

Contents

| | | |
|----------|---|-----------|
| 1 | Computational Fluid Dynamics Applications in Food Processing | 1 |
| 1.1 | Introduction to Computational Fluid Dynamics. | 1 |
| 1.2 | Theory of CFD Modeling. | 2 |
| 1.2.1 | Conservation of Mass Equation | 2 |
| 1.2.2 | Momentum Equation | 3 |
| 1.2.3 | Energy Equation. | 3 |
| 1.3 | Turbulence Model. | 3 |
| 1.4 | Reference Frames. | 4 |
| 1.5 | CFD Analysis | 7 |
| 1.6 | CFD Applications in Food Processing | 8 |
| 1.7 | Nomenclature | 9 |
| 2 | Computational Fluid Dynamics Applications in Spray Drying of Food Products | 11 |
| 2.1 | Spray Drying Process. | 11 |
| 2.1.1 | Atomization | 11 |
| 2.1.2 | Spray–Air Contact | 12 |
| 2.1.3 | Moisture Evaporation. | 13 |
| 2.1.4 | Separation of Dried Products | 13 |
| 2.2 | Types of Spray Dryers | 13 |
| 2.3 | Airflow Pattern. | 14 |
| 2.4 | Atomization | 14 |
| 2.5 | Particle Histories | 18 |
| 2.6 | Air–Particle Interaction | 18 |
| 2.7 | Particle Tracking | 19 |
| 2.8 | Particle Temperature | 21 |
| 2.9 | Residence Time of Particle. | 21 |
| 2.10 | Particle Deposition and Position | 23 |
| 2.11 | Current Trends | 24 |
| 2.12 | Scope for Future Research. | 25 |

| | |
|---|-----------|
| 3 Applications of Computational Fluid Dynamics in the Thermal Processing of Canned Foods | 27 |
| 3.1 Canning of Foods | 27 |
| 3.2 Canned Solid–Liquid Food Mixtures | 28 |
| 3.3 Bacterial Deactivation Kinetics | 28 |
| 3.4 Analysis of Fluid Flow Pattern During the Thermal Sterilization Process | 32 |
| 3.5 Thermal Processing of Canned Fruits | 32 |
| 3.5.1 Temperature Profile and the Slowest Heating Zone | 33 |
| 3.5.2 F_0 Value During Thermal Processing of Canned Pineapple Slices | 35 |
| 4 Computational Fluid Dynamics Modeling for Bread Baking Process | 37 |
| 4.1 Introduction | 37 |
| 4.2 Bread Baking Process | 38 |
| 4.3 CFD Modeling of the Bread Baking Process | 39 |
| 4.4 Scope for CFD Modeling in the Bread Baking Process | 47 |
| 5 CFD Modeling of Biological Systems with Human Interface | 49 |
| 5.1 Food Digestion Process | 49 |
| 5.2 Modeling of Food Digestion Inside the Human Stomach | 50 |
| 5.2.1 Stomach Geometry | 50 |
| 5.2.2 Deformation of Stomach Walls | 50 |
| 5.2.3 Fluid Flow Inside the Human Stomach | 52 |
| 5.2.4 Numerical Equations Governing Fluid Flow | 52 |
| 5.3 Rheological Properties of Food Materials | 53 |
| 5.3.1 Effect of Viscosity on Characteristic Flow Field Within the Stomach | 53 |
| 5.4 Effect of Solid–Liquid Density Difference on Particle Distribution | 54 |
| 5.5 Effect of Particle Loading on Mixing | 54 |
| 5.6 Modeling of the Absorption Process in the Small Intestine | 55 |
| 5.6.1 Movements in the Small Intestine Causing Mixing of Food | 57 |
| 5.6.2 Effect of Wall Contractions on Flow of Intestinal Contents | 58 |
| 6 Computational Fluid Dynamics Modeling for High Pressure Processing | 59 |

| | |
|---|----|
| 7 Applications of Computational Fluid Dynamics in Other | |
| Food Processing Operations | 63 |
| 7.1 CFD Simulation of Spray Freezing Operations | 63 |
| 7.1.1 CFD Simulation Methodology | 64 |
| 7.1.2 Comparison Between Measured and Predicted Gas | |
| Temperatures | 65 |
| 7.1.3 Particle Impact Positions | 66 |
| 7.2 CFD Modeling for Jet Impingement Oven. | 67 |
| 7.2.1 Flow Pattern of Impinging Jet | 69 |
| 7.2.2 Effect of Nozzle Geometry on Heat Transfer. | 70 |
| 7.3 Application of CFD Modeling in the Flour Milling Industry | 71 |
| 7.4 CFD Modeling of Fumigation of Flour Mills | 74 |
| References | 75 |
| Index | 85 |

Computational Fluid Dynamics Applications in Food Processing

Anandharamakrishnan, C.

2013, XI, 86 p. 36 illus., 24 illus. in color., Softcover

ISBN: 978-1-4614-7989-5