FLUIDIZATION





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FLUIDIZATION

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Kashikojima, Japan

EDITORS
Daizo Kunii
University of Tokyo

Ryozo Toei
Kyoto University

DIRECTOR OF CONFERENCES
Sandford S. Cole
Engineering Foundation

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To the memory of
Professor C. Y. Wen

a pioneer who contributed enormously to
the development of fluidization.

He is sorely missed by his colleagues
throughout the world.

IV INTERNATIONAL CONFERENCE ON FLUIDIZATION

PREFACE

It was in 1967 when the two of us attended the First "International Symposium on Fluidization," held at Eindhoven, the Netherlands. It was a successful symposium, and we were extremely impressed by the friendly atmosphere which prevailed amongst the specialists in fluidization.

During that symposium, we were able to enjoy a scenic boat cruise. It was while we were on board that we discussed the possibility of holding a similar international gathering in Japan. We were in agreement and made a "pledge on board" to hold one someday in the future.

Since then, several meetings have been held, which were entirely devoted to the field of fluidization, namely in Toulouse, France (1973), Asilomar, California, U.S.A (1975), Cambridge, England (1978), and in Henniker, New Hampshire, U.S.A (1980).

That our pledge was eventually realized was due to the considerable efforts on the part of the executive members of two organizations, namely the Engineering Foundation and the Society of Chemical Engineers, Japan. It was thus that the Fourth International Conference on Fluidization was held from May 29 to June 3, 1983, at Shima Kanko Hotel, Kashikojima, Japan.

More than 200 abstracts were intially submitted, making it a difficult task for executive members to select the most suitable papers. It was for this reason that the topics selected for presentation at the conference were limited to those dealing with gas-solid systems. All the papers received were reviewed thoroughly by two referees each, the names of whom are listed following this preface. Because of the rigorous review process, it is our belief that the final selections covered most of the important aspects of fluidization engineering.

Altogether, one hundred and three guests from nineteen countries around the world joined one hundred Japanese participants at Kashikojima. In addition, there were twenty-four spouses and three children, whose presence no doubt helped to create the warm and familial atmosphere which persisted throughout the six day period. During the conference, it was possible for all of the participants to become well acquainted with one another, not only during academic or engineering discussions, but also at other social activities scheduled in the afternoons and evenings.

This volume contains only the recorded results of the conference; as a result it cannot convey the unique atmosphere of the conference, one in which participants from around the world joined together in international cooperation. We do hope the readers of this volume will derive some benefits from the papers assembled here, and also be inspired to prepare for the Fifth International Symposium on Fluidization, to be held in Denmark, May 1986.

We would like to express our appreciation especially to the Engineering Foundation and its director of conferences, Dr. Sandford Cole, in sponsoring the conference, and then in cooperating with us in the organization and operation of the actual conference. Also we wish to acknowledge our thanks to the members of the International Organizing Committee, to the referees and to all the people who in various ways helped us in the planning, organizing, and operation of the Fourth International Conference on Fluidization. Without them, this conference would not have been realized.

Also, special appreciation is due to the National Science Foundation and to other Japanese organizations which offered assistance to overseas delegates who attended the conference.

Daizo Kunii & Ryozo Toei

June, 1983

Fluidization IV Referees

Dr. M. M. Avedesian
Noranda Research Centre, Pointe Claire, Canada
Dr. C. G. J. Baker
Separation Processes Service, Harwell, England
Dr. P. Basu
Cent. Mech. Eng. Res. Inst., Durgapur, India
Prof. J. M. Beeckmans
University of Western Ontario, London, Ontario, Canada
Prof. J. M. Beér
Massachuesetts Inst. of Tech., Cambridge, MA
Prof. M. A. Bergougnou
University of Western Ontario, London, Ontario, Canada
Dr. H. Bock
University Erlangen–Nürnberg, Erlangen, West Germany
Dr. J. S. M. Botterill
Univ. of Birmingham, Birmingham, U. K.
Dr. C. E. Capes
National Research Council, Ottawa, Canada
Prof. C. Chavarie
Ecole Polytechnique de Montreal, SUCC A Montreal, Quebec, Canada
Prof. J. C. Chen
Lehigh Univ., Bethlehem, PA, U.S.A.
Prof. G. Chen
Zhejiang Univ., Hangzhou, Zhejiang, PR China
Prof. T. Chiba
Hokkaido University, Sapporo, Japan
Prof. R. Clift
University of Surrey, Surrey, England
Dr. R. Collins
University College London, London, England
Dr. R. C. Darton
Shell Petroleum, Den Haag, Netherlands
Prof. J. F. Davidson
Univ. of Cambridge, Cambridge, England
Dr. S. Ehrlich
Electric Power Research Inst., Palo Alto, CA
Prof. N. Epstein
Univ. of British Columbia, Vancouver, Canada
Prof. L. T. Fan
Kansas State Univ., Manhattan, KS
Prof. T. J. Fitzgerald
TRW Energy Development Group, Redondo Beach, CA
Mr. Y. Fujima
Mitsubishi Heavy Industries, Ltd., Nagasaki, Japan
Prof. S. Furusaki
Univ. of Tokyo, Tokyo, Japan

Prof. T. Furusawa
Univ. of Tokyo, Tokyo, Japan
Prof. D. Geldart
Univ. of Bradford, Bradford, U.K.
Mr. S. E. George
Univ. of British Columbia, Vancouver, Canada
Dr. B. M. Gibbs
Univ. of Leeds, Leeds, England
Prof. L. R. Glicksman
Massachusetts Inst. of Tech., Cambridge, MA
Prof. J. R. Grace
Univ. of British Columbia, Vancouver, Canada
Prof. D. Harrison
Univ. of Keele, Keele, Staffs, England
Prof. M. Hasatani
Nagoya Univ., Nagoya, Japan
Dr. J. Highley
National Coal Board, Stoke Orchard, Cheltenham, U. K.
Prof. G. M. Homsy
Stanford Univ., Stanford, CA
Prof. M. Horio
Tokyo Univ. of Agric. & Tech., Tokyo, Japan
Dr. Y. Ikeda
Fuji Standard Research Inc., Tokyo, Japan
Prof. M. Ishida
Tokyo Inst. of Tech., Yokohama, Japan
Prof. R. Jackson
Univ. of Houston, Houston, TX
Dr. G. Jimbo
Nagoya Univ., Nagoya, Japan
Dr. I. Johnson
Argonne National Laboratory, Argonne, IL
Prof. M. R. Judd
Univ. of Natal, Durban Natal, South Africa
Prof. K. Kato
Gunma Univ., Kiryu-shi, Japan
Prof. Y. Kato
Dept. of Applied Chemistry, Fukuoka, Japan
Dr. J. Kawabata
Gov. Ind. Devel. Lab., Hokkaido, Sapporo, Japan
Dr. D. L. Keairns
Westinghouse R & D Center, Pittsburgh, PA
Mr. T. M. Knowlton
Institute of Gas Technology, Chicago, IL
Prof. H. Kobayashi
Hokkaido Univ., Sapporo, Japan
Dr. R. P. Krishnan
Oak Ridge National Laboratory, Tennessee
Prof. D. Kunii
Univ. of Tokyo, Tokyo, Japan

Prof. M. Kwauk
Academia Sinica, Beijing, PR China
Prof. J. Large
Univ. de Tech. de Compiegne, Compiegne, France
Prof. S. Leung
Univ. of Queensland, Queensland, Australia
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Oregon State University, Corvallis, OR
Prof. H. Littman
Rensselaer Polytechnic Inst., Troy, NY
Prof. L. Massimilla
Universitá di Napoli, Naples, Italy
Dr. Jr. H. Masson
Free University of Brussels, Brussels, Belgium
Dr. J. M Matsen
Exxon Res. and Eng. Company, Florham Park, NJ
Prof. R. Matsuno
Kyoto Univ., Kyoto, Japan
Prof. Y. Matuno
Kyushu Inst. of Tech., Kitakyushu, Japan
Prof. O. Molerus
Univ. Erlangen–Nürnberg, Erlangen, Germany
Prof. S. Mori
Nagoya Inst. of Tech., Nagoya, Japan
Prof. S. Morooka
Kyushu Univ., Fukuoka, Japan
Prof. I. Muchi
Nagoya Univ., Nagoya, Japan
Prof. A. W. Nienow
Univ. of Birmingham, Birmingham, U.K.
Prof. K. Østergaard
Technical Univ. of Denmark, Lyngby, Denmark
Prof. M. H. Peters
Rensselaer Polytechnic Inst., Troy, NY
Prof. O. E. Potter
Monash University, Clayton, Australia
Prof. Dr. K. Rietema
Technische Hogeschool Eindhoven, Eindhoven, Netherlands
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University College London, London, U.K.
Prof. S. C. Saxena
Univ. of Illinois at Chicago, Chicago, IL
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Universität Hannover, Hannover, Germany
Mr. Y. Shoji
Chiyoda Chem. Eng. & Constr. Co., Yokohama, Japan
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Virginia Polytechnic Inst. & State Univ., Blacksburg, VA
Prof. dr. ir. W.P.M. van Swaaij
Twente University, Enschede, Netherlands

Dr. I. Tanaka
Univ. of Occupational and Environmental Health, Fukuoka, Japan
Mr. J. Tatebayashi
Kawasaki Heavy Ind. Ltd., Osaka, Japan
Prof. S. Tone
Osaka Univ., Osaka, Japan
Prof. J. J. Van Deemter
Technological University, Delft, Netherlands
Prof. D. V. Vukovic
Univ. of Belgrade, Belgrade, Yugoslavia
Dr. D. F. Wells
D. F. Wells and Associates Inc., Avondale, PA
Prof. J. Werther
Tech. Univ. Hamburg–Harburg, Hamburg, Germany
Dr. A. B. Whitehead
CSIRO, Div. of Mineral Eng., Clayton, Australia
Dr. A. M. Xavier
Cambridge University, Cambridge, England
Dr. C. Yacono
Centre de Recherches, Compagnie Française de Raffinage, Hartlem, France
Prof. M. Yamazaki
Nagoya Univ., Nagoya, Japan
Dr. R. Yamazaki
Nagoya Univ., Nagoya, Japan
Dr. W. C. Yang
Westinghouse R & D Center, Pittsburgh, PA., U.S.A.
Dr. J. G. Yates
Univ. College London, London, England
Dr. J. Yerushalmi
Electric Power Research Inst., Palo Alto, CA
Prof. K. Yoshida
Univ. of Tokyo, Tokyo, Japan
Dr. F. A. Zenz
Particulate Solid Research Inc., Riverdale, Bronx, NY

CONTENTS

Session III
MOVEMENT OF SOLID PARTICLES

Session IV
ENTRAINMENT

Session V
HEAT TRANSFER

Session VI
FLUIDIZED BED COMBUSTION

Session VII
DISTRIBUTORS AND SPOUTED BEDS

Session VIII
CATALYTIC GAS-SOLID REACTORS

Session IX
NON-CATALYTIC GAS-SOLID REACTORS

Session X
COAL GASIFICATION

GAS FLOW PATTERNS ASSOCIATED WITH A GROWING SPHERICAL BUBBLE

R. Collins

Department of Mechanical Engineering
University College London
London WC1E 7JE, England

ABSTRACT

Theoretical relationships are derived to describe the gas flow pattern and the volume of gas contained in the cloud overlap region for a spherical bubble which grows as it rises in a fluidized bed.

SCOPE

A knowledge of the size of the cloud and its dependence on other parameters is an important element in many models of fluidized bed reactors. The objective of this work is to construct theory to describe the nature, shape and size of the gas cloud around a growing spherical bubble. Previous results for this problem relate to circular bubbles in two-dimensional beds.

CONCLUSIONS AND SIGNIFICANCE

In its steady form, Davidson's (4) model overestimates the volume of gas contained in the cloud overlap region but if bubble growth is incorporated in an unsteady form of the theory then significant changes in the gas flow pattern occur. Specifically, the cloud size is smaller than in the steady theory, the cloud boundary intercepts the bubble boundary and the gas entering the bubble to produce its growth does so through its base. The volume of the cloud overlap is substantially reduced by modest rates of bubble growth. Relationships to describe the variation of cloud overlap with α and with the growth rate parameter γ are given in Equations (15) and (18).

FORMULATION

The theoretical background relevant to this paper has been given by Davidson & Harrison (1), who used the theory to describe the division of gas between the phases in a freely-bubbling bed, and by Collins (2, 3), who studied gas flow patterns which result from the unsteady motion of an isolated two-dimensional bubble. The main theoretical result on which those studies were based is that the gas velocity field around a bubble moving unsteadily in a bed where voidage is constant may be described at any instant in terms of a velocity potential ϕ_G, where

$$\phi_G = \phi_{Go} + \phi_P . \qquad (1)$$