CLEMSON UNIVERSITY

Spring 2005

CHEMICAL AND BIOMOLECULAR ENGINEERING

DEPARTMENT NAME CHANGE

Chemical Engineering has been considered to be based upon the application of chemistry, physics, and math to the synthesis and processing of chemicals and other materials. While academic curricula in the past tended to focus on organic and inorganic chemistry, many chemical engineers worked in biochemical areas that are now called biotechnology, and a significant number of chemical engineering BS graduates went to medical school. With the increasing interest and research in biotechnology and the larger numbers of chemical engineers working in biotechnology and related industries, the chemical engineering profession has redefined the basis of the field to be chemistry, biology, physics, and math. Courses related to biology are now becoming required in many chemical engineering programs nationwide and internationally. Many top U.S. chemical engineering programs have in the past several years changed their name to "Chemical and Biomolecular Engineering" (University of Illinois, Cornell, University of Pennsylvania, Georgia Tech, North Carolina State, Ohio State, Notre Dame, Johns Hopkins, and Tulane), "Chemical and Biological Engineering" (University of Colorado, University of Wisconsin, Rensselaer, Northwestern, SUNY Buffalo, University of Alabama, University Missouri Rolla, University of Maine, Polytechnic University, Montana State University, Drexel University, and the University of British Columbia), "Chemical and Biochemical Engineering" (Rutgers University, University of Maryland Baltimore Campus), or "Chemical and Biomedical Engineering" (Florida State University and Syracuse University) in order to reflect this new direction and the involvement of many of their graduates in biomedical and biochemical endeavors. Name changes are currently being discussed at many other schools as well.

Earle Hall

As a result of the approved new chemical engineering curriculum at Clemson, courses in biochemistry and industrial microbiology are now required at the BS level. In addition, students can do a 3-course emphasis in Biomolecular science and engineering or any approved minor at Clemson including biological sciences or microbiology. The Department is also actively adding several new faculty in the areas of biotechnology and biomedical engineering. To reflect these changes, to emphasize the study and application of scientific principles from the molecular to the macroscopic scale, and to join the leading chemical engineering programs in charting new ways to integrate engineering, chemistry, biochemistry, and biology, the Board of Trustees of Clemson voted to change the name of the Department of Chemical Engineering to the **"Department of Chemical and Biomolecular Engineering"** effective February 2, 2005.

A Note from the Chair

As the cover story indicates, the name of the Department has changed to *Chemical and Biomolecular Engineering*. This does not mean that the curriculum has changed totally. In fact the new curriculum that is being phased in now is very similar to the curriculum followed more or less over the last 50 years. It still concentrates on mass and energy balances, thermodynamics, separations, transport phenomena (fluid mechanics, heat and mass transfer), and reaction kinetics. What has been added are courses in biochemistry and industrial microbiology to give all students a fundamental background in bio. In addition, the elective emphasis areas allow students to tailor part of the curriculum to focus on their interests and future plans. Such flexibility is needed more and more as the diversity of jobs that chemical engineers do expands. The curriculum is constantly evolving to meet the needs of the time. The addition of Biomolecular to our name helps to convey the wider chemical focus now of chemical engineering. More and more, biochemistry and cellular biology along with macromolecular science will be woven into standard chemical engineering courses along with organic and inorganic chemistry.

"Engineering is the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race."

Henry G. Scott, 1907

Good Bye to a Dear Friend...

This year the department lost a great friend and benefactor, Charles M. Culbertson II (B.S., 1971) passed away suddenly this past winter. In 2004, he and his wife Dianne established an annuity that will eventually benefit the Department of Chemical and Biomolecular Engineer. He will be greatly missed.

The Molecular Design of Advanced Carbon Materials

Mark C. Thies, Professor of Chemical Engineering, was recently awarded grants totaling $320,000 from both the Air Force Office of Scientific Research and the Petroleum Research Fund to develop a "molecularly based approach for the design of high-performance carbon materials from inexpensive carbonaceous pitches." Dr. Thies says that "our goal is to tailor the molecular composition of pitches for a desired end-product application." He explains that the empirical approach which industry now follows to produce pitch-based materials is no longer acceptable, as their high cost (e.g., up to $1500/lb for high thermal conductivity carbon fibers) is impeding their use in both structural and thermal applications. For example, the computer chip market for carbon-carbon composite heat sinks of high thermal conductivity is estimated to easily exceed $10 billion per year, but only if the price of the composite can be brought down. Advanced fractionation and characterization techniques are being employed to produce pitches whose molecular weight distribution has been optimized for a given end-product application.

Department of Energy Nuclear Hydrogen Initiative

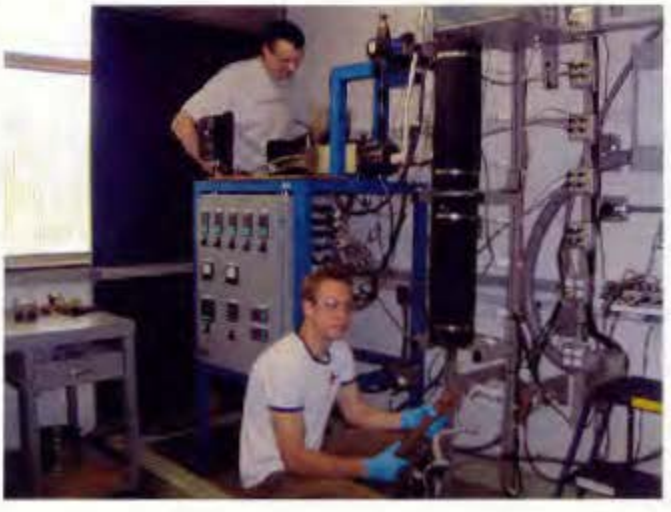
Mark C. Thies, has also received a $856,000, 3-year award from the Department of Energy to develop more efficient methods for the centralized production of hydrogen. The award was one of only three made nationwide under Department of Energy's Nuclear Hydrogen Initiative. In addition to Dr. Thies, the project team includes David Bruce from The Department of Chemical Engineering at Clemson, John O'Connell from Chemical Engineering at University of Virginia, and Max Gorensek from Savannah River National Lab.

"The irony is that today, most hydrogen is produced by using the very fossil fuels we're trying to replace," says Dr. Thies. "But we can also produce hydrogen by splitting water into its two elements, hydrogen and oxygen. The trick is to find the most energy-efficient manner for carrying out that splitting process."

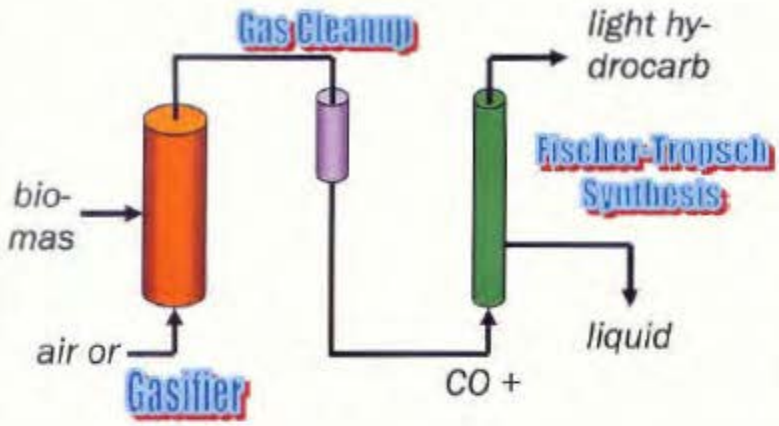
Dr. Thies explains that the proposed "thermochemical processes" have the potential to be much more energy-efficient and reliable than electrolysis, which uses an electric current to split the water. The so-called sulfur-iodine (S-I) cycle, which uses a series of coupled chemical reactions to reduce the energy required to split the water, is the leading international candidate for the centralized production of hydrogen, and will be the focus of the team's efforts.

The S-I process involves complex, highly nonideal phase behavior (would you believe two immiscible aqueous phases?) along with supercritical conditions, so you can see why Dr. Thies calls this project "a thermodynamicist's dream" (or nightmare, as the case may be). Clemson researchers will measure the phase equilibrium data required in order to develop reliable models of the S-I cycle.

"Another aspect of the research that I find particularly intriguing is the opportunity to interact with engineers and scientists in France, Italy, and Japan, all of whom have teams working on this process," says Dr. Thies.



Iron-Based Mixed Metal Carbide Fischer-Tropsch Catalysts



The State Technologies Advancement Collaborative (STAC) in conjunction with the Department of Energy has recently announced the awarding of a grant for $875,499 to Dr. James G. Goodwin, Jr. in the Department of Chemical and Biomolecular Engineering at Clemson University. The proposed 36-month research project involves Clemson University (the prime contractor), Louisiana State University, RTI, Süd-Chemie Inc., Rentech, the South Carolina State Energy Office, and the Louisiana State Energy Office. The research will address the need for highly active, selective, attrition resistant, and stable iron-based catalysts for converting low H_2/CO ratio syngas from coal and biomass to clean fuels, additives, and lubricants using the Fischer-Tropsch synthesis (FTS).

Gasification followed by FTS is currently the most promising method for upgrading low-value coal and biomass to high-value liquid fuels and chemicals. There are sufficient domestic reserves of coal to supply most of US fuel needs for more than one hundred years using FTS. Because biomass is formed by fixation of atmospheric CO_2, its use as a fuel feedstock is attractive because this results in virtually no net CO_2 emissions. The total biomass produced each year as waste material from agriculture and forest operations could be converted into roughly 40 billion gal/yr of liquid fuel, roughly 25% of the current US gasoline usage.

Bulk iron (Fe) catalysts are the catalysts of choice for converting low H_2/CO ratio syngas to fuels via FTS. These relatively low-cost catalysts have low methane selectivity and high water gas shift activity (which generates H_2 *in situ*). However, development of a bulk Fe FTS catalyst that combines high FT activity, low methane selectivity, high attrition resistance (i.e., ability to withstand physical breakage), and long-term stability (low deactivation rate) is still elusive and presents a widely recognized barrier to the commercial deployment of FTS for coal and biomass conversion.

Dr. Goodwin is internationally known for his extensive work in the catalysis of FTS.

Gyo Park, a PhD student in the Department, won the outstanding rising start Graduate Research Student Award in the poster competition of Focus on Research Month, held this April to celebrate research at Clemson. This honor included a cash prize and a "Rising Star" trophy. Gyo will be graduating this May with her Masters of Science in Chemical Engineering.

Stephen Robnett was the proud winner of the Western SC Section of AIChE Scholastic Achievement Award, presented to the graduating senior in Chemical Engineering with the highest scholastic average. Stephen will graduate in May with a BS in Chemical Engineering and a minor in Financial Management and plans to work for Dow Chemical after graduation.

AIChE recently awarded William Vining the American Institute of Chemical Engineers Award for completing his sophomore year with the highest scholastic average in his class. William is from Rock Hill, SC and is involved with Tau Beta Pi Fraternity, AIChE, Golden Key and many other campus organizations.

Congratulations to William Edwards (left) and Amol Janorkar (not pictured) who won this year's

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We would like to express our gratitude to all whose support helps us to improve the department. During the period of January 1, 2004 to December 31, 2004 a total of 151 individuals and corporations made contributions to the department.

We are deeply grateful for their generosity.

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Spring at Clemson!

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