



# Rocky Mountain AIChE News

May 2005

Volume 14 Number 8

## May Section Meeting: Tour of TDA Research and Presentation

The May 17th meeting will feature TDA Research, Inc. TDA Research, Inc. was founded in 1987 and is located in Wheat Ridge. TDA's staff of 65 develops catalysts and sorbents, advanced materials and components. Our development work is primarily supported by government R&D contracts. TDA retains the intellectual property developed under these contracts, and works in partnership with larger manufacturing companies to bring its products to market. In the past two years, in partnership with major companies which are leaders in their fields, they have commercialized the large-scale manufacture of fullerenes, the Direct Oxidation process to remove and recover sulfur from natural gas and electronically-conducting polymers that are made easier to process because they disperse in organic solvents. For more information and/or directions prior to the meeting, please see [www.tda.com](http://www.tda.com).

After dinner at the Golden Hotel, John Wright (TDA's Vice-President) will present a short talk describing TDA's operation and history, and describe some of the technologies they have developed and the routes that took them from the laboratory to manufacturing. The large scale manufacture of fullerenes (BuckyBalls) presents a particularly interesting story, spanning the gamut from a Nobel Prize for its discovery (the time-of-flight mass spectrometer in which fullerenes were discovered at Rice University in the late 80's is in use as an analytical instrument at TDA), through the hype and euphoria of the early 90s, the abject

### May Section Meeting

- Topic:** Tour of TDA Research and Presentation
- Speaker:** John Wright, Vice President of TDA
- Date:** Tuesday, May 17th
- Time:** 6:00 Social Hour  
6:30 Dinner  
7:15 Presentation  
8:00 Drive to TDA for tour
- Location:** Golden Hotel, 800 11<sup>th</sup> Ave., Golden  
TDA Research, 12345 W. 52<sup>nd</sup> Ave.,  
Wheat Ridge, 303-422-7819
- Menu:** Roasted Pork Loin with Habenero Plum Sauce, Smoked Chicken in Natural au Jus, Whipped Sweet Potatoes, Fresh Steamed Broccoli, & Green Salad. Cheesecake/Fresh Berries, Coffee, Hot Tea, Iced Tea, & Lemonade
- Cost:** Members: \$20  
Non-Members: \$25  
Students & Unemployed: \$10

Please RSVP by **Friday, May 13<sup>th</sup>** (early RSVPs are greatly appreciated!). Indicate your name, phone number, and number of attendees by e-mailing Tom Wellborn at [rockyaiche@yahoo.com](mailto:rockyaiche@yahoo.com). Alternatively, you may leave a voice mail for Tom at 303-933-0533.

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despair of the late 90s, and finally their manufacture at the ton/year scale in the last two years.

Following the talk, we will travel to TDA's Wheat Ridge facility to see the equipment that makes nanograms and kilograms of fullerenes, as well as facilities for testing catalysts and sorbents.

John Wright is the Vice President of TDA, and has been with TDA almost since its beginning. After receiving his B.S and M.S. from the University of New Hampshire and Princeton, he joined the Solar Energy Research Institute (SERI), now the National Renewable Energy Laboratory (NREL) in Golden. In 1988 he joined TDA, where he has led R&D in catalysis, fuel cells and fullerene synthesis, among the other sundry tasks of an R&D business.

## **COLORADO SCIENCE AND ENGINEERING FAIR WINNERS**

Congratulations to the following winners of the AIChE Special Award at the Colorado Science and Engineering Fair!

First Place Award: "Raising the Rayleigh Number: Plumes and Circulation in Turbulent Thermal Convection"

Meredith MacGregor, 10<sup>th</sup> Grade  
Fairview High School  
Boulder, Colorado

Second Place Award: "Clean Water for Developing Countries: Biosand Filtration and UV Disinfection"

Conor May, 7<sup>th</sup> Grade  
St. Columba Catholic School  
Durango, Colorado

### **NEW MEXICO CORNER**

New Mexico members are getting active and organized. For more information about the New Mexico meetings, contact Kerri Pratt at [PrattKL@cdm.com](mailto:PrattKL@cdm.com)

## **THANK YOU ROCKY MOUNTAIN AIChE**

By Marie Nguyen  
2005 AIChE Rocky Mountain Conference Chair

The Colorado School of Mines' Student Chapter of AIChE would like to give a sincere thank you to the Rocky Mountain AIChE Chapter for your \$500 sponsorship and support of the Rocky Mountain Regional Student Conference on April 1st - 2nd, 2005. With your help, our conference was a success with 90 students in attendance from eight different schools and 24 participating industry professionals. Students had the opportunity to experience engineering in action at six different industry tours, compete in the Chem-E-Car and Paper competitions, and attend workshops including a panelist discussion on law, medicine, and business and presentations on process engineering troubleshooting, the importance of licensing, and resume and interview skills. Lastly, we would like to congratulate the Chem-E-Car and Paper Competition winners. The University of Wyoming's "Purple Haze-J" Chem-E-Car team won with a vehicle driven by a potassium permanganate/hydrogen peroxide reaction, and Emily Levi from Colorado State University placed first with her paper titled "Transcription of Type II Collagen in Engineered Cartilage." We appreciate your contribution, and hope to see you next year at the Rocky Mountain Conference to be hosted by the University of Wyoming!



## **ALD NANOSOLUTIONS, Inc. Opens Facility**

**February, 2005** - P. Michael Masterson, CEO and Chairman of ALD NanoSolutions, Inc., of Broomfield, Colorado, announced today that ALD NanoSolutions, Inc., has opened a development and research facility in Broomfield. The company's Particle ALD™, recently named by Editors of R&D Magazine as one of the 100 most technologically significant products introduced into the world marketplace in 2004, will be refined at the plant located on 580 E. Burbank Street.

According to Karen Buechler, President and Chief Technology Officer of ALD NanoSolutions, two systems in the plant will be ready to provide samples for commercialization by April 2005. The systems will include one fluidized bed reactor, which will hold the capability to provide kilogram batches of Atomic Layer Deposition (ALD) to address grant awards and corporate customer requests. Analysis on results of the research being performed for the Department of Energy, the National Science Foundation, the Department of Defense and others will contribute to future research made possible with the new facility's capabilities.

ALD NanoSolutions, Inc. was founded in 2001 by P. Michael Masterson, Dr. Karen Buechler, and University of Colorado (CU) Professors Dr. Steven George and Dr. Alan Weimer. The company's proprietary technology is based on Atomic Layer Deposition (ALD) coating chemistry processing methods for particulate and polymeric surfaces developed at CU. The company is focused on commercializing its nano-coating processes, called Particle ALD™ and Polymer ALD™, and is targeting collaborative research agreements with domain partners for the discovery and validation of innovative composite materials in selected industries.

"The gate to the future applications is through the ability to innovate at the surface level where particles interact with the surrounding environment. Particle-ALD™ serves as an enabling technology, potentially providing for the control of ultrafine particle chemical, electrical, optical, magnetic, physical, and other surface properties. We are

looking at compelling ALD applications with commercialization potential that can be realized during the next three to five years," said Masterson.

The University of Colorado has licensed intellectual property to ALD NanoSolutions, Inc. and work performed under government Small Business Technology Transfer Research (STTR) awards from NSF, DOE, and DoD helped validate the technology in CU labs. For further information, please visit [www.aldnanosolutions.com](http://www.aldnanosolutions.com).

### ***Get Involved in Your AIChE Rocky Mountain Section***

Yes, it's that time of year again. As we start to wrap up the 2004-2005 academic calendar year, it is time to elect officers for the 2005-2006 year.

**We are in particular need of a volunteer for the Program Chair position for 2005-2006.** The program chair is a vital position because the Program Chair, with some assistance from the other officers, arranges the monthly Section meetings from September through May. The Program Chair gets, free of charge, one year of exhilarating activity, opportunities to meet new people, and the attainment of personal gratification and growth that cannot be attained in any other way (and, by the way, your back pain will go away and your lawn will stay green without water!!). In all seriousness, the Program Chair position is a good opportunity to meet new people and to help keep the Rocky Mountain Section active and interesting. After one year, the Program Chair (also known as the Vice-Chair) typically moves on to the Chair position for the following year.

If you are interested in the Program Chair position for next year, please call Tom Wellborn (303-933-0533) or Kevin Milliman (303-804-2374) for more information.

*If you are interested in any other of the officer positions for next year please contact Kevin Milliman for more info.*

## May Puzzler: Can you find a solution?

**Location:** ARCO Chemical Polybutadiene Unit and Oil Recovery Services (1985) - Channelview, TX and Savannah, GA

**Problem:** A world-scale olefins plant using petroleum naphtha (as opposed to ethane/propane mix) yielded significant quantities of C4 olefins, including butadiene. The butadiene was recovered, purified, and polymerized to manufacture a sealant which had many uses. The biggest use was in window seals, but this represented only 10% of the product volume's disposition, which also included rubber, resins, adhesives, elastomers, and composites. Despite its wide applications the polymer had many competitors with similar properties. In addition, a byproduct present in the finished product in small quantities (100 ppm) gave the polymer an extremely pungent odor, severely limiting its uses. This was vinyl-cyclohexane (VCH) dimer, which was particularly difficult to remove because of the polymer's high (and non-Newtonian) viscosity and the fact that its boiling point was above that required to degrade (and discolor) the polymer. Laboratory and clinical testing had demonstrated that if VCH levels on the order of 10 ppm could be achieved, the product could be used for lining tin cans in food service. This possible use represented a major increase in both realized price and market volume for a profit of several million dollars per year.

The polymerization reaction took place at mild conditions using small amounts of aqueous hydrogen peroxide catalyst in batch stirred tank reactors. Upon reaching a sufficient degree of polymerization, the reaction was quenched by the timely addition of an oxygen scavenger. Four reactors were stage-sequenced and their contents pumped to a holding vessel to maintain continuous flow to the recovery section of the process. Unreacted butadiene was easily recovered and purified for recycle using a flash drum and fractionation. A water wash recovered the peroxide and scavenger from the polymer. The remaining mixture was 1 wt% (100,000 ppm) VCH dimer with the balance polymer.

Since excessive temperature could lead to degradation of the polymer, 99.9% of the VCH dimer byproduct was recovered using a steam-jacketed wiped film evaporator operating under high vacuum. Vacuum was provided by a three stage direct-contact steam eductor (venturi) system. An inlet distributor at the top of the evaporator allowed the

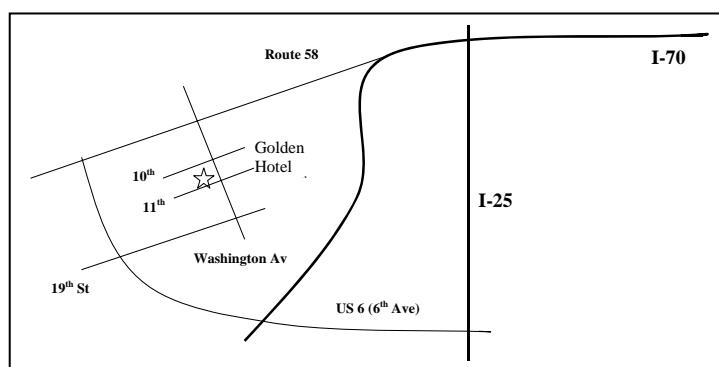
product to gravity flow evenly down the sides while being "wiped" by several blades on a shaft propelled by a motor on the bottom of the vessel. In this manner heat was gently transferred and polymer surface area maximized to facilitate removal of the VCH dimer. Load tests and modeling of the recovery section revealed a 25% increase in production of the profitable polymer could be achieved by the addition of an identical fifth reactor. However, upon completion and placement on-line, the VCH dimer content of the product increased exponentially, and rates were reduced to original throughput.

**Diagnosis:** Since the vacuum was fixed by the eductor design, attempts were made to increase temperature of the steam to the jacket and the wiper speed but they produced no result. After eliminating the possibilities that VCH dimer conversion had increased or that excess reactants were not recovered, it was concluded that the wiped-film evaporator had reached its limits of heat input, mass transfer, and vacuum for VCH dimer removal.

**Solution:** Check the web-site at <http://www.iche-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.

## UPCOMING MEETINGS

May is the last AIChE meeting for the 2004-2005 program year. There will be no meeting until Tuesday, September 20th. Next year we hope to have tours of a refinery, ammonia plant, simulated immersions, and presentations on olfactory senses, nanotechnology, and laser drilling! So reserve the third Tuesday of every month for AIChE in 2005-2006!



**TO GOLDEN HOTEL:** From I-70, take Route 58 (exit 265) toward Golden. Take Washington St exit and turn left at the stoplight.

# WHAT HAVE I MISSED?

## APRIL - Westminster

On April 19th, approximately 31 AIChE members and guests heard Craig Wildemuth (our section Treasurer) give a presentation on "Commercialization of Membrane Technology for Refining Applications". Wildemuth is General Manager, Gas Membranes and Director of Manufacturing for Grace Davison's Littleton manufacturing operation, and he brought several (some very large) cutaway samples of membranes for viewing by meeting attendees.

Wildemuth began his presentation by describing the advantages of membrane separation technologies, which include robust operation, energy efficiency, and (typically) linear scale-up. Disadvantages include fouling, rupture, and dissolution (referred to as solvent resistance). There are few materials of construction, but many designs, and applications are usually specific to bulk separations and do not normally produce high purity products. In addition to classic plate and frame, construction approaches also encompass spiral wound, cassette, hollow fiber, capillary, and tubular designs. It is common for system hardware to comprise two-thirds of installed cost, including membranes. Membranes are widely used in the water treatment and medical industries, and also maintain a niche in dehydration of alcohols and ethers where azeotropes limit distillation. Areas of growth for membrane applications include gas separation and solvent recovery.

Sulzer Chemtech continues to perfect a unique (albeit widely used) membrane separation process called Pervaporation for the dehydration of alcohols. It accomplishes removal of a specific compound by creating a partial pressure difference on the feed and permeate sides of the membrane through the use of vacuum. Mixture components are separated using differences in their rate of permeation through different types of polymer membranes. One design may remove water, while another may remove a certain hydrocarbon. Pervaporation combines two basic processes in one, evaporation and membrane transfer. Grace Davison is taking pervaporation to a new scale with the commercialization of its SBrane product. The goal is to assist refineries to meet new low sulfur gasoline requirements by removal and concentrating undesirable sulfur species prior to hydrotreating while retaining desirable high octane olefins in a stream that meets sulfur specs.

The most widely used membrane applications in the petroleum industry, currently, are vapor recovery in tank farms and hydrogen recovery in refineries and chemical plants, the latter with process designs marketed by Medal/Air Liquide, Air Products, and UOP. Newer developed applications embrace solvent recovery in lube oil manufacturing, specifically the MaxDeWax process licensed by ExxonMobil and developed jointly by Grace Davison and Exxon/Mobil for the Beaumont refinery. Membranes are also being used for recovery of olefins such as ethylene and propylene. The next most likely area for successful application of membranes in refineries will probably be aromatics removal from gasoline.

In conclusion, Wildemuth summarized his commercialization experiences with the "following rules of thumb": Economics: The values of the permeate plus retentate must sum to greater than the value of the feed for viability. Development: Seven plus years and \$15-20MM in expenses are typically required to bring membrane processes from idea to full scale for new refinery applications.

At the end of his presentation, Program Chair Tom Wellborn presented Wildemuth with his prize, a copy of "The Prize - The Epic Quest for Oil, Money and Power", by Daniel Yergin (1992).

**Solution for May Puzzler (page 3):** A nation-wide search was conducted for a toll processor who had available capacity for an evaporator of similar design and construction. Appropriate units were found in near Louisville, KY, Milwaukee, WI, and Savannah, GA. The latter was chosen because it had a vacuum pump system. A one day demonstration test on a truckload of product was conducted. After initial success (100 ppm VCH dimer content of the product), power was lost to the vacuum pump during a storm and the entire test batch was thrown off-spec to 2000 ppm VCH, which cast serious doubt on the validity of the test results. However, the toll processor agreed to re-run the off-spec material, an action which produced the desired high purity (10 ppm) product and proving that a second stage wiped film evaporator could be economically justified.

## AIChE Meetings

### 2005

Sept 11-14	LNG Conference Vancouver, BC
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
<b>2006</b>	
Apr 23-27	2006 Spring Nat'l Orlando, FL
June	Process Develop. Symposium Palm Springs, CA
Nov 12-17	2006 Annual Mtg. San Francisco, CA

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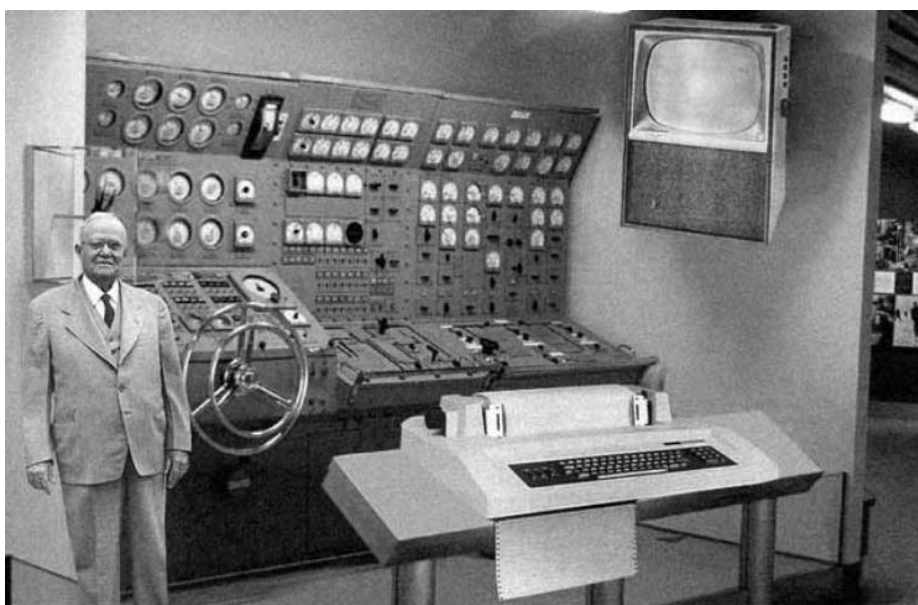
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The objectives of AIChE are to advance chemical engineering in theory and practice, to maintain a high professional standard among its members, and to serve society, particularly where chemical, engineering can contribute to the public interest.

*No joke.....from the 1954 Popular Mechanics Magazine*



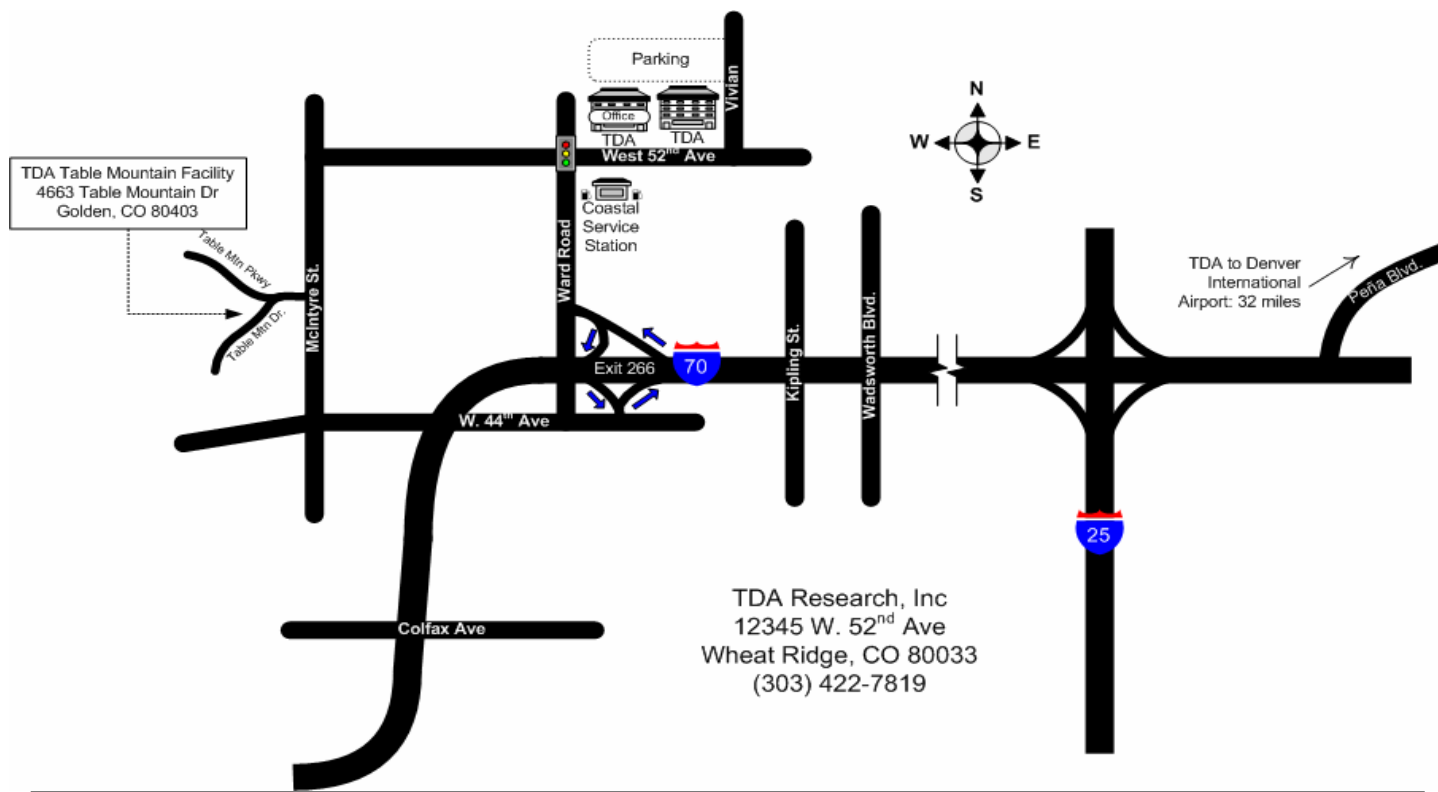
*Scientists from the RAND Corporation have created this model to illustrate how a "home computer" could look like in the year 2004. However the needed technology will not be economically feasible for the average home. Also the scientists readily admit that the computer will require not yet invented technology to actually work, but 50 years from now scientific progress is expected to solve these problems. With teletype interface and the Fortran language, the computer will be easy to use.*

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Send your E-MAIL address to  
[mmoes@ekiconsult.com](mailto:mmoes@ekiconsult.com) to receive  
this newsletter electronically!



**DIRECTIONS TO GOLDEN HOTEL ON PAGE 4. DIRECTIONS TO TDA RESEARCH:** Take I-70 west. Take the CO-72/WARD RD EXIT (#266). Turn right (north) onto Ward Rd. Turn right (east) onto West 52<sup>nd</sup> Ave. Turn left (north) onto Vivian. Turn left into the parking lot.