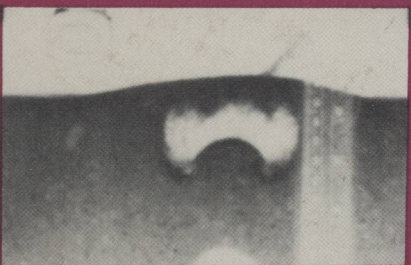
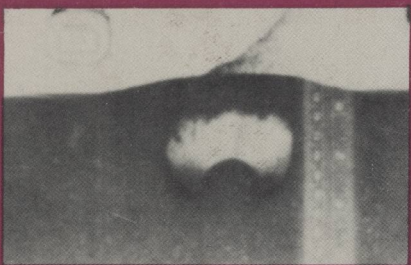


FLUIDIZATION



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Engineers, Japan

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International Conference on

FLUIDIZATION

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Shima Kanko Hotel
Kashikojima, Japan

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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.

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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 initially 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. Sanford 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 & Ryoza Toei

June, 1983

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GAS FLOW PATTERNS ASSOCIATED WITH A GROWING SPHERICAL BUBBLE

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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

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