press some doubt about the theory concerns the estimates of the rates of leakage of tracer gas from bubbles into the particulate phase around them and, particularly, the conclusion in the theory that gas flows into the bases of bubbles at the same rate at which it leaks out. Garcia et al. believe that our observations of rapid accumulation of tracer gas in the wake region behind a bubble can be accounted for by the shedding of tracer from the outer edge of our thin tracer clouds in the particulate phase above our bubbles; we believe that it can be accounted for by the continual release of solid particles from the unstable roof of a bubble, leading to addition of interstitial gas to the bubble at the top and entrapment of bubble-cavity gas at the floor.

Thus, there are alternative explanations of bubble behavior, each acceptable, we think, on the basis of presently available evidence.

Garcia, Grace, and Clift (1973) refer to their own observations of upward gas velocities inside bubbles using very light solid particles inside a fluid bed composed mainly of coal particles four to six times larger than our glass beads. Their observations are contrary to our own conclusion that, for our smaller glass beads, the direction of net gas flow probably was downward, with a rather large uncertainty which we reported. Our calculated downward flow rate came from a material balance which we believe is valid. We suggested that one way to account for the rapid growth of tracerfilled gas volume below each bubble, exceeding the flow rate down the bubble's sides, is to assume that there was entrapment of gas at the floor between solid particles that land there. Garcia et al. believe instead that the observed accumulation rates come entirely from diffusive shedding of tracer from the theoretical cylindrical cloud of gas outside each bubble. As we pointed out, our numerical results agreed approximately with the theoretical expectation. We think that either point of view about the rate of loss can be taken on the basis of the available data. The unsettled question seems to us to be whether tracer gas returns to a bubble or not.

Garcia et al. criticize our conclusions about solid volumetric flow rates which we derived from a similar material balance. They are correct in their assertion that we did not evaluate the contribution in this balance from solid particles which cross the tracer-gas streamline enclosing the wake region. The potential flow theory is clearly invalid for the base region below the flat floor of a bubble and there are no particle velocities available for making such estimates. Their direction is known, however. Because of the vertical pressure gradient in our bed, the gas tends to flow upward about 1.3 in/s faster than the solid. If such a downward flux of solid had been included in the balance for our wake regions, the derived value of the downward flow of solids onto the floor of our typical bubble would have been even greater than the value we reported.

We believe, finally, that the potential flow theory is supported by much of the available evidence but we continue to believe, as we stated, that conclusions from it about the mechanism by which tracer gas is lost from bubbles and whether tracer gas returns may be wrong.

LITERATURE CITED

1. Garcia, A., J. R. Grace, and R. Clift, "Behavior of Gas Bubbles in Fluidized Beds," *AIChE J.*, **19**, 369 (1973).
2. Rieke, R. D., and R. L. Pigford, "Behavior of Gas Bubbles in Fluidized Beds," *AIChE J.*, **17**, 1096 (1971).

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TO THE EDITOR

In a recent issue of this Journal, Angus, Edwards and Dunning (1) presented a helpful discussion of signal broadening in laser doppler velocimeters. In the Appendix to that paper they add an analysis of the beam in the region of the geometrical focus.

Additional diagrams of intensity for truncated gaussian beams that may be helpful to the reader are contained in the following article:

"Design of Optical Systems for use With Laser Beams" by Daphne J. Innes and Arnold L. Bloom published as the Spectra-Physics Laser Technical Bulletin Number 5, Mountain View, California.

LITERATURE CITED

Angus, John C., Robert V. Edwards, and John W. Dunning, Jr., "Signal Broadening in the Laser Doppler Velocimeter," *AIChE J.*, **17**, 1509 (1971).

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BOOKS (continued from page 414)

Europe and, likewise, industrial and academic professionals. Future International Symposia (such as that held in Amsterdam in May, 1972, and that to be held in Chicago in 1974) will also have state-of-the-art reviews. In summary, the book contains "chemical reaction engineering 1970" as it is seen by a wide range of experts in the field.

Thus, this book should be a very useful consolidation of the recent progress in chemical reaction engineering. The research contributions indicate the current directions of research and serve to alert both investigators and users to the next problems that will be attached and hopefully be solved.

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Editor's Note: Professor Bischoff was the chairman for this First International Symposium and, since the subject area was so broad, it was felt that he could best present a summary of the objectives of the symposium as well as to review its contents.

Guide for Safety in the Chemical Laboratory, Manufacturing Chemists Association, Van Nostrand Reinhold, New York (1972). $17.50.

This book provides the chemical laboratory supervisor with a practical guide for controlling laboratory safety problems.

Information on safety storing, handling, and disposing of chemicals in a laboratory is given. You might say that the coverage is weak because all details are not given. On the other hand, the coverage is strong in that the most frequently occurring accidents are treated and up-to-date references are given for follow-up details. This is as it should be so that the reader can personalize his own action for his particular circumstances.

The book provides safety guidelines for scale-up from the laboratory bench to the pilot plant that are not readily available elsewhere.

This book should be a welcome addition on safety designs and practices for all personnel involved in chemical laboratory operation.

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