
Contents

Preface	ix
Introduction	xi
List of Notations	xix
Chapter 1. General Notions	1
1.1. General notions	1
1.2. Forced convection, natural convection.	3
1.3. The calculation of heat transfer.	5
1.4. Convection coefficient	5
1.5. The program of our study	7
Chapter 2. Empirical Approaches	9
2.1. Introduction	9
2.2. The dimensionless numbers (or dimensionless criteria) of convection	10
2.2.1. The interest of the dimensionless representation is, at first sight, twofold.	10
2.2.2. Vaschy–Buckingham theorem.	10
2.2.3. Definition and significance of the dimensionless criteria of fluid mechanics and heat transfer.	11
2.3. Calculation of convection coefficients: external convection.	17
2.3.1. Case of a flat plate at constant temperature.	17
2.3.2. External convection on an obstacle: case of a tube outside a flow	22
2.4. Internal convection	22
2.4.1. Convection in a tube	22
2.4.2. Forced convection between two plates	24
2.5. Natural convection.	25
2.5.1. Let us recall useful dimensionless numbers	25

2.5.2. Nusselt calculation	26
2.6. Use of “standard” formulas	28
2.7. Some examples of applications	28
Chapter 3. The Boundary Layer	59
3.1. Introduction	59
3.2. The notion of a boundary layer	59
3.2.1. Boundary layer characteristics	60
3.2.2. The boundary layers can be approached by different methods	63
3.3. The external boundary layers: analytical treatment	63
3.3.1. The laminar boundary layer developed by a flat plate in a uniform flow	63
3.3.2. The turbulent boundary layer	73
3.4. Problem of scale	79
3.5. Applications of the boundary layer theory	81
3.6. External boundary layers: integral methods	143
3.6.1. Principle of the integral method	143
3.6.2. Integral methods for an external boundary layer on a flat plate, in Cartesian coordinates	144
3.7. Examples of applications of integral methods	151
Chapter 4. Heat Exchangers	185
4.1. Introduction and basic concepts	185
4.1.1. Classification test	186
4.2. Method of calculation of exchangers	187
4.2.1. Types of exchangers	187
4.2.2. Logarithmic mean temperature difference method (DTLM)	190
4.2.3. Number of transfer units method (N_{UT} method)	195
4.3. Conclusion	205
4.4. An example of the application of the methods	205
Appendices	217
Appendix 1. Physical Properties of Common Fluids	219
Appendix 2. Physical Properties of Common Solids	221
Appendix 3. Thermodynamic Properties of Water Vapor	225
Appendix 4. The General Equations of Fluid Mechanics	229

Appendix 5. The Dynamic and Thermal Laminar Boundary Layer	253
Appendix 6. Table of Functions: $erf(x)$, $erfc(x)$ and $ierfc(x)$.	273
References.	275
Index.	283