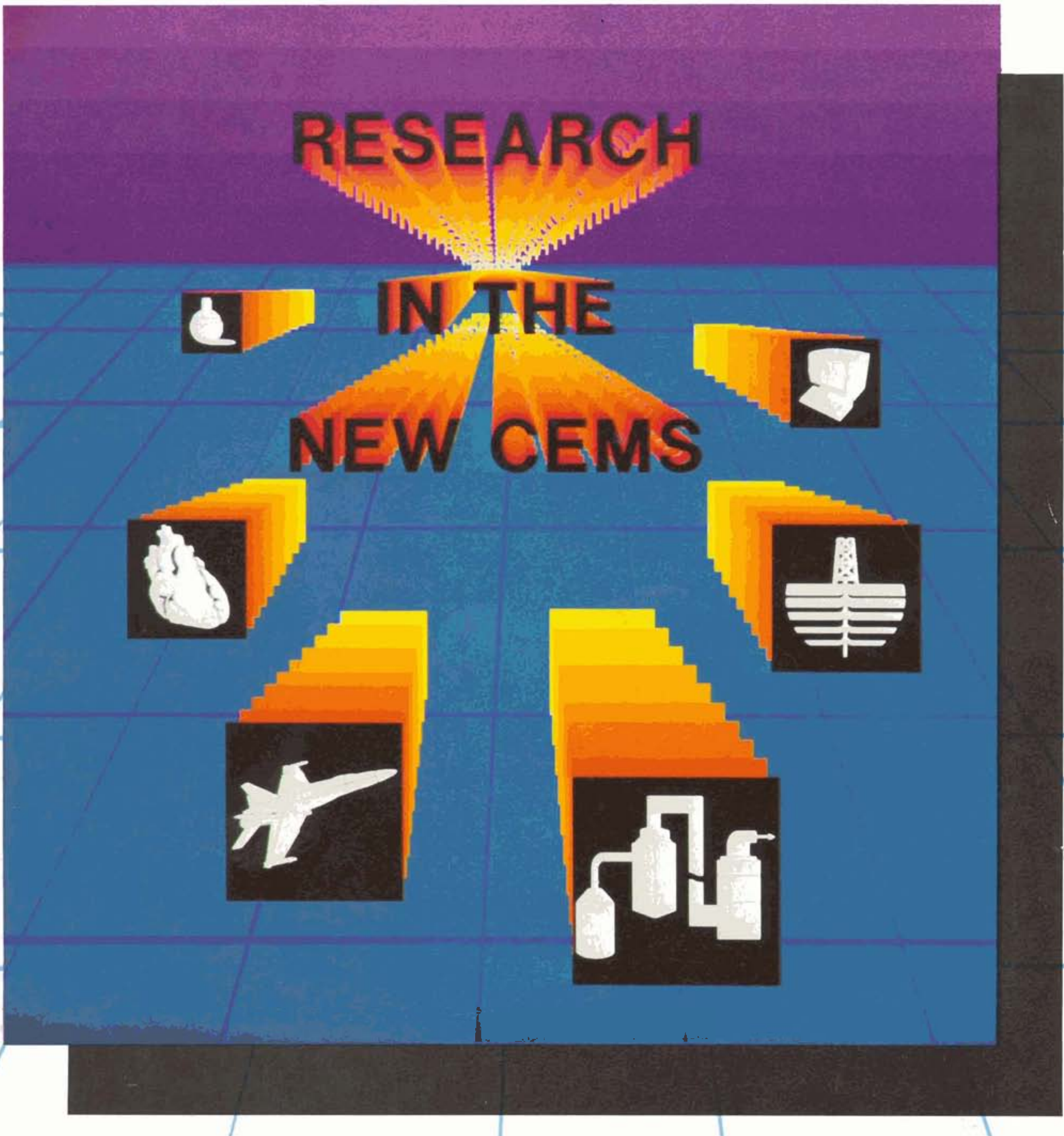
Fall 1983

OKCHE

SCHOOL OF CHEMICAL ENGINEERING AND MATERIALS SCIENCE THE UNIVERSITY OF OKLAHOMA



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A Growing Faculty Brings Excitement to CEMS

Most of the recent issues of *OkChE* magazine have introduced new members of the CEMS faculty to you. It may be surprising for you to know that half of our faculty members have been with the department for three years or less.

Because the faculty and their research interests shape the focus of the department and provide the excitement, they have contributed dramatically to the change our program has experienced over the last several years. Now, in addition to introducing you to our newest faculty members, we'd like to present the new OU CEMS.

To do this, we asked each faculty member to choose one or two of his ongoing research projects and prepare a brief description. As you look over the following pages, you will be impressed by the wide variety of projects and their potential for making major contributions to chemical engineering and materials science technology for the coming decades.

This is an exciting time to be on the CEMS faculty and in the CEMS graduate program. And the excitement is quickly communicated to the undergraduates through the classrooms and labs, as we see projects developing and producing results of importance to American industry and the American public in general.

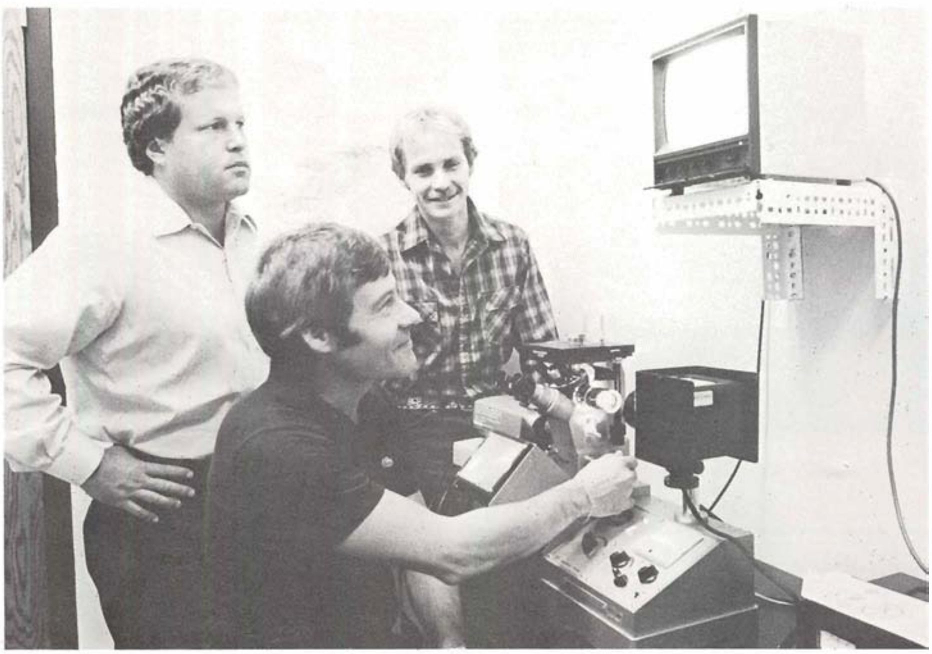
The Effect of Surface Conditions upon the Deformation of Metals

Robert Jay Block

Concurrent with the present interest in materials for space applications and the general progress in all phases of materials engineering, the use of metals having specially prepared surfaces has grown enormously. Examples of these surface-substrate composites are apparent almost without limit.

Electroplated metals, anodized aluminum, and clad materials are three of the most common classes which have wide engineering application. In addition, a fourth group—metals having an oxidized layer at the surface—probably includes all metals as they are found in service.

Thus, the importance of understanding the mechanisms determining the behavior of these composite materials is well recognized. However, understanding the behavior of such materials extends far beyond the utility of coated metals. The



Dr. Robert Block (seated) and students Joe King (right) and Bill Coleman review the micro-strcture of a nickel-base superalloy on a new metallograph.

phenomena governing their behavior involve the basic mechanisms which dictate the strength properties of all materials.

When a composite material consisting of a metal and a thin surface coating is strained, the deformation process may bring about rupture of the coating. This is especially common in systems made up of a ductile base and brittle coating, but it may also be observed with thin coatings of metals which exhibit ductile behavior in bulk form.

Film rupture processes are known to play a role in several phenomena, for example, stress corrosion cracking, brittle fracture of cold worked metals, and the reduced fatigue properties of anodized aluminum. Thus, the behavior of surface films can influence the chemical and mechanical properties of metals.

Robert Block's studies of the effects of surface conditions has directed inquiry into both the behavior of the coating and the base metal. The latter problem has been complicated by peculiarities in the deformation characteristics of the near surface layers of the metal independent of whether a coating has been applied.

Using observations of the dislocation densities and arrangements as a measure of the extent to which plastic deformation has proceeded, Block has studied the separate roles of the surface and underlying bulk material in coated and uncoated metals.

Through fundamental studies of the type described, it is hoped that new information about specific failure processes and the basic mechanism of plastic deformation in solids will evolve.

Failure Analyses of Aircraft Components

Raymond D. Daniels

In the summer of 1978, the University of Oklahoma was asked by the U.S. Air Force to study service failures of a number of aircraft components. These studies were to supplement in-house investigations by the Air Force. The emphasis was on failures that had become chronic problems and needed additional study. The project has expanded to include investigation of repair processes and modifications of components to increase performance and reliability. The project, headed by Raymond Daniels, is now in its sixth year.

Dr. Raymond Daniels and graduate student Philip Perkins use the optical metallograph.

Failure analyses require a knowledge of the design and processing of various product forms and the operating and environmental conditions in which components function. Techniques of metallographic examination and fracture analysis are employed to determine failure mechanisms and causes of failure. The many interrelated factors involved in a typical failure make the failure analysis a broad learning experience.

The project has provided support for a number of students, both graduate and undergraduate. Two master's theses have been completed under this project, and several more are in process.

A spin-off project from studies of the failure of breech chambers on cartridge-ignition aircraft starters will study stress corrosion cracking of high-strength steels in combustion product residues.

These projects have received $477,000 in contract support.

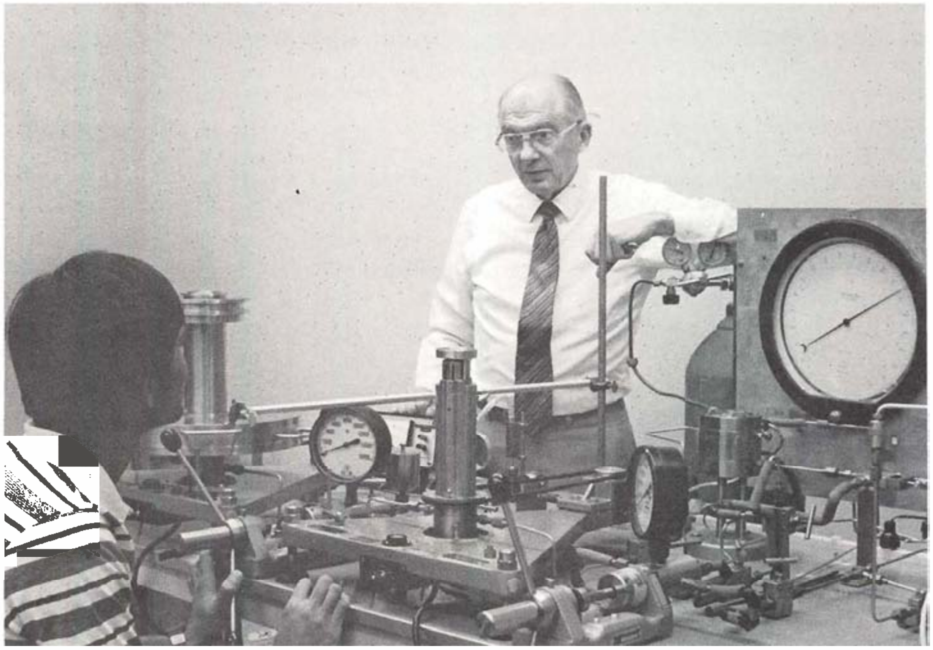
Extreme-Accuracy Compressibility Factors and Supercritical Extraction

Rex T. Ellington

With a long-standing interest in experimental research and high-quality data, Rex Ellington is moving swiftly to establish a new lab and further the reputation he won years ago for his own work and work done for him by others. Within six months of joining CEMS, he was in final negotiations with the Gas Research Institute on a $247,000 project, lasting into 1985, to acquire new extremely accurate data on the compressibility factors of mixtures of natural gas components.

These data will be put to use immediately on Kenneth Starling's project to develop a new correlation for increasing the accuracy of metering gas in custody transfer. The work has been undertaken as a joint project between OU and GRI with the purchase of a special compressibility cell with seed money provided by the university. Data are being gathered in manual operation while waiting for automatic control equipment delivery.

In addition to personal research on control systems and CPI plant reliability and quality management, Ellington is starting a long-term program on the extraction of heavy oils and tars by use of solvents at conditions above their critical points. The objective is to define better ways of separating oils than thermal fractionation for future refineries. Lube stock dewaxing, fine chemical separation, and close-boiling mixture separation are specific targets. Application of the newest predictive methods for design of these systems will also be investigated.



Dr. Rex Ellington and Vikas Orwal use the lastest technology to gather the most accurate compressibility data possible.

It is hoped the results of the work will have direct application to new processes as feedstocks become heavier, lubestocks less plentiful, and metals' contents higher. The work will also have direct application to miscible EOR recovery systems. Proposals are being prepared for DOE, ACS, and oil company support.

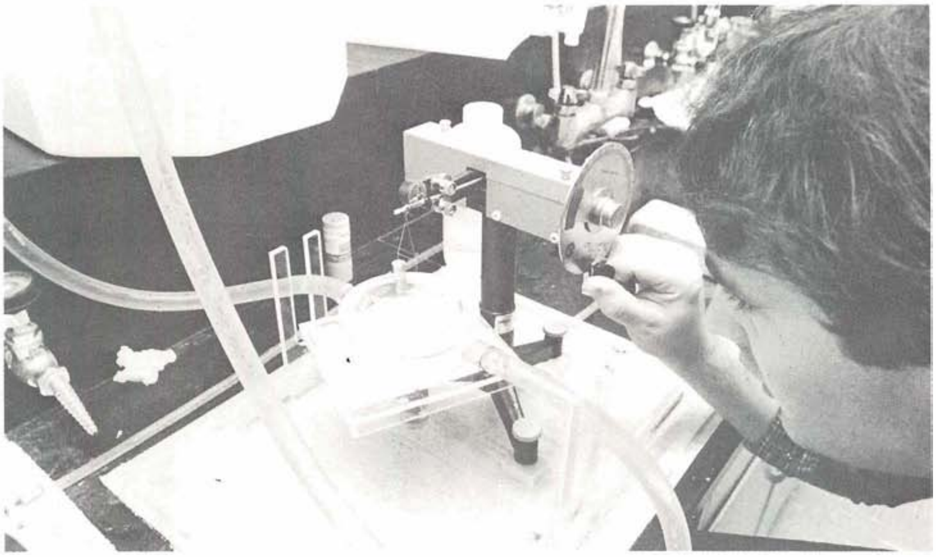
Surfactant Adsorption Used for a New Separations Process

Jeffrey H. Harwell

One major area of Jeff Harwell's research is the investigation of the feasibility of a new low-energy separation process he has invented. Two forces have combined over the last decade to make the development of a new generation of low-energy separations processes for chemical engineering unit operations crucial to our country's economic growth. One of these forces is the increased importance of economic treatments of large quantities of the dilute aqueous solutions encountered in wastewater treatment and the expanding biotechnology field. The other is the dramatic rise in energy costs in conventional separations processes.

By manipulating process parameters—for example, the pH of the solution—surfactant (from *surface active agent*) molecules can be made to form aggregates at solid/liquid interfaces. Molecules of interest in a process stream dissolve in these aggregates, thus recovering or removing them from the stream. When the surfactant aggregates be-

Dr. Jeffrey Harwell (left) and Ali Arshad discuss an enhanced oil recovery experiment.



Graduate student Tim Fitzgerald measures a surface tension in characterizing a surfactant.

come saturated with the molecules being recovered, the aggregates and their contents can then be made to break up by again shifting a process variable like the pH.

Before this new technology can be implemented, the co-adsorption of these surfactants and recoverable molecules must be examined to determine general features of their behavior, to obtain thermodynamic parameters of interest, and to develop models useful for predicting their behavior. In conjunction with this, bench-scale studies are being made on model systems to obtain data for scale-ups and for studies of economic feasibility in comparison with conventional processes.

As an example, one model system already chosen is the recovery of ethanol from aqueous solutions at concentrations such as are encountered in the production of alcohol fuels from biomass by fermentation. The commercial potential of this technology has been greatly reduced by the high-energy costs of recovering the ethanol by conventional techniques like distillation. Harwell believes that if his new process can significantly reduce these costs, this will be a major boost to the development of a new industry.

Proposals for financial support of the various aspects of this project have been submitted to the National Science Foundation and the American Chemical Society's Petroleum Research Fund and are pending at this time.

Engineering Applications of Molecular Theory

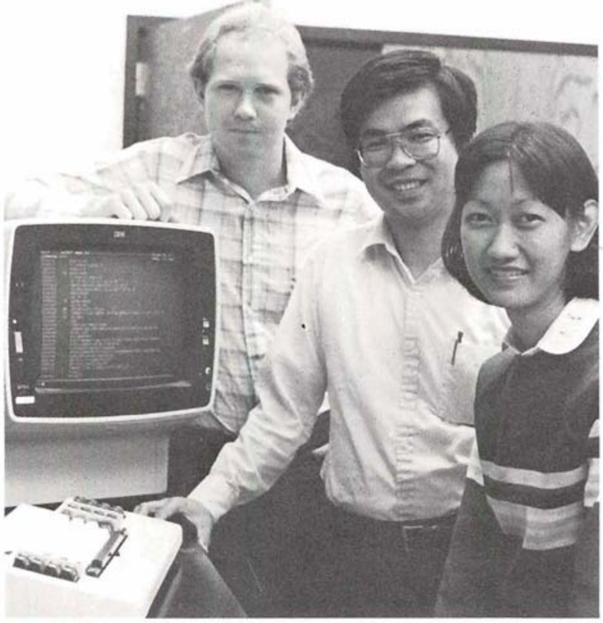
Lloyd L. Lee

Lloyd Lee is currently enjoying a well-deserved sabbatical vacation. His research, however, continues through his graduate students. Lee's work involves the important field of molecular theory and particularly deals with applying these theories to meet industrial needs.

A major stumbling block in most new processes is the lack of experimentally determined physical properties for sometimes very specific systems of interest. The promise of molecular theory is the elimination of time-consuming experimental investigations for each new system that comes up in a process. Of course, this promise has not yet been realized, but improved results from molecular theories are being published daily. Some of the specific areas of Lee's research are the following:

One student is currently attempting to modify a theory for electrolyte solutions called the Mean Spherical Approximation or MSA. Electrolyte solutions are involved in many biological and industrial situations. For example, determining equilibrium conditions in corrosion studies requires a knowledge of the thermodynamic properties of the electrolyte solution which may consist of several dissolved salts. The first and most well-known theory of electrolytes is the Debye-Hückel theory which is only valid at very low concentrations and does not recognize the finite size of ionic species. The MSA is only one of several theories which has been developed in the last few years. It is of particular practical interest because it can be used for dilute solutions as well as molten salts (important in fuel-cell technology), it can be extended to mixtures of salts, and the properties are given by analytical equations. Recent work has shown that the MSA theory will be a powerful predictive tool.

Another project is the development of an equation of state for long chain hydrocarbons. The new equation is modeled after the non-spherical square-well potential with the hard convex body potential as the reference and the attractive part derived from the approximations of the pair density functions.



CEMS students working with Dr. Lloyd Lee—Lester Landis, Su Lin, and Sawitree Kanchanakpan—take a moment's break from their "number crunching."

Fundamentals and Applications in Corrosion and Polymers

Carl E. Locke

Carl E. Locke's research concerns materials, with emphasis on corrosion and polymers. Presently, six graduate students and two undergraduate students are working on two corrosion and one polymer projects.

The Federal Highway Administration is attempting to develop a new deicing material to replace salt which is corrosive and whose runoff damages the environment. FHWA has decided calcium magnesium acetate (CMA) is a good prospective material for this purpose. The OU group is studying corrosion of bridge materials in CMA solutions using weight loss, cracking susceptibility, and electrochemical techniques. CMA is produced by reacting acetic acid with dolomite.

Three graduate students, Kevin Kennelley, Virginia Luster, and Mark Boren, and one undergraduate student, David Hilton, are working on this project. FHWA has funded this work for two years with $141,700.

Virginia Luster, master's student in chemical engineering, and Kevin Kennelley, Ph.D. student in metallurgical engineering, are conducting electrochemical experiments as part of a project funded by the Federal Highway Administration under the supervision of Dr. Carl Locke.

Locke is also studying the corrosion caused by high-density completion fluids which are used in deep, high-pressure wells. These fluids contain very high concentrations of zinc chloride, zinc bromide, and calcium chloride and are very corrosive. This project is funded by the on-campus Energy Resources Institute for one year as a seed-money project.

One graduate student, Russ Davidson, and one undergraduate student, Mark Pilling, are working on this project. They will conduct the electrochemical experiments in an autoclave at pressures to 3000 psig and 300°F. The goal is to determine the effectiveness of electrochemical techniques for systems such as this and then seek outside support for further work.

In addition, Locke is working with the Oklahoma Department of Transportation as an advisor for an installation of cathodic protection on two bridge decks near Tulsa. This project is funded at a low level and does not involve any students.

Two graduate students are obtaining viscoelastic properties of several commercially available epoxy polymer concretes. These materials are used to replace Portland cement concrete in compression foundation repair. The goal of this work is to develop an understanding of the properties of these products and compare these with field-use experience. This will possibly permit the development of materials testing as a means to screen new products for this application.

Coal Liquefaction and Mixing Effects in Emulsion Polymerization Reactors

Richard G. Mallinson

Rick Mallinson's current research interest continues to be in the area of complex rate processes. Specifically, the nature of the degradation of the initial polymeric structure of coal in terms of the reactions of specific chemical groups within the coal is under investigation. This is important in determining the product quality and necessary process conditions for optimal conversion of the coal to fuels. This type of analysis is applicable to both traditional liquefaction schemes as well as more novel processes such as supercritical solvent extraction.

Computerized infrared spectroscopy and nuclear magnetic resonance are two of the major techniques used to identify the chemical, structural groups in the coal and its products, while swelling of the coal and size exclusion chromatography provide the necessary link with the molecular size of the macromolecular chains in coal and the distribution of sizes in the products.

Another area of interest is in polymerization reaction engineering. In particular, a project examining the mixing effects on emulsion polymerization is under way. The mixing patterns can have significant effects on the kinetics of polymerization, thereby influencing the number and size distribution of the product polymer molecules. Scale-up of laboratory results is a particularly difficult problem.

Dr. Richard G. Mallinson

New to CEMS This Year

Rick Mallinson has come to OU by way of Purdue, where he obtained his MSChE in 1979 and recently completed his doctoral thesis. Prior to that, however, he spent four years at Tulane University in New Orleans gaining bachelor's degrees in both biomedical and chemical engineering.

He started his research career early, spending time during his junior year doing synthetic organic chemistry in Tulane's chemistry department and a biomedical project studying mass transfer in artifical kidneys within the chemical engineering department during his senior year.

At Purdue in 1977, he began working with Professors K. C. Chao and R. A. Greenkorn on coal liquefaction chemistry and kinetics. His master's thesis dealt with the kinetics of reactions of sulfur, nitrogen, and oxygen containing compounds found in coal liquefaction products. His Ph.D. thesis proposed a kinetic model based upon the chemical reactions which liquefy the coal rather than the more traditional methods of modelling liquefaction kinetics based on the solubility of the products.

Rick enjoys interacting with students, both at the graduate and undergraduate levels and recently became advisor for the AIChE student chapter.

Away from the lab and classroom, Rick enjoys squash, racketball, volleyball, and swimming for sporting activity and many types of music to accompany reading at home for relaxation.

Blood Cell Deformability and Surface Reaction Requirements

Edgar A. O'Rear

Investigation of abnormal flow properties of red blood cells (erythrocytes) represents a large research effort in Ed O'Rear's laboratories. Exposure of blood to nonphysiologic forces (shear stresses) in certain medical devices adversely affects the ability of an erythrocyte to change its shape—as it must—to survive circulatory constrictions.

Reduced deformability shortens red cell lifespan and contributes to anemia. With the aid of a viscometer, it is possible to mimic this cellular damage using blood from healthy individuals; potential therapeutic agents can then be tested without taking blood from patients who can ill afford to donate (project sponsored by the American Heart Association, $51,700).

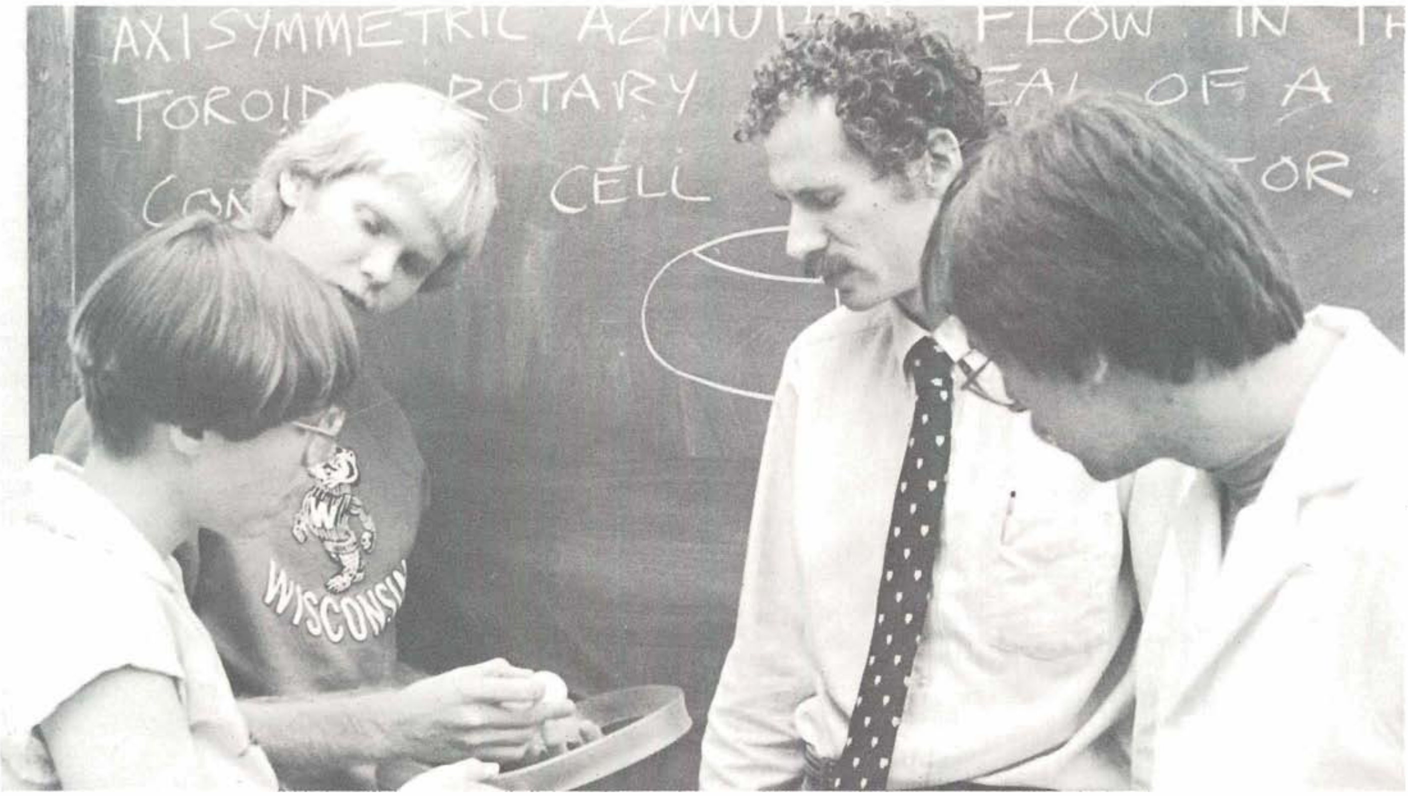
A similar study addresses the compatibility of fluorocarbon blood substitutes with the erythrocyte. One such fluorocarbon suspension has been used in more than 200 clinical trials in Japan and Europe and to a lesser extent in the United States.

The long-term prognosis for a patient whose treatment necessitates transfusion can depend on that individual's red cell mass reassuming the responsibility for oxygen transport. Consequently, the effect of fluorocarbons and their emulsifiers on red cell lifespan is an important consideration in their development.

Additional work concentrates on the theoretical modeling and experimental verification of mechanical trauma during extracorporeal circulation and on red cell rheology as a factor in instances of hypoxia during childbirth.

Another project, Kinetics of Orientational Requirements for Surface Reactions, will assess kinetic restrictions caused by the degree of order necessary for surface reactions. Specifically, pericyclic organic reactions have well-documented stereo-chemical requirements for their transition states. These geometrics imposed by symmetry conservation of the molecular orbitals will serve as models to design and study the kinetics of a series of reactions with increasing spatial requirements.

Other research planned includes the design of a new viscometer and innovative techniques on the formation of surface films.



Dr. Ed O'Rear (second from right) discusses the rotary seal of a continuous cell separator with (left to right) Gretchen Holloway, Chris Harvey, and Jim Giguere.

An Improved Technique for Blood Separations

John M. Radovich

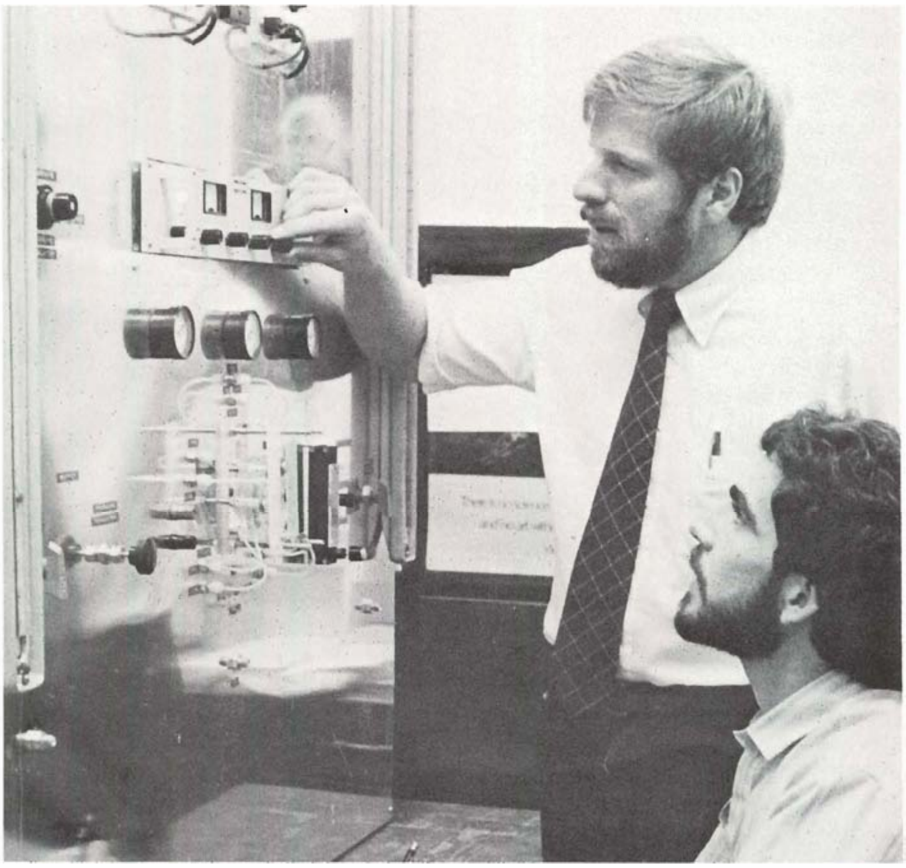
Most of Jay Radovich's research projects are related to mass transfer. One of these is a study of the feasibility of combining electrophoresis with membrane plasma filtration to separate blood products.

The use of plasmapheresis and/or plasma exchange (the continuous separation of whole blood into plasma and cell-rich fractions with the reinfusion of the cellular fraction) for the treatment of various diseases has increased dramatically in the last few years. Most of these disease states are characterized by high plasma concentrations of pathologic or pathogenic substances which have molecular weights much greater than albumin.

Because plasmapheresis is nonselective with respect to plasma solutes, removal of the deleterious solutes results in removal of the needed solutes also. The voluminous loss of needed plasma components and the quantity and expense of the replacement fluids are the fundamental disadvantages of plasmapheresis. It is becoming increasingly obvious that there is an insufficient supply of plasma or plasma products to permit widespread use of plasma exchange therapy.

Membrane plasma filtration selectively removes large molecules by passing the plasma through a porous membrane. The effectiveness of the filtration step depends on the selectivity of the membrane which is controlled by concentration polarization (CP). CP is the build-up of retained solutes on the membrane surface. The use of increased flow rate to control CP may lead to higher membrane fluxes and smaller membrane areas but not necessarily better separation.

Radovich has developed a technique which minimizes CP effects, augmenting flow-rate control techniques. He has combined electrophoresis with cross-flow ultrafiltration by applying an electric field perpendicular to the fluid flow across the membrane. The electric field acts against the pressure drop across the membrane to keep the membrane surface clear of retained species.



Dr. Jay Radovich (standing) with Tim Proffitt is adjusting the electrical field strength in a membrane plasmapheresis unit.

Separation of macromolecules is accomplished by interaction of the membrane, which discriminates on the basis of molecular size and shape, and the electric field which affects the number of molecules of a given electrophoretic mobility that reach the membrane.

This research is the first step toward development of a selective membrane plasma filtration process. This would mean a decrease in or the elimination of the demand for replacement fluids in plasmapheresis therapy.

Current support is provided by a biomedical research support grant administered by OU from NIH. A proposal is pending with National Institute of Health (Heart, Lung and Blood Institute), and collaboration is ongoing with the American Red Cross on proposals to the Army and Navy medical research commands.

Improvements in Enhanced Oil Recovery Chemical Flooding Technology

John Scamehorn

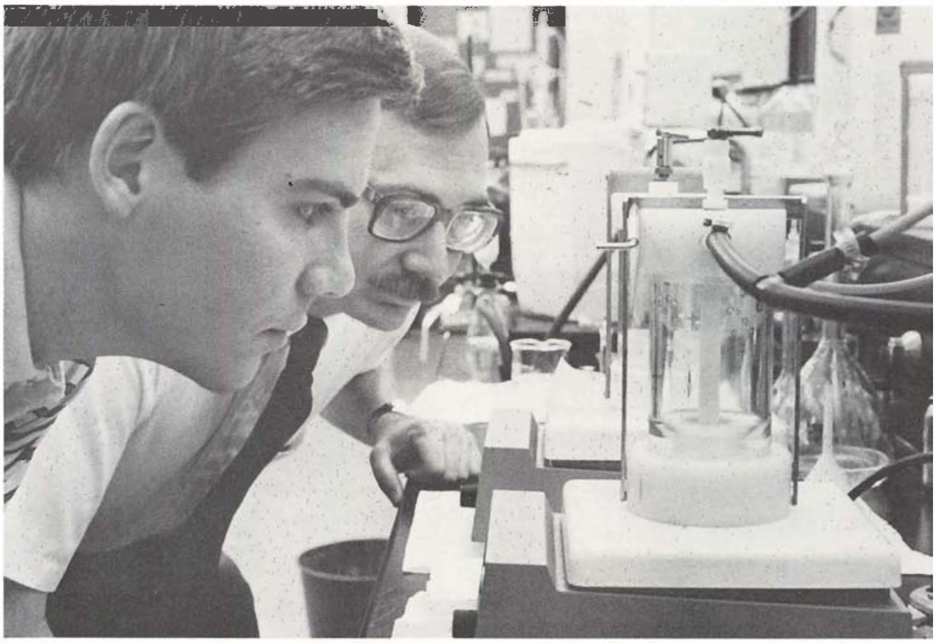
John Scamehorn's main research interest since joining CEMS two years ago has been in the area of enhanced oil recovery by surfactant flooding.

Surfactant flooding has the potential of recovering more than 10 billion barrels of additional crude oil in this country and five times this level worldwide. However, significant technological and economic problems in the implementation of the technology obstruct its commercialization. Scamehorn's research is aimed at solving some of these problems.

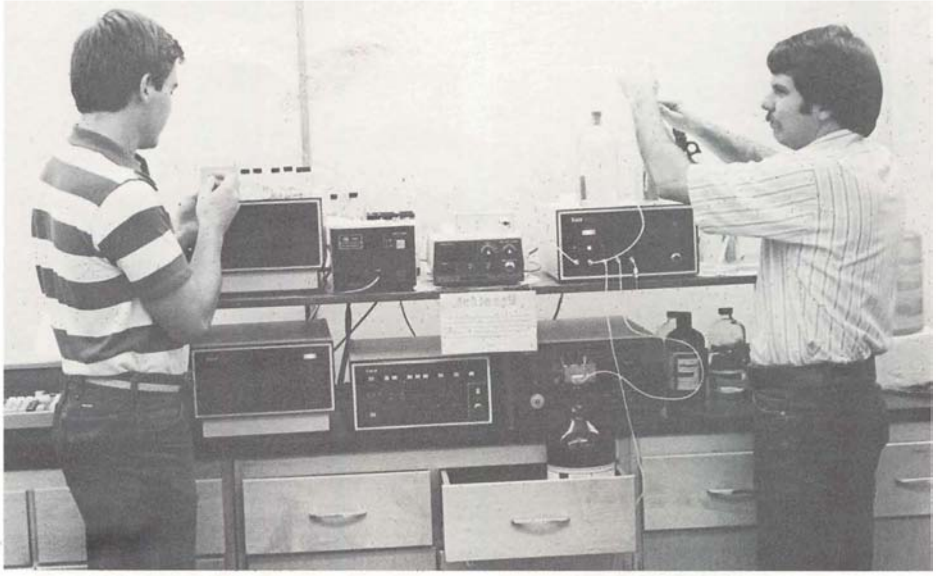
The unique approach taken in this work is the use of surfactant mixtures composed of structurally very dissimilar surfactants in a surfactant slug. The thermodynamic nonidealities of mixing in these solutions can be synergistic in surfactant flooding. Inexpensive, commercially available surfactants can be used rather than having to synthesize expensive formulations.

Some specific problems being addressed by this approach are the development of surfactant slugs for use in high-salinity reservoirs, reduction of surfactant adsorption on minerals, reduction of surfactant precipitation, and elimination of the need for alcohol in the slug formulation.

This research has received support from the National Science Foundation, the Petroleum Research Fund of the American Chemical Society, the OU Energy Resources Institute, and the Oklahoma Mining and Minerals Resources Research Institute. There are six graduate students working on theses on the project, and 14 undergraduates have been involved with this research over the past two years.



Dr. John Scamehorn (left) and Kevin Stellner are adjusting the stirring rate over an ultrafiltration membrane.



Kevin [redacted]ce Roberts are analyzing surfactant concertrations.

3-D Oriented Polymer Fiber Structures

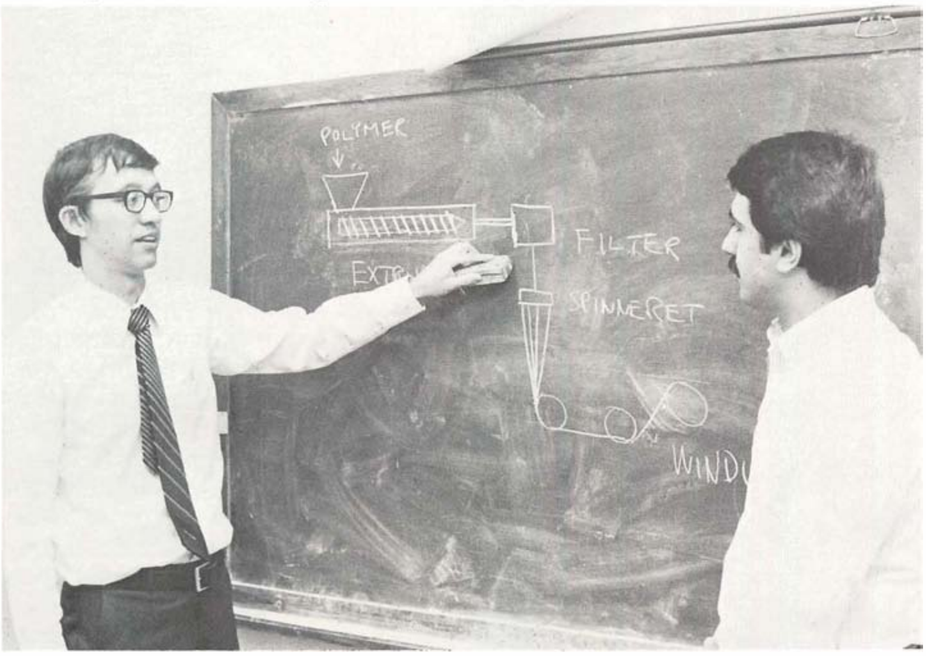
Robert L. Shambaugh

The American auto industry has met the challenge of better fuel economy through more efficient engines, aerodynamic design, and lighter, stronger materials. We at OU are taking a similar tack: Not only are we investing heavily in energy research, but we are also increasing our efforts in materials and design.

Robert Shambaugh of CEMS is developing new, high-strength materials for the 21st century. A major area of this work involves the production of three-dimensional fibrous structures formed from anisotropic melt polymers. Anisotropic melt polymers consist of aromatic, rod-like molecules which form fibrous materials that, on a weight basis, are 10 times as strong as steel. Unlike most synthetic fibers (polyester, nylon, etc.), anisotropic polymers are fully oriented by the spinning process—no subsequent mechanical drawing is needed to bring the fibers up to full strength.

Melt-blowing is a specialized fiber-spinning technique wherein a hot gas impinges on a stream of molten polymer and forms a mass of sub-denier (very fine) filaments. In Shambaugh's process, melt-blowing is applied to the spinning of anisotropic melt polymers to produce a random, three-dimensional structure of fully oriented (i.e., strong) fibers. Various techniques can be used to bond the fibers together; the resultant structure is extremely strong and light.

If every fiber-fiber crossover is bonded, the resultant material is very stiff and rigid. However, if only 10 percent, for example, of the crossovers are bonded, the resultant material will be more elastic and have high-energy absorbing capacity. Since much of the structure is air, varying the processing conditions can produce densities in the range of 0.1 to 1 gm/cm^3.



Dr. Robert Shambaugh (left) discusses the layout of a melt-spinning apparatus with Hamid Farzammehr.

Applications of this material include aerospace and automotive structural members as well as military armor. A proposal for financial support for this program is being prepared for submittal to the Department of Defense.

New to CEMS This Year

Bob Shambaugh joined the CEMS faculty in the fall semester of 1983. Bob and his wife, Karen, have two children—Danielle, aged 4; and Brent, aged 4 months.

Bob spent summers as a steelworker in his hometown of Youngstown, Ohio, while earning his BSChE at Case Western Reserve University. Upon graduation, he worked three years for the industrial chemicals department of Du Pont. While doing process design and supervisory work in various plant expansion and pollution control projects, he learned the differences between commodity industrial chemicals (sulfuric acid and zinc ammonium chloride) and proprietary products (Torvex^R ceramic catalyst support). Bob considers his Du Pont plant experience a valuable benefit in teaching students who will generally go to work for industry after receiving a bachelor's degree.

Bob returned to Case in 1973 and earned his doctorate in chemical engineering in 1976. His graduate work was on the removal of heavy metals from wastewater via ozonation. From 1976 to 1978, he was an assistant professor at Syracuse University in New York, where he learned a lot about teaching, engineering, and cross-country skiing.

Back with Du Pont in 1978 at the experimental station in Wilmington, Delaware, Bob developed interests in polymer science and, in particular, synthetic fibers. A move in 1982 to Du Pont's Nashville research and development group broadened these interests to the area of spun-bonded (nonwoven) synthetic fabrics.

Bob's present research interests at OU are in polymeric materials. One facet of these interests is the use of melt-blown spinning techniques to produce three-dimensional composite structures of high strength, liquid crystal polymers. A second facet is electrostatic spinning and yarn handling.

OU is investing heavily in the Energy Center and energy-related research. Bob feels that his and other researchers' work on materials is an important complement to this energy work—materials' strength, light weight, and compatibility are vital components in any energy-related process.

Bob's personal interests include tennis, handball, and hiking. Another interest, carpentry, was developed because of his and his wife's propensity for buying homes in need of "a little repair."

Theoretical Thermodynamics, Combustion Kinetics, and Natural Gas Treatment

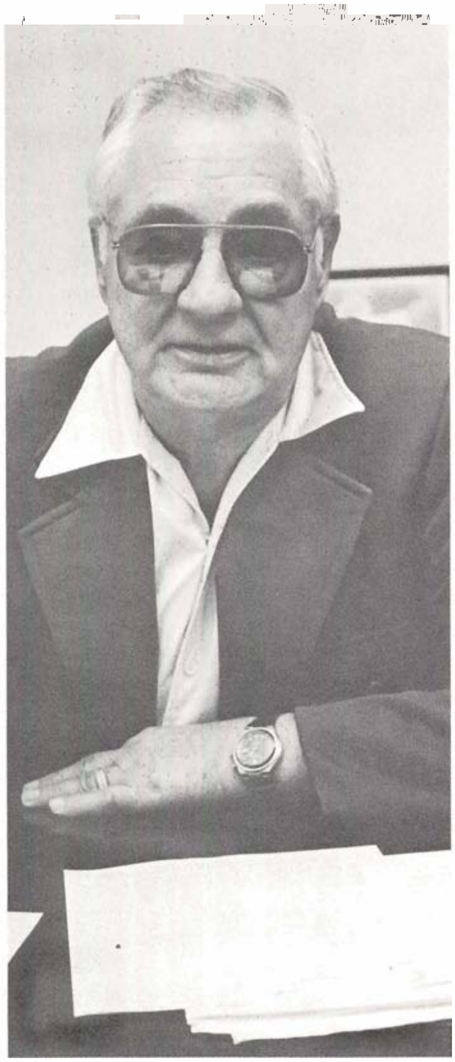
C. M. Sliepcevich

The research of C. M. Sliepcevich ranges from the most esoteric to the most practical of topics. Some of the oldest—if not eternal—topics are concerned with elementary principles of thermodynamics. For example, the inextricability between the Gibbs equation and the entropy balance is generally not recognized; optional formulations for these fundamental second-law expressions are valid to the extent that they satisfy mutual compatibility or reciprocity requirements.

Another area of persistent confusion—as reaffirmed by recent publications—stems from the hybrid concept of energy as a result of its being a function of state rather than a point function. This leads to misinterpretations of the concept of standard states and the significance of their arbitrary nature.

Progress in analysis and modeling of heterogeneous reactions has been hindered by a preoccupation with predicting the spatial and temporal distribution of temperature based on the assumption of overall n-th order kinetics. Combustion reactions are often assumed to follow pseudo first-order kinetics; in other cases the Arrhenius parameters and a reaction order are "crunched out" on computers.

In reality, the kinetic mechanisms governing the reactions are dependent on spatial direction,



Dr. C. M. Sleipcevich

orientation, and time. Because of obvious difficulties in scale up, laboratory experimentation must be more than a down-sized version; it needs to fulfill certain physical analogue or simulation requirements. Another approach for systems involving the combustion of solids is to generate a model based on the assumption of multiple, parallel reactions which need not be identified specifically beyond prescribing temperature intervals over which they predominate.

The removal of carbon dioxide from natural gas is a problem that has confronted the industry from inception. A number of processes based on physical adsorption or absorption or chemical extraction have been developed primarily for gases in which the carbon dioxide content is under 10 percent.

However, in the future, with expanded use of carbon dioxide in enhanced oil recovery, or production of natural gas from the Overthrust Belt, where the carbon dioxide content can run as high as five times the hydrocarbon content, new separation processes will have to be developed. One approach is a series of flash separations which must operate within relatively narrow confines of temperature and pressure to avoid formation of solid phases which would cause operating problems.

Design and Control of Bio-Engineering Processes

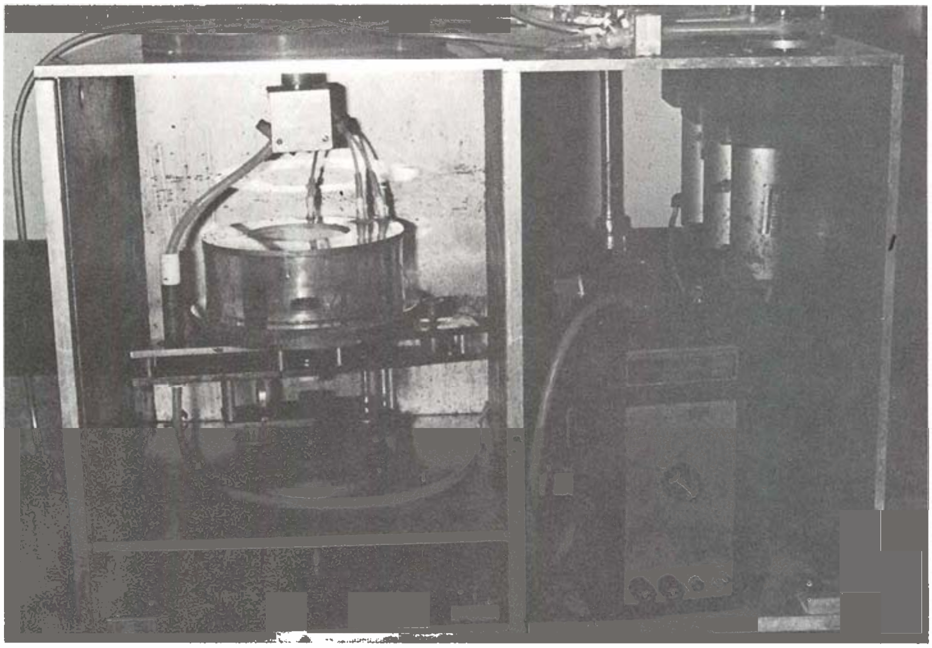
Sam S. Sofer

Sam Sofer's research group at OU has focused its attention on the design of biomedical and biochemical systems. Some of the design methods learned from working at a petrochemical plant, with help ($174,000) from the National Science Foundation, were specifically applied to fields involving pharmaceuticals, biogas, carcinogens, bioethanol, blood separation, and hepatic detoxification (artificial liver). Work involving biomass conversion to fuels was supported by the Electric Power Research Institute.

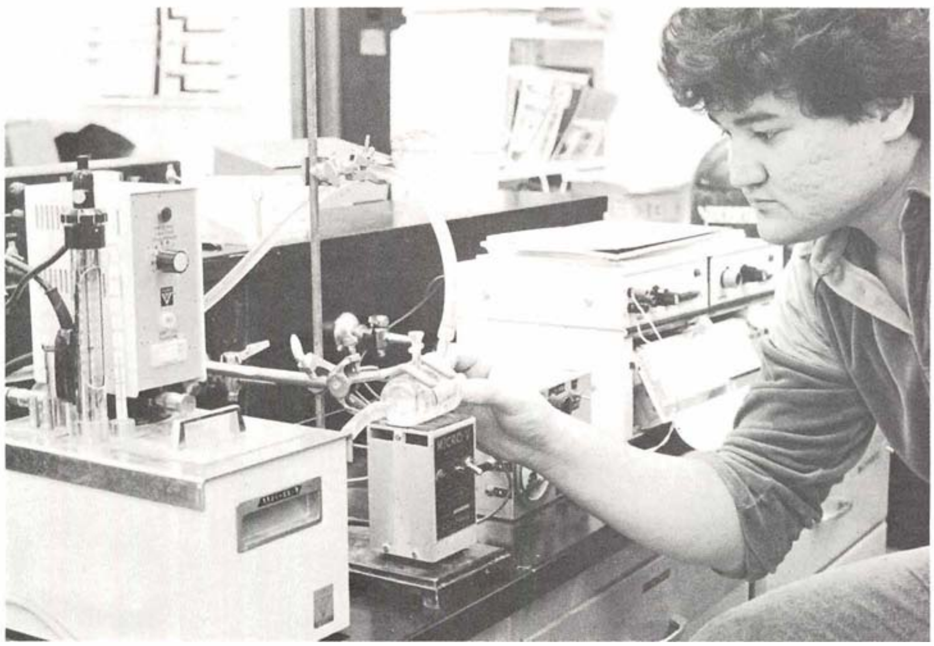
The National Institutes of Health also supported the construction (from scratch!) of a special multistage centrifuge device which may have many potential applications in leukemia and other blood-related diseases.

Recently the design techniques, with support from the National Science Foundation, have been extended to include computer control of systems as applied to biotechnology. Digital control programs written by students are applied to monitor and control a unit for the production of bioethanol from corn, milo, or wheat using a brand-new immobilized-cell reactor.

This control computer may also be programmed to run the centrifuge or other processing units. The goal now is to incorporate new control and simulation technologies to all existing experiments: blood processing, immobilized-enzyme reactors for pharmaceuticals and detoxification, and biomass engineering.



Blood is separated in a centrifuge having an antitwister mechanism. The system is adaptable to control by a microprocessor.



As part of Dr. Sam Sofer's research group, Carl Camp works with beads made of gel and containing entrapped yeast cells to produce ethanol and carbon dioxide from biomass sugars.

High-Accuracy Supercompressibility Factors for the Natural Gas Industry

Kenneth E. Starling

The third and final year is now under way for a Gas Research Institute-sponsored project headed by Kenneth E. Starling to develop a new supercompressibility factor correlation for the more accurate prediction of natural gas flow rates. Composed of undergraduates, graduate students, and research associates, the OU group hopes to complete work next summer which could help solve discrepancies in custody transfer calculations in the United States amounting to several hundred thousand dollars a day. In addition, the research is fostering closer cooperation between American and European research and development groups which promises to benefit both.

The European gas industry first drew attention to the need for a more accurate supercompressibility factor correlation to compute gas flow rate through orifice meters. They noted a discrepancy of as much as .3 percent between actual measurement and the rate of flow calculated by the NX-19 method developed in the sixties and still in use today. The tremendous leap in natural gas prices coupled with doubts about the accuracy of measurement of gases involved in custody transfers gave added importance to the proposal presented to GRI by Starling. The project was funded, and research began in 1981.

An analysis of the NX-19 method by the OU group revealed that changes in the types of gas wells drilled today have made the tables obsolete. Developed for a natural gas consisting of almost pure methane within a rather narrow pressure-temperature range, the NX-19 method does not accurately predict supercompressibility factors for many of the natural gases currently produced. These gases are likely to have higher hydrocarbon or diluent concentrations and flow at greater pressures from deep reservoirs or at lower temperatures. The final correlation toward which the research is moving will be accurate for a wide range of gases and pressure-temperature conditions.

Involvement of domestic and international gas producers has greatly benefited the supercompressibility factor correlation research. Domestic gas transmission companies have provided analyses of samples drawn from their wells while international cooperation is best illustrated by the visit from the Netherlands of Dr. Sip Reintsema, an employee of Gasunie, a gas transmission company. Reintsema's six-month stay at OU allowed for an exchange which will aid both the U.S. and European gas industries.

Dr. Kenneth Starling and Kesavalu Hewanth-Kumar look over student research results.

Chemical Engineering Organization Recognized

An OU CEMS professor was present when Gov. George Nigh recognized the 75th anniversary of the American Institute of Chemical Engineers. Present for the recent Engineering Day proclamation were (left) F. Morgan Warzel, Phillips Petroleum Co. and chairman of the Bartlesville section of AIChE; Rex Ellington, OU professor of chemical engineering and materials science; state Rep. George Vaughn, Big Cabin; Nigh; Robert L. Rorschach, president of Process Technology, Tulsa, representing the University of Tulsa and the Tulsa section of AIChE; Billy L. Crynes, professor and head of Oklahoma State University's School of Chemical Engineering; and Richard D. Melling, a Conoco engineer and chairman of the Central Okalhoma section of AIChE, Ponca City. AIChE has more than 1,000 members in its Central, Tulsa and Oklahoma City chapters.

K Hudson Honored

K Hudson, a research and design technologist with the School of Chemical Engineering and Materials Science, receives the Distinguished Service Award for outstanding contributions to the university community in recognition of his superior service from OU President Banowsky in May 1983. K has been with the dpeartment since August 1971.

From the Director

Dear Alumni and Friends:

The state of the School of Chemical Engineering and Materials Science continues to be good. The new faculty described in this issue along with the other faculty that have come to OU in the past three years have given us a considerable boost. We now have half our chemical engineering faculty with two years or less of OU experience. In addition, the size of the faculty is the largest in the history of CEMS. The total faculty size is 14 (12 in chemical engineering and two in metallurgical engineering).

We do have a serious concern about the condition of the state's financial situation. As this issue goes to press, we have the prospect of a shortfall in state revenues which would necessitate a cut in the university budget. At this point the amount of shortfall and its impact on CEMS are not known. We do know that if the shortfall goes above $60 million, we are faced with universitywide "furloughs" (a pseudonym for paycut). We hope, however, that the governor and other state officials will see the wisdom in maintaining the excellent momentum we have gained over the past few years and will consider tax increases. The public schools, highways, and other state programs all face similar difficulties.

I do think the long-run future for CEMS is excellent. We continue to have outstanding students, a superior faculty, and a fine new facility coming—the Energy Center. We will keep you informed about developments in future issues of *OKChE* magazine.

Sincerely,

Carl E. Locke

Carl E. Locke
Director

OKChE Board Meeting

The new OKChE board met in April 1983 and approved new members and a new organizational arrangement. The board membership is as follows:

Richard G. Askew
Don Green
Verne Griffith—secretary/treasurer
Mary S. Justice
James A. Kennelley
Garman O. Kimmell
Ed C. Lindenberg—vice chairman
Charles R. Perry—chairman
Robert S. Purgason
Laurance S. Reid
C. Thomas Sciance
F. Mark Townsend
M. F. Wirges
Frank Wolfe
Carl E. Locke (ex-officio)

The board formed four committees: academic, finance, nominating, and executive. In addition, a new set of bylaws was approved, and since the meeting, these have been endorsed by Martin C. Jischke, dean of engineering, and OU President William S. Banowsky.

The board decided to meet twice a year instead of the one time a year as has been done in the past. You will be kept informed through the magazine and other communications of future activities of the board.

Financial Summary of OKChE

The financial condition of OKChE is fairly good. The total contributions for the past five years are listed below:

78–79	$ 22,975
79–80	29,083
80–81	30,884
81–82	11,525
82–83	22,268
	$116,735

The expenditures for 1982–83 are also listed below:

Magazine	$ 6,843
Student Activities	882
Scholarships	10,450
Laboratory Equipment	910
Board Meeting Expenses	1,052
Retirement Reception for F. Mark Townsend	1,249
	$21,386

We would like to increase the amount of the scholarships supported by OKChE, and we know there are other worthy projects in the Unit Operations Laboratory. We continue to need your help and hope you can donate to OKChE again this year.

By now you should have received a separate solicitation letter which, together with the information in this magazine, should make our departmental needs and aspirations clear. Thank you for the help you have given us throughout the years.

Gulf Gives $50,000 of $150,000 Commitment to CEMS

To assist in the purchase of an interactive computer, the Gulf Oil Corp. has presented the third installment of a $150,000 gift to the University of Oklahoma School of Chemical Engineering and Materials Science.

An interactive computer system with enough terminals for students to have almost immediate access to the system is a top priority of the school.

CEMS is striving to have one of the finest undergraduate chemical engineering programs in the country. To complement its program, the school needs facilities similar to those encountered in industry. Any additional funds needed will be sought from both within and outside the university.

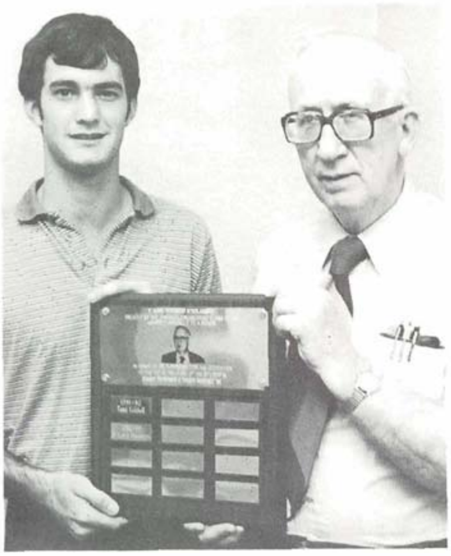
The departmental assistance grants are awarded by Gulf to support special projects proposed by specific departments in colleges and universities. In addition to these grants, Gulf's Aid to Education Program includes undergraduate scholarships, graduate fellowships, employee gift matching, capital grants, and various special grants.

The final installment of a $150,000 grant to assist in the purchase of an interactive computer system for the University of Oklahoma School of Chemical Engineering and Materials Science is presented to OU officials by J. L. Huitt (third from left), president of Gulf Oil Exploration and Production Co. The $50,000 check was presented to Carl E. Locke (left), director of the OU School of Chemical Engineering and Materials Science; OU President William S. Banowsky; and Martin C. Jischke, dean of the OU College of Engineering.

Mobil Oil Corp. Gift

A $7,000 gift from Mobil Oil Corp. of Denver has been presented to the University of Oklahoma College of Engineering for two of its schools—petroleum and geological engineering and chemical engineering and materials science. The gift was presented by George H. Liveris (second from left), a 1952 OU geology graduate and Mobil division engineer of special projects/producing, to OU officials John M. "Jay" Radovich (left), associate professor of chemical engineering and materials science; Martin C. Jischke, dean of the College of Engineering; and Ronald D. Evans, Curtis W. Mewbourne professor of petroleum engineering.

Honors and Awards



Dr. F. Mark Townsend presents Bernie Mike Baldwin with the 1983 Townsend Scholarship.

Students in CEMS have excelled this year as scholars and leaders. Among the honorees are:

Michael P. Bresson, Bartlesville graduate. Bresson received the Letzeiser silver medal at the OU Senior Awards Banquet last spring.

Jeff Finch, Ponca City sophomore. A 4.0 g.p.a. student, Finch was honored as outstanding freshman in mathematics with the Nathan A. Court Award.

Ted Jones, Idaho Falls, Idaho, senior. Jones has been named as one of 12 recipients of an American Gas Association scholarship for $1,000.

Yong Hwan "Danny" Kim, Moore senior. Kim has been given the 1983 Honors Education Award for his work on a proposal to begin evaluations of a liquid/liquid chromathography device used to separate biological compounds and blood components.

Ralph John Markland, Edmond senior. Markland is president of Alpha Phi Omega, a service project organization.

Scott Dwain Roswurm, Billings, Mont., junior. The American Society for Metals has awarded one of 25 undergraduate scholarships to Roswurm this fall. The honor carries a $500 stipend and certificate.

Mohammed Tahiri, Washington D.C. graduate. Tahiri is supported in the OU CEMS graduate program by a Fulbright Scholarship.

Billie Winter, Bartlesville graduate. Winter has received the Outstanding Scholar Award for the Freshman Year, an award given among the University Scholars.

Mark Yeskie, Norman graduate. Yeskie, who recently completed an M.S. in chemical engineering at the University of Delaware, has received the Phillips Petroleum Fellowship for 1983–84. He will work with Jeff Harwell in surfactant flooding research.

Graduate students **Tai Luong**, Oklahoma City; **James F. Rathman**, Norman; **Jeffrey L. Savidge**, Norman; and **Kevin L. Stellner**, Norman, have been chosen for $3,000 merit fellowships from the Oklahoma Mining and Mineral Resources Research Institute.

Lowry Blakeburn, Muskogee graduate; **Russ Davidson**, Frankfort, Ill., graduate; **Lam Nguyen**, Tahlequah graduate; **Ronald Rauniker**, Wilburton graduate; and **Carol St. John**, Norman graduate, all receive partial support from Conoco.

Awards Banquet

The Eighth Annual Chemical Engineering Awards Banquet was held April 8, 1983, in the Oklahoma Memorial Union, honoring all Program of Excellence students.

Special departmental awards were presented to the following students:

Celanese Award for Outstanding Freshman in Chemical Engineering—John William Barton, Tulsa

CEMS Award for Outstanding Sophomore—Ralph John Markland, Edmond

Phillips Award for Outstanding Junior in Chemical Engineering—Jimmy John Ivie, Midwest City

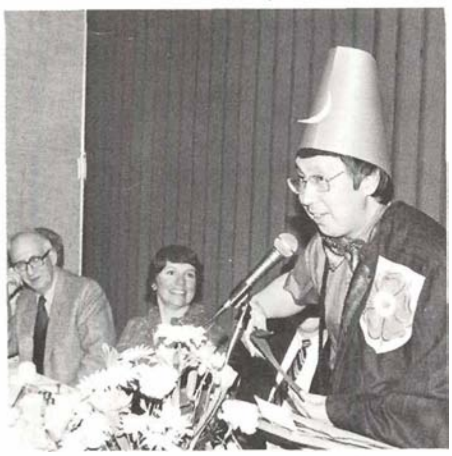
Pamela Pesek Johnson Awards for Outstanding Senior Groups in Chemical Engineering Design:
Best Presentation—Hocus Pocus
Tie for Best Project—Chemical Engineering Design (CED) and Innovative Design Corporation (IDC)

Outstanding Metallurgical Award—Ronald Raunikar, Wilburton

Robert Vaughan Award for Excellence in Chemistry—Deanette Susan Dockery, Bartlesville

American Institute of Chemists Oustanding Senior Award—Pamela Tucker, McPherson, Kansas

AIChE Student Scholarship Award—Robert Brent Landers, Miami



Dr. Lloyd Lee served as the well-prepared master of ceremonies for this year's Awards Banquet.

Employment Uncertainty Facing CEMS Grads

A greatly reduced demand for chemical engineering graduates occurred last spring, due to the drop in oil drilling, production, and refining, coupled with the state of the chemical industry. We do not have exact statistics concerning employment after the semester ended because students tend to disappear and we can't get information from them. But we do know that by graduation in May, only about one-half of our CEMS students either had gotten jobs or had decided to go to graduate school.

We also know that a few students working at a job hunt on their own obtained jobs during the summer. In addition, we have been able to recommend a few students to people who have called in looking for employees.

This problem is not unique at OU. Several other universities in the region have also related similar sorts of statistics. *Chemical and Engineering News* had a cover article on the 1984 employment outlook for chemical engineers and chemists in their October 17, 1983, issue.

The statistics indicated 35 percent of the BSChE graduates were not employed and were looking for work at graduation. By comparison, about seven percent were in the same situation in 1981. The C&EN article also stated that "signs point to better times."

We think there are indications that things will be slightly better this year than they were last year. However, we expect jobs will not be plentiful and our students will need to work very hard on their own in addition to the on-campus interviews.

The sudden drop in job openings led to severe strains on the job interview sign-up system in the Career Planning and Placement office in the fall and spring semesters of 1982–83. This fall, Career Planning and Placement put in a bid system for job interviews. Each student started with 999 points and could bid all or a portion of these to be placed on an interview schedule of a given company. The details of how these were bid, the amount charged, and other features are a bit complicated and will not be discussed here. We do know, however, that a prime company interview slot will cost a ChE student about 200 points. Therefore, on the average a student can interview with four to five companies.

At this date, we cannot predict employment success for our spring 1984 graduates. We would like to think all students will be hired. If not, we may see a trend toward lower enrollments in chemical engineering. We have, in fact, seen a drop in the freshman enrollment this year. The enrollment of chemical engineers by class for this fall and last fall are shown below.

We graduated 63 BSChEs last year and expect to do about the same this year. The difference in that number and the ones classified as seniors is due to the computer designation of a senior by credit hours only.

We hope the fine students graduating this December, May, and July will be successful in finding employment. They started into chemical engineering at a time when job opportunities were great and now, due to things beyond their control, are faced with poorer job prospects. We are confident they can be as outstanding as employees as they have been as students if they are given the chance.

Chemical Engineering

	Fresh.	Soph.	Jr.	Sr.	Undergrad.	Grad.	TOTAL
Fall 1982	92	80	84	113	369	63	432
Fall 1983	59	78	100	124	324	74	398

Metallurgical Engineering

	Fresh.	*Soph.*	*Jr.*	*Sr.*	*Undergrad.*	*Grad.*	*TOTAL*
Fall 1982	2	3	2	9	16	8	24
Fall 1983	0	3	5	3	11	9	20

Feedback from Alumni Can Help CEMS Students

In addition to giving CEMS students the best possible classroom and lab experiences to prepare them for employment, the department would like to sponsor a series of seminars based on suggestions from alumni about their own experiences in industry.

Initiated by Rex Ellington, who has had more than 30 years of industrial experience himself, the seminars will address matters that affect the graduate primarily in the first five years. Some of the considerations might be the following: What a young engineer *really* does, shift work, company politics, interpersonal relationships, communicating, working with unions, etc.

As alumni, you can assist us in identifying non-technical concerns for which you were least prepared in moving into industry. Please send suggestions for topics or willingness to participate to Rex Ellington at CEMS, 202 W. Boyd, Norman, OK 73019. We'd like to give future OU graduates an edge on the competition by helping them to a good start.

Alumni Notes

Let us know where you are and what you are doing. Please fill out one of the enclosed information cards and send it to us. We will publish the information in our next issue of *OkChE*.

1930s

James Pipines, '39 bsche, 221 Lynn Dr., Paterson, NJ, is now retired from the firm of Pipines/Tromeur & Assoc. Architects and Engineers.

1940s

W. Jack Anderson, '43 bsche, 3924 Antone, Santa Barbara, CA 93110, retired from Standard Oil Co. (Ind.) in 1975. He started his own consulting work and completed a three-year LNG job in Indonesia and a refinery job in West Africa. His family includes his wife, Betty, and two married sons.

H. Merle Evans, '40 bsche, 3907 E. 4th, Tulsa, OK 74112, has retired from the Department of Energy in Washington D.C.

Ed Lindenberg, '47 bs, 1401 W. Detroit, Broken Arrow, OK 74102, is now retired from Warren Petroleum in Tulsa.

1950s

D. I. (Pete) Davis, '56 bsche, 8518 Burning Hills, Houston, TX 77071, is the regional manager with the Foxboro Company in Houston.

1960s

Wilson Lee, '68 ms, 51 Hearthstone Road, Bloomfield, NJ 07000, works as senior scientist for Richardson-Vicks Inc. in Shelton, Conn.

Timothy D. Stanley, '69 bs met, P.O. Box 591, Tulsa, OK, is employed as an attorney with Standard Oil Co. (Ind.) in patents and licensing.

John H. Waller, '61 bs, 16100 Baywood, Granger, IN 46530, is now executive vice president-general manager of Speareflex in Kalamazoo, Mich. His wife, Lou, '60 bsn, is vice president/advertising graphics for NPC Communications. Daughter Jenny is a senior at Tufts, and son David is a freshman at Williams.

1970s

Francis A. Ferraro, '71 bsche, 69 Morton Street, Canton, MA 02021, has recently moved to Massachusetts to work for Stone & Webster Engineering Corp. as the lead licensing engineer for fossil and miscellaneous projects. He also recently received his MBA from Kent State University in Ohio.

Maureen T. O'Brian, '78 bs, P.O. Box 360 Anchorage, AK 99510, has transferred from ARCO Oil and Gas Co. in Houston to ARCO Alaska Inc. in Anchorage where she is now senior facilities engineer. She has begun working on an MBA and is enjoying her return to school.

Bernard J. Van Wie, '77 bs, '79 ms, '82 phd, assistant professor in the chemical engineering department at Washington State University in Pullman, WA 99164.

1980s

Norman and Nancy (Cox) Farrell, '81 bsche, P.O. Box 5595, Borger TX 79008 are both process engineers at Phillips in Borger. They send their love and congratulations to Dr. Townsend!

Thomas Green, '82 bs, 524 Burbank, Muskogee, OK 74403, is now employed as a chemical engineer with the Oklahoma Natural Gas Co.

Steven F. Reber, '82 bsche, 1119 Julie Lane, Powell, WY 82435, works as an engineer with Amoco Production Co. But he says he's still drinking beer and playing video.

In Memoriam

Mrs. Ruth Williams Huntington died Saturday, September 24, in Norman. She was the wife of "Doc" Huntington, long-time chairman of CEMS. "Doc" Huntington preceded her in death in 1972.

Mrs. Huntington, known as "Ducky" to her acquaintances, took an active interest in her husband's teaching career and helped make the Huntington household a home away from home for generations of chemical engineering students.

Mrs. Huntington's family has designated the OU Foundation, 660 Parrington Oval, Norman, Oklahoma 73019, appropriate for expressions of sympathy. Donations should be specified to the Huntington Memorial Fund.

Faculty Update

Rex T. Ellington had a paper entitled "A Cheaper, More Effective Path to Oil Shale Commercialization" in the AIChE summer meeting in Denver. He presented a paper on fundamental gas laws at the International School of Hydrocarbon Measurement in April.

Jeff H. Harwell received a grant from the Energy Resources Institute for enhanced oil recovery research. A paper of his on chemical recovery injection strategies was recently chosen to appear in the Society of Petroleum Engineers' journal. A review paper on surfactant adsorption and modelling has been chosen to appear in the proceedings of an international conference on oil recovery to occur in Europe next spring.

Carl E. Locke served as general chairman of the NACE South Central Regional Meeting which occurred Oct. 17–19, 1983. He also received a research contract of $141,000 from the Federal Highway Administration for a study of the corrosion tendencies of a new deicing material.

John F. Scamehorn presented a paper entitled "Counterion Binding on Mixed Micelles" at an ACS meeting in Toronto last June.

S. S. Sofer is now director of undergraduate labs. He served on a proposal review board for biochemical processes for the National Science Foundation. He also served on the *AIChE Journal* review board and was awarded a small grant for work in the area of blood centrifugation.