# CHEMICAL ENGINEERING JOURNAL

## An International Journal of Research and Development

### Co-Editors:

Environmental Chemical Engineering:

Professor Laurence Weatherley, University of Canterbury, Dept. of Chemical and Process Engineering, Private Bag 4800, Christchurch, New Zealand

Chemical Reaction Engineering:

Professor Jesus Santamaria, University of Zaragoza, Dept. of Chemical and Environmental Engineering, 50009 Zaragoza, Spain

#### **Editorial Board**

Prof. J.M. Asua, Universidad del Pais Vasco, San Sebastian, Spain

Prof. D.V. Boger, Univ. of Melbourne, Melbourne, Australia

Prof. G. Casamatta, Institut National Polytechnique, Toulouse,

Dr. R. Cerro, Univ. of Alabama, Huntsville, AL, USA

Prof. D.P.Y. Chang. University of California Davis. Davis. CA. USA

Prof. P. Forzatti, Politecnico di Milano, Milano, Italy

Prof. Dr. H. Hofmann, Universität Erlangen Nurnberg, Erlangen, Germany

Prof. H.H. Kung, Northwestern University, Evanston, IL, USA

Prof. G. McKay, Hong Kong University of Science and Technology, Hong Kong, China

Prof. E.B. Nauman, Rensselaer Polytechnic Institute, Troy, NY, USA

Prof. J. Petera, Technical University of Lodz, Lodz, Poland

Prof. Dr. R.P. Pohorecki, Warsaw Technical University, Warsaw, Poland

Prof. D. Reible, Lousiana State University, Baton Rouge, LA, USA

Prof. A.E. Rodrigues. Univ. of Porto. Porto. Portugal

Dr. J. Spivey, Louisiana State University, Baton Rouge, LA, USA

Prof. G. Stevens, Univ. of Melbourne, Melbourne, Australia

Prof. K.-L. Yeung, Hong Kong University of Science and Technology, Hong Kong, China

### Aims and Scope

The Chemical Engineering Journal provides an international forum for the presentation of original research, interpretative reviews and discussion of new development in the areas of Environmental Chemical Engineering and Chemical Reaction Engineering. Papers which describe novel theory and its application to practice are welcome, as are those which illustrate the transfer of techniques from other disciplines. Reports of carefully executed experimental work, which is soundly interpreted are also welcome.

The Environmental Chemical Engineering section presents papers dealing with topics in environmental chemical and process engineering. Treatment processes, environmental risk analysis, environmental process control and measurement, clean process technology and sustainability are covered. Papers in which knowledge from other disciplines is integrated with chemical engineering are especially welcome.

The Chemical Reaction Engineering section presents papers on a wide range of topics including reaction kinetics, applied catalysis, simulation and optimization of different types of reactors, unsteady-state reactors, multiphase reactors, and fundamental investigations of the processes of heat, mass and momentum transfer that take place along with chemical reaction. Research works addressing critical areas of reactor engineering (e.g. reactor materials, control strategies, reactor safety and environmental issues), and emerging reactor technologies (e.g. membrane reactors, chromatographic reactors, unconventional fluidized beds, electrochemical reactors, micro-reactors, etc.) are particularly welcome.

Publication information: Chemical Engineering Journal (ISSN 1385-8947). For 2003, volume(s) 88-95 are scheduled for publication. Subscription prices are available upon request from the Publisher or from the Regional Sales Office nearest you or from this journal's website (http://www.elsevier.com/locate/cej). Further information is available on this journal and other Elsevier products through Elsevier's website: (http://www.elsevier.com). Subscriptions are accepted on a prepaid basis only and are entered on a calendar year basis. Issues are sent by standard mail (surface within Europe, air delivery outside Europe). Priority rates are available upon request. Claims for missing issues should be made within six months of the date of dispatch.

**USA mailing notice:** - Chemical Engineering Journal (ISSN 1385-8947) is published *monthly*, with the exception of February, June and October, by Elsevier B.V. (P.O. Box 211, 1000 AE Amsterdam, The Netherlands).

Annual subscription price in the USA US\$ 2179.00 (valid in North, Central and South America), including air speed delivery. Second class periodical postage paid at Jamaica, NY 11431.

**USA POSTMASTER:** Send address changes to Chemical Engineering Journal, Publications Expediting, Inc., 200 Meacham Avenue, Elmont, NY11003.

**AIRFREIGHT AND MAILING** in the USA by Publication Expediting Inc., 200 Meacham Avenue, Elmont, NY 11003.

**Orders, claims and product enquiries:** please contact the Customer Support Department at the Regional Sales Office nearest you:

New York: Elsevier, PO Box 945, New York, NY 10159-0945, USA; phone: (+1) (212) 633 3730 [toll free number for North American customers: 1-888-4ES-INFO (437-4636)]; fax: (+1) (212) 633 3680; e-mail: usinfo-f@elsevier.com

Amsterdam: Elsevier, PO Box 211, 1000 AE Amsterdam, The Netherlands; phone: (+31) 20 4853757; fax: (+31) 20 4853432; e-mail: nlinfo-f@elsevier.com

**Tokyo:** Elsevier, 9-15 Higashi-Azabu 1-chome, Minato-ku, Tokyo 106-0044, Japan; phone: (+81) (3) 55615033; fax: (+81) (3) 55615047; e-mail: info@elsevier.co.jp

Singapore: Elsevier, 3 Killiney Road, #08-01 Winsland House I, Singapore 239519; phone: (+65) 6349 0200; fax: (+65) 6733 1510; e-mail: asiainfo@elsevier.com.sq

Rio de Janeiro: Elsevier, Rua Sete de Setembro 111/16 Andar, 20050-002 Centro, Rio de Janeiro-RJ, Brazil; phone: (+55) (21) 509 5340; fax: (+55) (21) 507 1991; e-mail: elsevier@campus.com.br [Note (Latin America): for orders, claims and help desk information, please contact the Regional Sales Office in New York as listed above]

## Advertising Information

Advertising orders and enquiries can be sent to: **USA**, **Canada and South America**: Mr Tino DeCarlo, The Advertising Department, Elsevier Inc., 360 Park Avenue South, New York, NY 10010-1710, USA; phone: (+1) (212) 633 3815; fax: (+1) (212) 633 3820; e-mail: t.decarlo@elsevier.com. **Japan**: The Advertising Department, Elsevier K.K., 9-15 Higashi-Azabu 1-chome, Minato-ku, Tokyo 106-0044, Japan; phone: (+81) (3) 5561 5033; fax: (+81) (3) 5561 5047. **Europe and ROW:** Commercial Sales Department, Elsevier Ltd., The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK; phone: (+44) 1865 843016; fax: (+44) 1865 843976; e-mail: media@elsevier.com

🛇 The paper used in this publications meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

Printed in The Netherlands

doi:10.1016/S1385-8947(03)00138-4