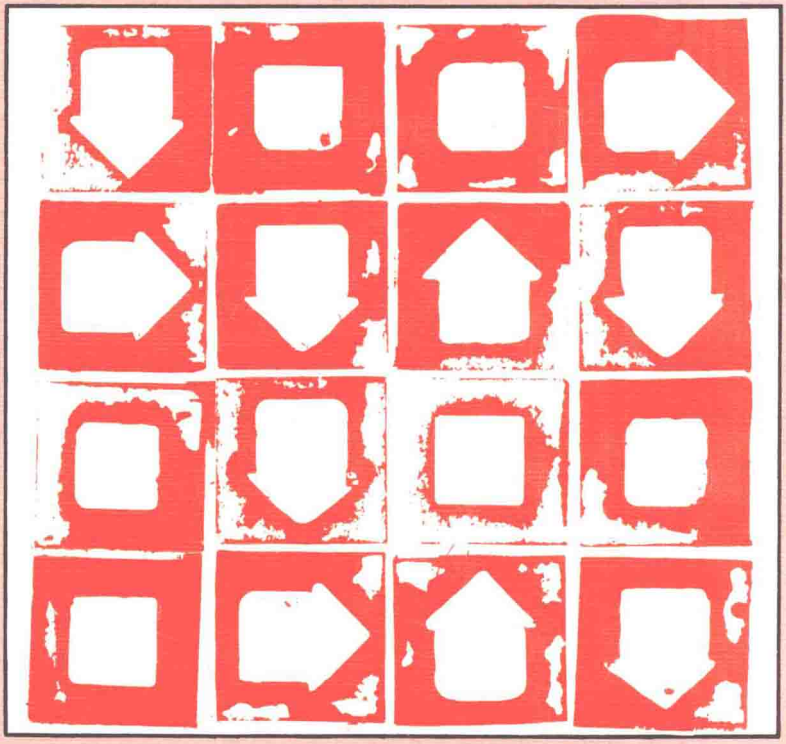
FOOD ENGINEERING AND PROCESS APPLICATIONS

Volume 2

UNIT OPERATIONS

Edited by

M. LE MAGUER and P. JELEN



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Proceedings of the Fourth International Congress on Engineering and Food held between 7 and 10 July 1985 at Edmonton, Alberta, Canada

ADVISORY EDITORIAL BOARD

FOREWORD

It was an honour for Canada to serve as host for the 4th International Congress on Engineering and Food. Food engineering and the whole concept of food processing are matters of vital national and international interest. It is fitting that this Congress was held in Edmonton, a city that symbolizes the Canadian spirit and will to achieve.

Governments everywhere cannot ignore the agri-food sector when it comes to laying down national policies. In Canada, 40% of our economic activity is related in some way to our agri-food industry. The 4000 food and beverage processing companies make a significant contribution to this effort.

It has long been acknowledged that research has a crucial role to play in creating national prosperity, through growth and enhanced competitiveness of the industry. Any discussion of food processing research implies transfer of technology. The importance of technology transfer cannot be emphasized enough. It must be a primary concern of all food processors, researchers and engineers. A Canadian example of technology transfer is the development of our edible oil industry. Three decades ago there was no edible oil industry in Canada based on rapeseed. Now, our version of rapeseed, canola, is a major cash crop for domestic processing and export. Nowadays, Canadian canola is a commodity to be reckoned with on the world stage.

It is important for the future of many countries in the world that we move more vigorously than in the past to raise the productive capacity and competitive level of the food processing industry. If we succeed, the world will become less dependent upon raw material exports from producing countries such as Canada. Other countries must take the same approach by focusing on commodities important to them.

The food processing industry in various parts of the world is not an island to itself. It does have a social responsibility to the countries in which it operates. All of us in the food business have a responsibility to feed people who do not have enough to eat. There are no easy solutions to the problems of hunger, but if each country built a strong and dynamic food industry and thereby created jobs, wealth and economic strength, we can end the hunger on this planet. As professionals in the food industry we must not lose sight of our collective responsibility to provide a safe, abundant and wholesome food supply for all, and we must share our knowledge with others. This book is an excellent example of international cooperation and goodwill among the food scientists and engineers who can influence the progress in development of new food processing techniques for tomorrow.

Dr E. J. LeRoux
Assistant Deputy Minister, Research,
Agriculture Canada

PREFACE

The two volumes of *Food Engineering and Process Applications* were assembled from the papers presented at the Fourth International Congress on Engineering and Food held in Edmonton, Canada in July 1985.

The Congress was organized under the auspices of the Faculties of Agriculture and Engineering of the University of Alberta and the sponsorship of national and international engineering and food science societies. It was supported with major grants from the Natural Sciences and Engineering Research Council of Canada, the Regional Industrial Expansion program of the Government of Canada, the Alberta Agriculture Research Council, and the University of Alberta.

This is the third in a series of compilations which have now contributed significantly to the literature in Food Engineering. It presents a broad coverage of basic and applied research subjects dealing with the application of engineering principles to food processing operations. It shows again the evolution of Food Engineering towards a well defined and identifiable field of engineering in its own right and illustrates the vast potential of engineering scientists and industrial researchers to generate new and original information.

Because of the large number of contributions included, it was decided to organize the work in two volumes with distinctly different themes. Volume 1 deals more specifically with basic aspects of physical and transport properties of foods, kinetics and mathematical modeling, selected heat and mass transfer problems and thermal processing and irradiation. Volume 2 is concerned with various unit operations and industrial processes and includes most of the invited symposia papers supplemented with contributions in the areas of Food Freezing,

Extrusion Engineering, Membrane Processing, Genetic Engineering, Energy and Food Processing Operations, or Industrial Engineering and Process Control. Its final section contains a selection of papers addressing the ever present problem of Food Engineering in developing countries. While the selection of the contributions for the respective volumes may appear somewhat arbitrary, it is a result of our deliberate attempt to finish with two approximately equal volumes dealing with the two dominant themes of contemporary Food Engineering—transport phenomena and unit operations.

Although we as editors must assume full responsibility for the final product, we would be remiss not to express our thanks to many of our colleagues listed as the Editorial Board who assisted us with screening the contributions for their technical suitability. Sincere thanks are also due to Dr R. Biswal for helping at different stages of the preparation of the volumes, and finally to our wives, Ivy and Sylva, for constant encouragement and understanding which made our tasks much easier.

M. Le Maguer
P. Jelen

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II. Extrusion Engineering and Food Process Applications

III. Membrane Processing and Other Separation Techniques

VII. Food Engineering in Developing Countries

Part I

Food Freezing

1

FREEZING OF FOODS: AN OVERVIEW

R. L. EARLE

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ABSTRACT

In this paper the heat transfer medium external to the food is considered, and the surface heat transfer coefficients from the medium to the food surface which may have to be measured. In turn the medium has to be coupled to the refrigeration unit. If a flow system is used this consumes energy, and the overall energy needed for freezing should be minimised. Real systems often suffer from lack of uniformity of conditions. Food quality is considered in relation to the freezing. Finally in a production unit the product has to be organised so as to pass efficiently through the process, meeting the required standards of quality.

INTRODUCTION

People living in cold climates noticed early that if foodstuffs were exposed to low temperatures, and especially if they were frozen, they lasted longer. So preservation of foods by freezing was practised. But this was subject to the natural availability of a suitable cold sink. The artificial creation of such a cold sink became a practical reality with the development of mechanical refrigeration from around 1850. The history of refrigeration is well described in the book by Thevenot.[1] It shows how freezing of foods became in time very widespread.

Refrigeration influenced not only individual people but whole countries, and the country most influenced was New Zealand. It was set up as an off-shore farm for Great Britain, made possible by