



# Rocky Mountain AICHE News

March 2003

Volume 12 Number 6

## March Section Meeting: Technology and Economics of Hydrogen Derived from Biomass

Hydrogen is an important energy vector for the future, just as electricity is today. It is able to serve a wide variety of needs with a single distribution network and at the same time provides resource and generation technology flexibility. A key argument for hydrogen is its environmental benefit, as the product of its use is simply water vapor. Renewable resources, nuclear energy, and fossil fuels with carbon capture and sequestration can all contribute to a future climate neutral hydrogen economy. The renewable carbon option of biomass to generate electricity and liquid fuels has been in development for over three decades. Based on this, it is possible to describe the biomass resource potential and the near-term technologies for its conversion to hydrogen. Our presentation this month focuses on the technology and economics of hydrogen derived from biomass. The talk is based on a February 2003 presentation to the National Academy of Sciences.

The presentation will be given by Ralph Overend, research fellow at the National Renewable Energy Laboratory. Dr. Overend has worked in bioenergy and renewable energy since 1973 as a researcher, research manager, and coordinator of research and development in both Canada and the United States. His nearly 20 years with the National Research Council of Canada, was as manager of the Bioenergy program, and advisor to the Department of Energy Mines and Resources on biomass energy. In addition, he served as coordinator of Canadian renewables R&D for several years. He joined the United States Department of Energy Biomass Power

### March Section Meeting

- Speaker:** Dr. Ralph Overend  
National Renewable Energy  
Laboratory
- Topic:** Technology and Economics of  
Hydrogen Derived from Biomass
- Date:** Tuesday, March 18, 2003
- Time:** 5:30 p.m. Social Hour  
6:00 p.m. Dinner  
6:45 p.m. Presentation
- Location:** National Renewable Energy Lab  
Visitor's Center  
15013 Denver West Parkway  
Golden, CO 80401  
303-275-3000
- Cost:** \$15 (half price for students and unemployed)

Please RSVP by **Friday, March 14th**. Indicate your name, phone number, and number of attendees by e-mailing Kevin Milliman at [kevin.milliman@earthtech.com](mailto:kevin.milliman@earthtech.com). Alternatively, you may leave a voice mail for Kevin at 303-804-2374.

program at the National Renewable Energy Laboratory in 1990, and has worked extensively in the development of long-range plans and strategies for biomass power and biofuels since that time.

*SPECIAL THANKS TO ED WOLFRUM FOR HIS ASSISTANCE IN COORDINATING THIS MONTH'S SPEAKER*

## **Snapshot Natural Attenuation with Isotopes**

By Terry Gulliver  
Applied Hydrology Associates, Inc.

Applied Hydrology Associates, Inc. (AHA) has a site in Pasadena, Texas with *tert*-butyl alcohol (TBA) in shallow groundwater, with a decade of monitoring data that shows the plume is shrinking, not moving. We managed through comparison with other nearby plumes to show TBA is not merely evaporating or diffusing into clays. The signs of microbial activity were not so clear, due to a lot of background variability in indicators of microbial respiration such as oxygen and sulfate, and a lack of identifiable by-products.

We did buttress our claim with some fuzzy sulfate data (high background variability) and some hydrogen analyses that indicate sulfate-reducing bugs are at work. And by pushing carbonate titrations a bit further than usual (to pH 2), we found enough carbon dioxide in the water to account for the lost TBA. But this was a big pile of imprecise circumstantial evidence. And we wanted to be able to generalize our findings ("TBA degrades"), not just make the case for this one site. TBA, after all, is becoming another demonized agent in the MTBE scares, particularly in California. So we weighed in with isotopes.

Isotopes are variants of elements that have more or less neutrons in their nuclei. For instance, most carbon has 12 neutrons ( $^{12}\text{C}$ ), but a small amount of naturally occurring, stable carbon has 13 neutrons ( $^{13}\text{C}$ ). Now, the  $^{13}\text{C}$  makes a bit stronger bond in a hydrocarbon compound than  $^{12}\text{C}$ , because of its extra gravity, which doesn't hardly change its properties,

except that the finely tuned energy harvesting of bacteria does favor  $^{12}\text{C}$  over  $^{13}\text{C}$  compounds. This results in an enrichment of  $^{13}\text{C}$  in the remainder as the compound is consumed, over the original fraction.

So the ratio of  $^{13}\text{C}$  to  $^{12}\text{C}$  increases in TBA in samples collected along the plume from source to front, and we have a snapshot picture of natural attenuation. No other process can account for this "fractionation" of the TBA. We have recently confirmed that the responsible microbes are sulfate-reducing, by showing  $^{34}\text{S}/^{32}\text{S}$  increases in sulfate; also, that  $^{13}\text{C}/^{12}\text{C}$  in carbonate decreases down the plume, due to preferential mineralization of lighter TBA to  $\text{CO}_2$ .

Isotopes have long been used for any number of things, such as estimating ages of archeological material with  $^{14}\text{C}$ , figuring seawater temperature in fossil corals from stable oxygen isotope ratios, and more abstruse research. Now stable isotopes like  $^2\text{H}$ ,  $^{13}\text{C}$ ,  $^{18}\text{O}$  and  $^{34}\text{S}$  are increasingly used in environmental remediation, to characterize geochemistry, to argue for natural attenuation, and for discrimination of your contamination versus mine (forensics). It is just very recently that we have been able to separate compounds by gas chromatography and analyze stable isotope ratios in each compound, rather than in the total sample. At the cutting edge, samples from the Pasadena TBA plume are being analyzed at the University of Waterloo for  $^2\text{H}$  (deuterium) ratios in the TBA, which is expected to be an even more sensitive tool than  $^{13}\text{C}$ .

You can contact Applied Hydrology Associates, Inc. at (303) 782-0164.

## **UPCOMING MEETINGS**

*Do you have a topic you would like to learn about? Would you or your company like to present a program or host a meeting? Please contact Kevin Milliman at 303-804-2374 or e-mail to [kevin.milliman@earthtech.com](mailto:kevin.milliman@earthtech.com) with your suggestions.*

## *AIChE Meetings*

**2003**

May 4-7	2003 Management Amelia Island, FL
May 5-8	Offshore Tech Houston, TX
June 22-25	Process Develop. Symposium Poconos, PA
Sept 4-5	Engr. & Construc. Contracting Scottsdale, AZ
Sept 15-18	Safety in Ammonia Plants Orlando, FL
Sept 23-25	CCPS Int'l Scottsdale, AZ
Nov 16-21	2003 Annual Mtng San Francisco, CA

**2004**

Apr 25-Apr 29	2004 Spring Nat'l New Orleans, LA
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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.

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