UNIVERSITY OF CALIFORNIA, RIVERSIDE

UCR | College of Engineering- Center for Environmental Research & Technology

Volume 5, Number 1 February 2007

# Atmospheric Lab Takes Quantum Leap

## $1.5 million from W.M. Keck Foundation leads to new era of instrumentation

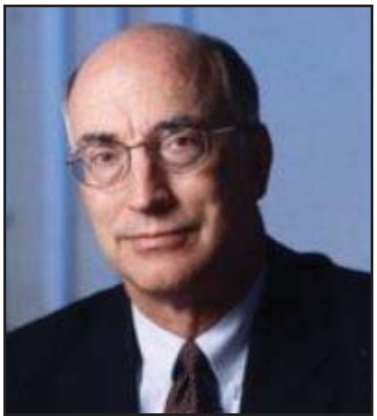
With a $1.5 million grant from the W.M. Keck Foundation, CE-CERT's Atmospheric Processes Laboratory (APL) has moved into the stratosphere, even though it studies chemical and physical processes in the troposphere. The grant has led to the establishment of the W.M. Keck Atmospheric Research Laboratory within APL.

The troposphere, the atmospheric layer closest to the earth, is where much of what we refer to as air pollution is created. Hydrocarbons and NOx released from a myriad of sources including vehicles and smokestacks, undergo complex chemical reactions to form secondary pollutants such as ozone and fine particulate matter.

When it opened in 2001, the APL reflected the latest in atmospheric chamber design. It experiments could be controlled for temperature, pressure and humidity. Its 200 kw Argon light closely replicated the range of sunlight.

**See KECK, p. 8**

*This Agilent high performance liquid chromatograph and time-of-flight mass spectrometer is one of the state-of-the-art instruments added to the Atmospheric Processes Lab using the W.M. Keck Foundation grant.*



## Wyman Named AAAS Fellow

The American Association for the Advancement of Science named CE-CERT researcher Dr. Charles Wyman a 2006 AAAS Fellow. The AAAS awarded this distinction to 449 members this year.

The 158-year-old AAAS annually recognizes individual faculty members for their socially and scientifically distinguished contributions. Wyman, one of 21 UC Riverside faculty to receive the fellowship, was cited for his work on the conversion of cellulosic biomass to ethanol.

AAAS members are nominated by three existing Fellows, reviewed by a steering committee and presented for election..

## CE-CERT Starts Project with Paints Industry

The National Paint and Coatings Association has funded a $335,000 first order life-cycle analysis of their products at CE-CERT.

The research will study "total eco-system impacts, including air, water, natural resources, hazardous waste, municipal solid waste and quality of life."

Meetings of the technical advisory group, composed of both industry and regulatory agency representatives, began in January.

The study is expected to include additional work through UCR's Environmental Research Institute and possible additional funding from regulatory agencies.

# Research

*CE-CERT Director Dr. Matthew Barth accepts the Pyke Johnson award on behalf of a CE-CERT research team. Barth, John Collins, George Scora, Dr. Joseph Norbeck and Nicole Davis produced* "Measuring and Modeling Emissions from Extremely Low Emitting Vehicles"*, a paper the Transportation Research Board judged worthy of the award. The Pyke Johnson award is not given every year, but only when a paper warrants it. With Barth are (left) Neil Pederson, Administrator of the Maryland State Highway Administration and Council Chair for TRB's Technical Activities Division, and (right) Robert E. Skinner, Jr., TRB's Executive Director.*

## Grants and Contracts, 4th Quarter

CE-CERT researchers won $426,292 in new grants and contracts during the fourth quarter.

Major projects include the initial phases of the first-order life cycle assessment for the National Paint and Coatings Association mentioned on page 1.

Other new work includes Dr. Wayne Miller's continued research on emissions from seaports -- in this case a contract from Mitsui Shipbuilding and Engineering to study particulate emissions from the auxiliary engines of ocean-going vessels.

The University of California Transportation Center, based at UC Berkeley, awarded CE-CERT $90,000 for use as graduate student scholarships. (See page 7 for this year's winners).

Other funders included the Coachella Valley Association of Governments, the U.S. Navy, Holland & Hart, LLC and Viresco Energy LLC (See p. 5 for more).

**Dr. Heejung Jung**, recently appointed Professor of Mechanical Engineering at UCR, has joined the Emissions and Fuels Research group at CE-CERT. Dr. Jung received his PhD in Mechanical Engineering from the University of Minnesota, and joins CE-CERT most recently from the University of California, Davis where he held a Postdoctoral position.

While Dr. Jung has varied research interests, including PM emissions, nanoparticle synthesis, and air quality, he has expressed a desire to continue and further develop his investigation into the kinetics of soot oxidation.

Using the facilities available at CE-CERT, Dr. Jung hopes to produce more data on soot oxidation that will be crucial to better design diesel particulate filters. Soot particles emitted from diesel engines have deleterious consequences for both the environment and the human respiratory system. Dr. Jung's research will contribute to the effectiveness of filters to be used on many new diesel vehicles.

# SCAMPERing after Dust

*CE-CERT's Dennis Fitz has devised a system to measure dust kicked up on roads, from logging routes to the interstates.*

*SCAMPER stands for System for the Continuous Aerosol Monitoring of Particle Emission Rates from Roads. A sensor is mounted on the front bumper of a vehicle, in this case CE-CERT's Ford Expedition, to measure ambient dust levels. A second sensor is mounted on the trailer to make the same measurements. In crude terms, the difference between the measurements is the amount of particles kicked up by the vehicle. SCAMPER was testing emissions from a haul road near the Utah carbonate plant in the background.*

By DENNIS FITZ

Particles less than 10um aerodynamic diameter (PM10), can effectively enter human respiratory systems where they cause deleterious health effects. PM10 has been designated as a criteria air pollutant and both State and Federal concentration standards have been established. These standards are routinely exceeded in many urban air basins. Dust generated from travel on paved roads is an obvious source of PM10. What is not obvious is the magnitude of this contribution to the PM10 concentrations. The problem is that it is difficult to quantify the emission rates for vehicles operated on roads because these emissions are fugitive in nature. They are not confined to a stack or duct where the rates can be quantitatively measured. To formulate effective control measures, the contribution of PM10 generated from this source must be accurately known.

A series of studies were conducted in the 1970's to measure PM10 emission rates from vehicles on paved roads by measuring PM10 concentrations upwind and downwind of roadways and applying a mass balance model to estimate the source strength. The roads used were at mining operations where the pavement was subject to considerable amounts of soil deposition. Since these measurements were extremely labor intensive, an empirical formula was developed that related the PM10 emission rate to the silt loading on the pavement (from vacuuming, sieving, and weighing) and the weight of vehicles. This formula has subsequently been used to estimate the contribution from this source to PM10 inventories developed all over the country. These inventories generally show that this source is a major component of the PM10 of geologic origin. A number of upwind-downwind studies conducted in urban areas to validate this algorithm have been generally unsuccessful because the PM10 concentration difference between upwind and downwind often is within

*Following a street sweeper down the road during a contract for Clark County, Nevada in September.*

*Engineer Kurt Bumiller, who usually operates SCAMPER and gathers the data.*

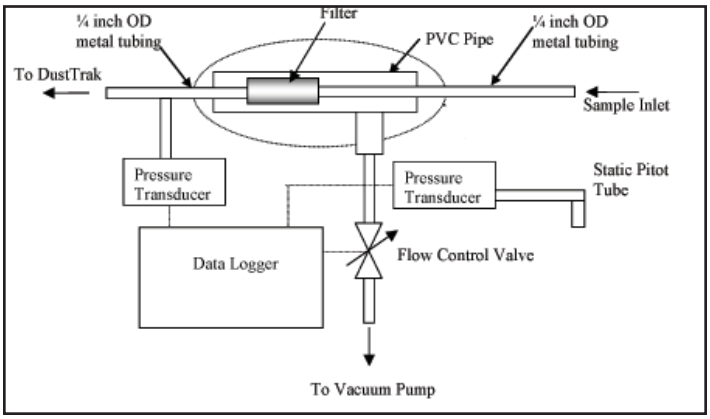
*Dennis Fitz, manager of CE-CERT's Atmospheric Processes Group and designer of the SCAMPER system.*

onds. Sensors are mounted in the front of the vehicle and on a trailer behind it in the well-mixed wake. A special inlet probe was designed to allow isokinetic sampling under all speed conditions. As a first approximation the emission rate was based on the PM10 concentration difference between front and behind the moving vehicle multiplied by the frontal area of the test vehicle. A GPS is used to determine the position and all data are logged by a data acquisition PC.

The SCAMPER has been evaluated in a number of tests conducted in Clark County Nevada and has been shown to be equivalent to the method of measuring silt content and applying an algorithm. Unlike the silt-measuring approach, which involves tedious and often dangerous vacuuming of roadways, the SCAMPER can quickly survey large areas and investigating hot spots on roadways caused by greater than normal deposition of PM10 forming debris. This technique is therefore not only useful for inventory development, but also for enforcement.

the measurement uncertainty.

To more accurately determine the PM10 emission rates from vehicles, we have developed an alternative approach called the SCAMPER (System for the Continuous Aerosol Monitoring of Particle Emission Rates from Roads). In this approach, PM10 concentrations are measured directly in the wake of a moving vehicle. This improves the measurement sensitivity for estimating the emission rates for vehicle on paved roads. Optical sensors are used to measure PM10 concentrations with a time resolution of approximately two sec-




*Schematic of intake system*

# Private Firm Leads Hydrogasification to Pilot Scale

Diesel from coal or waste?

It's research started by the late Dr. Colin Hackett and being continued by Dr. Joseph Norbeck and Dr. Chan Seung Park.

Now, a Riverside private sector firm has stepped forward to take it from the bench scale of CE-CERT's laboratories to a 10-tons-a-day pilot plant.

Viresco Energy, LLC is a venture of its president, Jim Guthrie, and a number of investors. At a press conference, Guthrie unveiled plans for a $15 million plant to test CE-CERT's technology at the higher level. If things go well, Guthrie envisions a commercial plant, perhaps in a Utah coal field, in five to ten years.


*San Bernardino Sun reporter Andrew Silva listens as Viresco Energy President Jim Guthrie explains some of the technology in transforming such materials as coal, wood or muncipal waste into diesel fuel.*

The process, which is in the process of being patented, uses high pressure and heat to break down carbonaceous materials, such as coal or wood waste, into methane. The methane can then be converted to diesel fuel through the established Fischer-Tropsch process.

The new CE-CERT process configures three thermo-chemical process reactors that can produce nearly pure paraffin hydrocarbon liquids (similar to petroleum-derived diesel fuels) and wax-like compounds (similar to petroleum-derived paraffin jellies). These waxes can be processed to produce even more liquid paraffins. The process is self-sustaining, without the need for additional fuels or energy sources.

A Laboratory Scale Integrated System Prototype (LISP) for a unique carbonaceous matter-to-energy process was designed, constructed and proved promising. The LISP consists of three main components: hydrogasification of the carbonaceous material, steam reforming of the producer-gas and Fischer-Tropsch synthesis of reformed gas into diesel fuel. Associated with the integrated process is a slurry pump system for feedstock and a hot producer-gas clean-up system for protecting the downstream catalysts from potential impurities in the feed.

"One of the advantages of this is we will reduce the need for imported oil," Norbeck told the San Bernardino Sun. Diesel fuel could be produced for about $1 a gallon, although the retail price would be higher, he said.

The techniques for turning carbon-based solids into fuel have been around for centuries. Faced with boycott for its former apartheid policies, South Africa produced virtually all of its liquid fuels from coal.

However, those processes were not as inexpensive as petroleum-based fuels and were often quite dirty.

CE-CERT's new process holds the promise of being cost-effective, especially if oil prices remain high, and having few environmental side effects.

The fuel lacks sulfur, oxides of nitrogen and other pollutants, said Neal Richter, Viresco's technical advisor.

The new process can be completed in six minutes, whereas earlier methods took an hour for the transformation. Norbeck said the research team isn't sure of the reasons for the difference, but the new processes uses hydrogen and steam at close to 1,500 degrees to break down the carbonaceous material into gases. Earlier methods used oxygen, he said.

Viresco Energy also is talking with the city of Riverside about using sludge from its sewage treatment plant as the raw material for a a 400 ton-per-day plant, said Guthrie..

Such plants, if successful, would open a whole new market for Viresco and give cities an alternative to waste disposal.

# People

## Yee takes first in Guthrie Undergrad Research Competition

Lindsay Yee won first prize in the 4th annual Jim Guthrie Undergraduate Research Competition. Yee's presentation was on "*Ozone and Secondary Organic Aerosol Formation from Agricultural Pesticides*." Her efforts won her $200.

Second place honors, and $100, went to Karel Jansen for his presentation on "*Chemical Characterization and Analysis of Jet Aircraft Emissions*."

Piotr Gawecki, Billy Phan and Chris Salam shared third place and $50 apiece. Phan's paper was entitled "*High Temperature Sulfur Removal for Synthetic Diesel Production*"; Gawecki's "*Analysis of Impurity in the Producer Gas of Steam Hydrogasification Process*" amd Salam's "*Quantifying and Characterizing Extra-Polymeric Substances from Beach Sediment Biofilms*."

The award is named in honor of Jim Guthrie, a Riverside entrepreneur and CE-CERT supporter, who endowed the awards.

This year's event, held at the Bourns College of Engineering, highlighted research on a variety of topics.

A panel of judges, including professors, researchers and graduate students, selected winners on the basis of aesthetic and verbal presentation, as well as the quality of research presented.

## Transportation Systems Group Gives Five Papers at IEEE Conference

CE-CERT's Transportation Systems Research group, represented by Group Manager Dr. Matthew Barth, presented five papers at this year's Institute of Electrical and Electronics Engineers Conference on Intelligent Transportation Systems.

The research shared at this year's event reflected the collaborative efforts of TSR staff and student researchers, and covered a variety of topics, including inter-vehicle communication, intelligent speed adaptation, and automatic vehicle location efficiency.

Barth presented papers entitled, *An Adaptive Dissemination Method for Inter-Vehicle Communication-Based Decentralized Traffic Information Systems*, *An Energy and Emissions Impact Evaluation of Intelligent Speed Adaptation*, *Improving Automatic Vehicle Location Efficiency through Aperiodic Filtering*, *Policy and Behavior Research for the California Partners for Advanced Highways and Transit (PATH)*, and *Vehicle Trajectory-Based Road Type and Congestion Recognition using Wavelet Analysis*.

## Students Present at AAAR Conference

Dr. David R. Cocker and CE-CERT graduate students attended the American Association for Aerosol Research International Aerosol Conference in St. Paul, Mn to present and observe research findings.

Doctoral student Bethany Warren gave a well-attended 20-minute presentation entitled, *Secondary Organic Aerosol Formation and Chemical Speciation for the Cyclohexene-Ozone System in the Presence of Water Vapor and Inorganic Salts*.

*L to R: Chaudhary, Nigam, Warren, Cocker and Malloy*

Graduate students Quentin Malloy and Ajay Chaudhary each presented posters, *Secondary organic Aerosol Formation from the Photo-oxidation of m, o, p-xylene* and *Effects of Real-World Driving Conditions on Gaseous and Particulate Emissions In-Use Heavy Duty Diesel Trucks*, respectively.

Additionally, graduate student Abhilash Nigam presented two well-received posters titled, *PM Emission Measurements from Back-up Generators: Method V vs. ISO 8178* and *Effect of Fuel Sulfur Content and Control Technology on PM Emissions from Ship's Auxiliary Engines*.

A recent CE-CERT collaborator, PhD student Mikko Lemmetty from Finland, also gave a 20 minute presentation, *The Effect of Different Dilution-Cooling Conditions on Nucleation on Diesel Exhaust*.

*Lab helper Laurie Graham and Engineer Mike Todd lead the charge up "The Rock" before a staff meeting and pot-luck. The climb becomes more difficult as you move around to the right.*

# First UCTC Graduate Fellowships in Transportation Awarded for 2006-07

Kent Johnson, Quentin Malloy, George Scora and Anh Vu were the winners of the first scholarships awarded at UC Riverside under the University of California Transportation Center Graduate Fellowships Program.

The students, all of whom work at CE-CERT, were the first winners since CE-CERT became involved in the UCTC program.

The graduate fellowships are being offered to encourage and aid graduate students focusing on Transportation Research at UCR.

To qualify, students had to be a U.S. Citizen or Permanent Resident planning (or planning to pursue) a career in transportation with a focus on ground transport; a full-time graduate student at the University of California-Riverside; have a minimum grade point average of 3.5; and a combined (math and verbal) GRE score of at least 1350.

The fellowships can be used for tuition, state fees, and/or stipends. If awarded a fellowship, recipients must provide a short annual report on their research.

*Johnson*

*Malloy*

*Scora*

*Vu*

## RAP Students Named

The Research Advancement Program has brought a gifted group of UCR freshmen and sophomores to CE-CERT for the start of what promises to be a productive 2006-2007 academic year.

RAP will give Evan Davis, Jason Elliott, Madison Holsinger, and Dylan Switzer the opportunity to conduct research at CE-CERT under the guidance of experienced CE-CERT researchers.

Freshman Evan Davis will team with CE-CERT Director Matthew Barth and others of the Transportation Systems Research group. Dylan Switzer, also a freshman, began working this summer with Dr. David Cocker and the Atmospheric Processes Group. A Mechanical Engineering major, Jason Elliott has begun work with Dr. Heejung Jung as a member of the Emissions and Fuels Research group. Madison Holsinger, a Bioengineering student, works with Dr. Bin Yang in the Sustainable Energy Systems Research group.

## Wei Li Takes Prize

Wei Li, a graduate student with the Emissions and Fuels Research group, earned second place for his poster entitled, *Evaluation of Particulate Matter Emissions of Light—Duty Gasoline Vehicles Operating in California*, at the Asian American Environmental Symposium.

The symposium, held at the University of California, Los Angeles, was organized by the Southern California Chinese American Environmental Protection Association and the Asian American Environmental Partnership. It brought together students, government officials, and industry representatives.

Li, recognized along with students from USC and Caltech, was awarded $200. The judging committee selected winners on the basis of originality, relevance of the project to the themes of the conference, and student's role and contribution to the project.

**KECK, from p. 1**

The new suite of chemical instrumentation provided under the W.M. Keck grant, coupled with the initial reactor design, allows for careful investigations of the chemical processes leading to the formation of ozone and fine particulate under well simulated atmospheric conditions. This will, in turn, lead to advancements in our understanding of the processes leading to these secondary pollutants critical for predicting the impact of current and future mitigation strategies.

The original chamber facility, constructed with $2.9 million in support from the EPA, is comprised of dual 90 cubic meter FEP Teflon® film chambers, and was designed for investigations of atmospheric processes at very low NOx concentrations. The large volume minimizes wall interferences and provides suitable sample volume for a suite of instrumentations. The chamber in which the reactors reside is continually flushed with purified air to reduce background contamination within the system.

Instrumentation

The gas-phase instrumentation includes:

• A custom-designed cavity ring-down spectrometer for monitoring oxidants and oxidation products,

• A high-sensitivity Ionicon proton transfer reaction mass spectrometer for real-time measures of hydrocarbon decay and oxidant product formation.

• Custom-built analyzers for measuring peroxyacetyl nitrate and NO2 with high specificity

• A long path-length tunable diode laser absorption spectrometer for formaldehyde and NO2 monitoring

Aerosol

• An aerodyne high-resolution time-of-flight mass spectrometer for online determination of size and chemical composition

• An array of particle size and counting tools including: dual scanning electrical mobility analyzers and ultrafine condensation particle counters

• A Kanomax aerosol particle analyzer for determination of particle exact mass

• A tandem differential mobility analyzer to measure organic and/or water uptake by particles

• An Agilent liquid chromatograph with high resolution time-of-flight mass spectrometer for offline determination of chemical composition of collected gaseous and aerosol products.

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1084 Columbia Ave.
Riverside, CA 92507