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The Center for Energy Studies is a multidisciplinary research center, the central liaison for energy research, education, and public service at The University of Texas at Austin. Dr. Herbert H. Woodson is director.

Editor: Jennifer Evans

Polymer Membranes

Center researchers are patiently turning an alchemy into a science

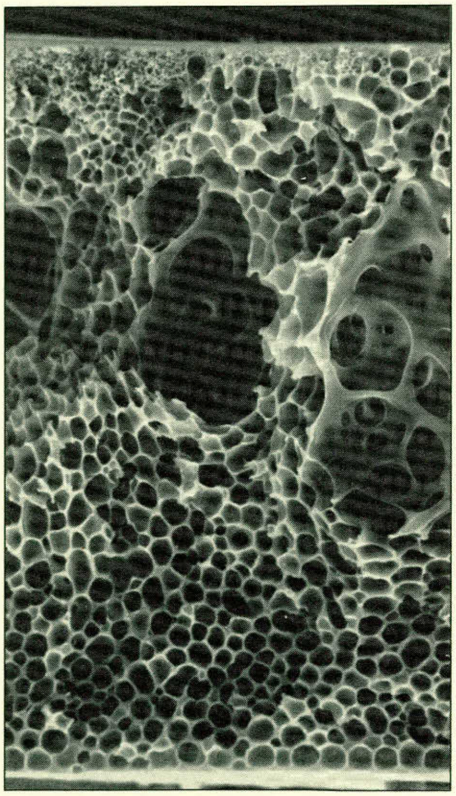
One of the country's largest university research programs on industrial membranes is being carried out jointly by UT's Separations Research Program and Center for Polymer Research.

Membranes are a new technology used in a variety of ways by industry, for example, to separate hydrogen and nitrogen in ammonia synthesis, to purify water through reverse osmosis, and to perform ultrafiltration of dairy products.

The value of a membrane is that some gases or liquids will cross it and some will be mostly excluded. This preferential action is called the membrane's selectivity. The exterior of a human cell acts as a selective membrane.

UT chemical engineering faculty members William J. Koros, Douglas R. Lloyd, and Donald R. Paul, 25 graduate students, and visiting scientist Jacob Koresh are studying many aspects of membrane technology: basic chemistry, characterization, testing, conditioning, and manufacturing techniques.

"The basic mystery is, how do you predict how a new polymer will perform in a given application?" said William J. Koros, professor of chemical engineering. "If you vary one little thing—add one little dash of something—a polymer that wasn't interesting can become very interesting. At present it's a bit like alchemy."



The skin of this polyether sulfone membrane (white layer at top) separates mixed gases, while the rest of the membrane is a coarse-pored support layer (photo courtesy of GKSS, West Germany).

In the area of gas separations, this

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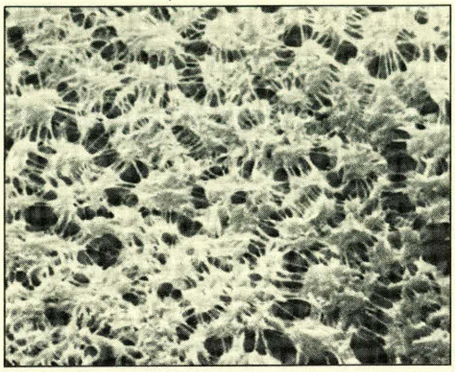
group has been investigating a number of polymer types—polyimides, polycarbonates, polysulfones, polyolefins, and cellulose acetates—and methods for chemically modifying them, such as carboxylation and fluorination.

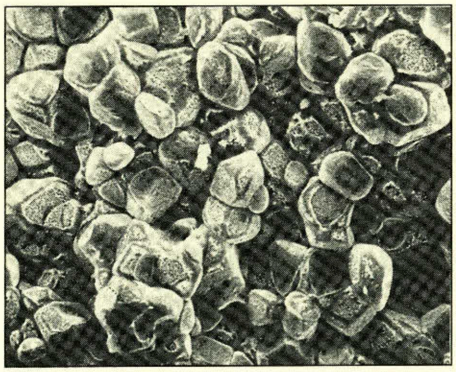
Different polymers seem to be required for optimum separaton of different gas pairs. For example, some new polyimides offer the best possibilities for separating carbon dioxide and methane, a process potentially useful in tertiary oil recovery. A substituted polycarbonate is currently the best candidate for separating oxygen from nitrogen. A commercial poly ether imide is attractive for helium and methane separations.

"The real value of the research goes considerably beyond the specific polyimides themselves. We've carried out a careful, systematic study of which factors tend to change the permeability and selectivity in a polymer," said Dr. Paul. The researchers' goal is a framework of reliable principles for predicting membrane performance.

Most membranes used in actual separations processes resemble milky white pieces of cellophane. Each membrane is cast so that two layers are formed. The thick layer is a porous support about 100 microns thick, and the thin skin, which does the work and is the true membrane, is only one-hundredth as thick.

The researchers have developed a method for conditioning gas membranes to improve their productivity and have tested it successfully on several types of membranes. The university has applied for a US patent on the technique.





Because of its weblike structure and uniform pore size, the top polypropylene membrane is stronger than the bottom one and a better separator for microfiltration of liquids.

Future research will continue in these areas and expand into two new areas: ceramic membranes and polymer barriers, a cousin of membranes. Polymers with good barrier properties are needed for example in food packaging so that a soft drink remains carbonated or so that the fresh smell of a food is not stolen by its wrapping.

While the work of Drs. Koros and Paul deals with separating gases, Dr. Lloyd is investigating ways to manufacture membranes for separating liquid mixtures. His liquids separations work is sponsored by the Separations Research Program, 3M, and the National Science Foundation.

Dr. Lloyd said his goal also is to develop a more fundamental understanding of how membranes form, by mapping the factors that affect it.

Much of Dr. Lloyd's work involves crystalline polymers, used today in microfiltration, ultrafiltration, diaper linings, skin grafts, controlled-release medicines.

A method of making crystalline polymers has been developed by 3M and Enka in which the membrane polymer is mixed with a diluent and heated and cooled while being cast as a thin membrane sheet. Crystalline polymers, unlike most other membrane materials, are able to withstand contact with organic solvents and temperatures of 100° C (212° F) and higher, Dr. Lloyd said.■

UT Austin Energy

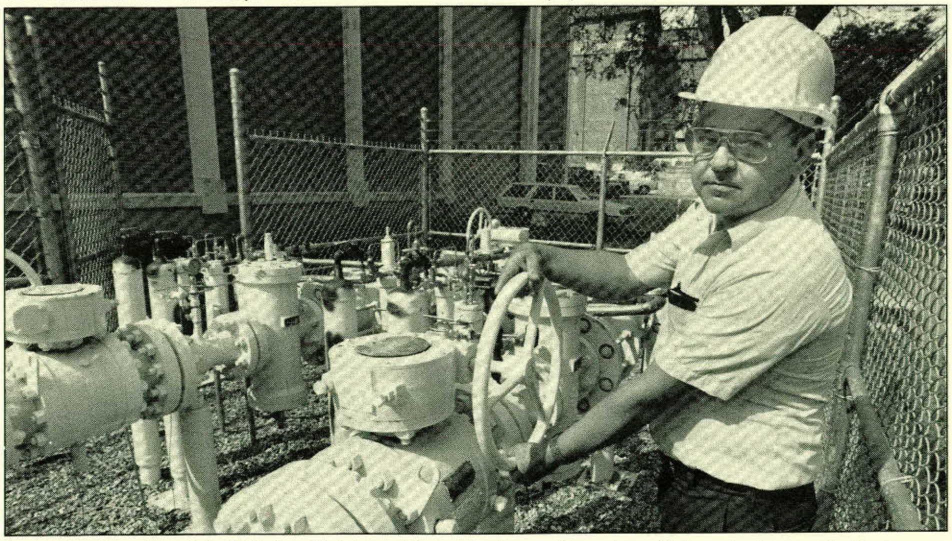
41-Mile Gas Pipeline Saves UT $6 Million a Year

A cost-reduction measure by The University of Texas at Austin has won an award in a competition sponsored by the National Association of College and University Business Officers and the US Steel Foundation, Inc.

UT Austin received an award for its construction of a natural gas pipeline, which is saving the university $6 million annually.

Having recently found out that it was not required to purchase its natural gas from a local utility company, the university reached an agreement with a pipeline transportation firm and a natural gas supplier to construct a 41-mile pipeline directly to the campus heating and power plant.

According to G. Charles Franklin, UT vice-president for business affairs, the principal benefits of the pipeline are lower natural gas prices, a lifetime contract for the transportation of natural gas from the most competitive source, and guaranteed pressure in the pipeline.■



Louis Zschiesche of the Utilities Division adjusts a valve on the university's natural gas pipeline, which recently won a national award.

CES Update

Office of Director

Center researchers are investigating a way to burn gas fuels more efficiently and with less pollution by **positioning the flame within a porous piece of ceramic.**

A gas flame burning directly inside a solid but porous ceramic block behaves differently from an open flame, said John R. Howell, chairman of the UT Department of Mechanical Engineering.

Dr. Howell, mechanical engineering faculty members Ronald D. Matthews and Philip L. Varghese, and postdoctoral researcher Yih-Kanq Chen are studying combustion within ceramic blocks. Ceramics that can withstand high temperature without melting are being used. Through a spongelike block of a material like aluminum oxide or zirconium oxide, gas can flow freely.

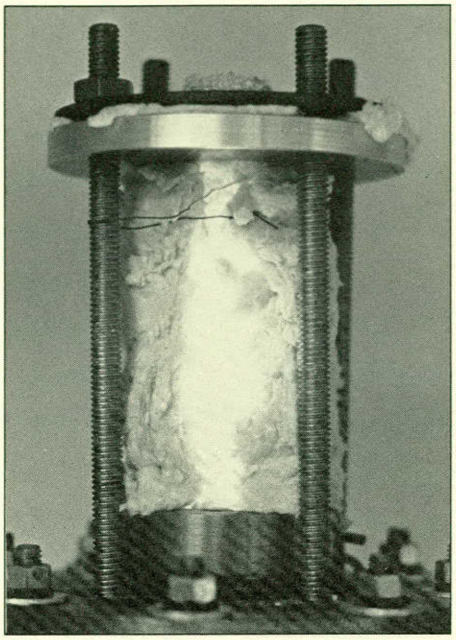
Computer simulations of combustion in porous blocks predict that several advantages may be gained. Because the solid radiates heat much better than an open flame does, the gas mixture is preheated as it flows through the porous block toward the combustion zone.

Thus flames inside porous ceramic blocks are hotter than they would be if the gas mixture burned freely, and the combustion tends to be more complete. The strong radiation heat transfer also makes these burners more efficient heaters. Dr. Howell said measurements have confirmed some of these predictions.

According to Dr. Varghese, ceramic burners have three potential advantages over conventional burners. First, they permit burning of mixtures with less fuel than normal, a means of saving on fuel costs.

Second, they may be used to burn poor fuels like sewage sludge, which has a high water content. The flame temperature of a poor fuel is normally too low to keep the flame lit. Thus a better fuel, such as methane, must be added to stabilize the flame. Ceramic burners may do the same job with little or no extra fuel.

Finally, ceramic burners may provide a means of disposing of toxic chemical wastes by burning them completely to harmless products inside the high-temperature reaction zone.



A flame burning within a porous piece of ceramic burns hotter and more completely.

The UT group is studying combustion within the porous ceramics in several ways, including optical measurements. The absorption of tunable-laser radiation will be used to determine the concentration of important chemical compounds in the flame. The researchers are developing a detailed computer model of the entire process, which will be useful in the design of ceramic burners for practical applications, Dr. Varghese said.

The researchers have also started a cooperative program with the Tokyo Institute of Technology.

Conservation and Solar Energy

Conservation and Solar researchers have developed a computer model for research, design, and development of **a cooling method called ice storage.**

Ice storage is growing as a cooling system for commercial buildings. Several hundred systems have been installed in the United States, particularly in California, Arizona, Florida, Illinois, and the Dallas, Texas, area.

Electric utilities strapped for capacity and hit by huge peak demands late on hot summer afternoons are spurring the popularity of ice-storage cooling. These summer-peaking utilities have begun to increase their peak demand charges and to offer rebates to motivate large customers to reduce their power use during the hot peak hours.

The new model is called the CBS/ICE program. It simulates the hour-by-hour operation of the ice-on-coil type of ice storage system. In an ice-on-coil system, water in a tank is chilled with refrigerant coils so that ice forms directly on the coils. The ice that is built up off-peak (usually at night) is melted during the hot peak hours the next day to cool the building air with very little electricity.

Although ice-storage manufacturers develop proprietary models, the CBS/ICE program is the first public-domain model of ice storage, according to center researcher Scott C. Silver, its primary developer.

Other participants in the project are Bruce D. Hunn, head of the Conservation and Solar Energy Program; Jerold W. Jones, UT professor of mechanical engineering; John L. Peterson, research associate; and Andre Milbitz, mechanical engineering graduate student. The project is sponsored by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

CBS/ICE is designed to be used with a well-known computer model for building energy analysis, DOE-2, and runs on the VAX minicomputer.

The model and its user's manual are scheduled for release in 1988. The format, cost, and method of ordering will be announced in a future issue of *Energy Studies*. Those who would like more information may write Scott C. Silver, Conservation and Solar Energy Program, Center for Energy Studies, The University of Texas at Austin, 10100 Burnet Road, Austin, Texas 78758.

Process Energetics

A short course entitled **"Industrial Electrification: Technology and Economics"** will be taught January 11-14 at the Thompson Conference Center at The University of Texas at Austin. (Continued on page 4)

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Leaders of the course will be Philip S. Schmidt and Frederick T. Sparrow. Dr. Schmidt is head of the center's Process Energetics Program and professor of mechanical engineering at UT. Dr. Sparrow is director of the Institute for Interdisciplinary Engineering Studies at Purdue University and is a professor of engineering and of economics.

The course is useful to industrial marketing specialists, planners, and forecasters at utilities and to engineers and managers in the process manufacturing industries.

Course topics include (1) process and fuel competition; (2) advanced electrotechnologies for metals reduction, metal fabrication, nonmetal bulk material production, and nonmetal fabrication; and (3) R&D and long-term trends in industrial electrification.

The course is sponsored by the American Public Power Association and the Center for Energy Studies. The cost for tuition and materials for APPA members before December 15 is $695 and after that date, $795. The cost for nonmembers is $1,095. For registration, contact Andrea Griffin, the American Public Power Association, 202/775-8300.

Separations Research Program

"Distillation: Whither, Not Whether" was the topic of the keynote address given by James R. Fair, head of the center's Separations Research Program in Brighton, England, September 7. He addressed the world's largest distillation conference, the Fourth International Symposium on Distillation. Dr. Fair gave a second keynote talk September 14, at the Conference on Gas-Liquid Contacting, held at the University of Liège in Belgium.

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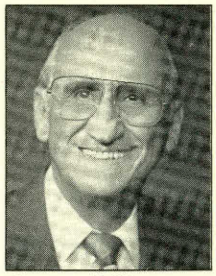
Earnest F. Gloyna

Earnest F. Gloyna, who ended almost 18 years as dean of the UT College of Engineering in September, has joined the Separations Research Program. Dr. Gloyna, a professor of civil engineering who holds the Bettie Margaret Smith Chair in Environmental Health Engineering, will conduct research on industrial waste treatment and hazardous waste detoxification.

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Experts from the Separations Research Program will teach a five-day **short course on "Separation of Fluid Mixtures"** February 8-12 in Austin.

The course is cosponsored by the center and UT Continuing Engineering Studies and is aimed at chemical, refining, and process industry professionals, such as engineers and plant operators, who deal with fluid separations.

The course will begin with analysis of the state of the art of seven separations processes:

- ☐ distillation
- ☐ liquid-liquid extraction
- ☐ adsorption/chromatographic separations
- ☐ absorption
- ☐ membrane separations
- ☐ separations with chemical reactions (such as flue gas desulfurization)
- ☐ supercritical extraction.

Comparisons of these processes and significant design considerations will be covered.

The faculty for the course are all principal investigators in the center's Separations Research Program: James R. Fair, program head and holder of the John J. McKetta Centennial Chair in Engineering; Jose Luis Bravo, program manager; and UT chemical engineering faculty members Keith P. Johnston, William J. Koros, Donald R. Paul, and Gary T. Rochelle.

The price of tuition for the five-day course is $735. The tentative location is the UT Thompson Conference Center.

For information on registration, contact UT Continuing Engineering Studies, 512/471-3506, The University of Texas at Austin, Austin, Texas 78712.

Services

D. Cheryl Wilkins resigned as assistant director at the center to move to Knoxville, Tennessee, in September. She had served on the staff of the center since it was originally formed in 1974.

Roselyn Witherspoon, formerly with the University of Massachusetts, has joined the center as executive assistant. ■