FOREWORD

The rapid development of biotechnology we are witnessing nowadays is strongly related to the advances in bioprocess engineering. This field of engineering, including both bioreactor engineering and down-stream processing, is an integration of biological, biochemical and engineering principles, leading to the quantitative description of biotechnological processes conducted on an industrial scale. A very important part of bioprocess engineering problems involves the fluid mechanics problems occurring in biotechnological equipment. These are both the problems related to bioreactor design and operation, and to down-stream processing operations, such as micro- and ultrafiltration, centrifugation, precipitation, extraction, sorptions, flocculation, mixing, fluid transportation, etc.

This volume is focused mainly on fluid mechanical problems in bioreactor engineering.

Hydrodynamics of stirred bioreactors are discussed by AW Nienow from the Centre for Biochemical Engineering, University of Birmingham, UK. To quote one of the reviewers "the Nienow school was certainly one of the most active ones in the past decade." Nienow also discusses the basic rheological properties of fluids and the fundamentals of the turbulence theory; this is why his contribution has been placed at the beginning of the volume. The basic parameters of agitation are then discussed for both non-aerated and aerated systems. The chapter is concluded by consideration of different kinds of agitators and retrofitting problems.

The second contribution is by Y Chisti from the Department of Chemical Engineering, University of Waterloo, Canada. It discusses hydrodynamics of pneumatically agitated bioreactors, concentrating upon major aspects of design and operation of such bioreactors: power input, gas holdup, liquid circulation, gas-liquid separation, solid suspension, mixing and mass transfer (both gas-liquid and liquid-solid transfer). Different kinds of pneumatically driven bioreactors and their practical, industrial applications are also described.

The third contribution discusses in some detail the influence of air bubbles on microorganisms and cells. It has been written by Jeffrey J Chalmers from the Department of Chemical Engineering, Ohio State University. The author concentrates on the mechanism of damage caused by gas bubbles in animal and insect cell cultures and on the ways to protect these cells from the damage.

The last of the papers, written by J Bałdyga and myself (both from the faculty of Chemical and Process Engineering, Warsaw University of Technology, Poland), describes some new ideas in the turbulence theory and their consequences for biological sysems. In particular we discuss the extensions of the classical theory of isotropic turbulence taking into account the fine scale intermittency of turbulence, and examine their application to biotechnological processes.

It is hoped that this volume shall contribute to better understanding of the fluid mechanical phenomena occurring in biotechnological equipment, especially in bioreactors.

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