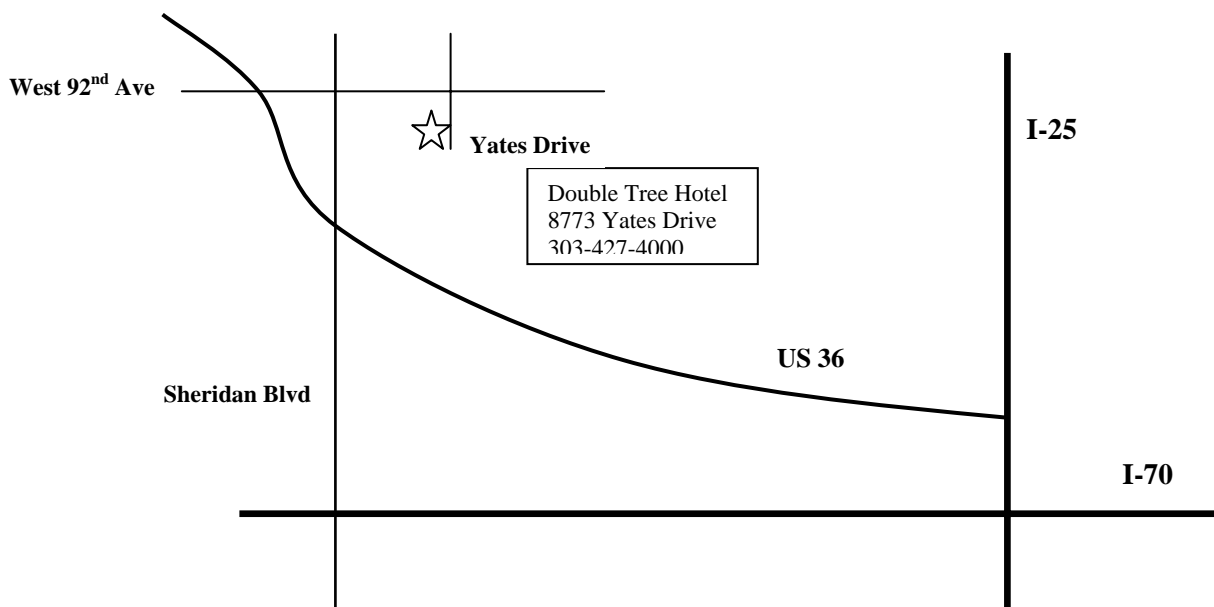
Solution for November Puzzler (page 2): Install a trim valve jumper (at a cost of about \$60M) around the main steam injection, whose control parameters were tuned to perform the fine adjustments, while the main valve was tuned to provide immediate and timely response in the event of saturator pump failure to prevent the steam-to-carbon ratio from falling below 3.

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America Institute of Chemical Engineers
1025 West Peakview Circle
Littleton, CO 80120-3327

On the Web at:

<http://www.aiche-rm.org>

*Send your E-MAIL address to
mmoes@ekiconsult.com to receive
this newsletter electronically!*



DIRECTIONS: Take I-25 to US 36 (Boulder Turnpike). Travel west on US 36. Exit at Sheridan Blvd and go north (to the right). Turn right at the first light which is W. 92nd Ave. Turn right at the first street which is Yates Drive. The Double Tree hotel is at the bottom of the hill on the right hand (west) side.