

The AIChE Journal, a publication of the American Institute of Chemical Engineers, is devoted to fundamental research and developments having immediate or potential value in chemical engineering.

PUBLISHER

J. C. Forman

PUBLICATIONS DIRECTOR

Larry Resen

EDITOR

Robert H. Kadlec

MANAGING EDITOR

Maura Mullen

TECHNICAL EDITOR

Haeja L. Han

EDITORIAL ASSISTANT

Michelle Kiernan

EDITORIAL BOARD

Alan J. Brainard
Coleman B. Brosilow
Joseph D. Henry, Jr.
Robert L. Kabel
Daniel D. Perlmutter
Joseph A. Polack
Ronald W. Rousseau
Roger A. Schmitz
W. R. Schowalter
John C. Slattery
Kenneth E. Starling
Charles B. Weinberger



SEVENTY FIVE YEARS OF PROGRESS

Publication Office, 20th and Northampton Streets, Easton, Pa. 18042. Published in January, March, May, July, September, and November by the American Institute of Chemical Engineers, 345 East 47 Street, New York, New York 10017. (ISSN 0001-1541) Manuscripts should be submitted to Robert H. Kadlec, Editorial Offices, Department of Chemical Engineering, Dow Building, The University of Michigan, Ann Arbor, Michigan 48109. Statements and opinions in the *AIChE Journal* are those of the contributors, and the American Institute of Chemical Engineers assumes no responsibility for them. Subscription: one year, \$85; special member rate, \$16; additional yearly postage outside U.S.A. \$5 (foreign subscriptions payable in advance). Single copies: \$16.50. Single copies more than one year old: \$17.50. Second-class postage paid at New York, N.Y. and additional mailing offices. Copyright 1983 by the American Institute of Chemical Engineers, National headquarters of AIChE is concerned about nondelivery of copies of the *AIChE Journal* and urgently requests subscribers to give prompt notification of any change of address. Sixty days must be allowed for changes to be made in the records.

Postmaster: Please send change of addresses to *AIChE Journal*, 345 East 47 Street, New York, N.Y. 10017.

AIChE Symposium Series Recent Studies

S 224 Cryogenic Processes and Equipment 1982. A collection of papers dealing in areas of cryogenic processes and equipment including support systems at relatively high temperatures appear in this volume. In addition, advances in understanding of transport phenomena and equilibration processes are documented.

1983. 143pp. AIChE members \$20; others \$40.

S 225 Heat Transfer—Seattle 1983. This volume is comprised of selected papers presented at the National Heat Transfer Conference in Seattle in July 1983.

1983. 438pp. AIChE members \$30; others \$60.

S 226 Underground Coal Gasification: The State of the Art. The papers in this volume are written by some of the foremost experts in UCG research and development from universities, government research laboratories and industry.

1983. 185pp. AIChE members \$25; others \$50.

1983 Prepayment Policy: Payment must accompany all orders for less than 10 books. AIChE members may order only one copy of each title at the member price, and must indicate Membership ID Number and countersign purchase orders in order to qualify for AIChE Member Price. No charge for postage and handling on prepaid U.S. orders which are shipped bookrate. All foreign orders, regardless of quantity, must be accompanied by payment in U.S. dollars and include \$2.00 per book to cover postage and handling on bookrate shipments. When faster service is required, please contact AIChE to determine additional cost. *Pro forma* invoice will be supplied on request. Prices are subject to change.

Order from Publications Sales, Dept. J, American Institute of Chemical Engineers, 345 East 47 Street, New York, New York 10017.

ASK FOR THE AIChE PUBLICATIONS CATALOG.

Reproducing Copies

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by AIChE for libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the \$2.00 per copy fee is paid directly to CCC, 21 Congress St., Salem, MA 01970. This consent does not extend to copying for general distribution, for advertising or promotional purposes, for inclusion in a publication, or for resale. Articles published before 1978 are subject to the same copyright conditions and the fee for each article is \$2.00.

AIChE Journal fee code: 0001-1541/83 \$2.00