

# CONTENTS

<i>Preface</i>	vii
<i>Acknowledgement</i>	ix
<i>Nomenclature</i>	xi
<b>1. Industrial Biofouling</b>	<b>1</b>
1. Introduction	1
<b>2. Fluid Flow, Mass and Heat Transfer</b>	<b>7</b>
2.1. Introduction	7
2.2. Fluid Flow	7
2.3. Mass Transfer	11
2.4. Heat Transfer	18
2.5. Concluding Remarks	21
<b>3. Biofilms</b>	<b>23</b>
3.1. Introduction	23
3.2. Microbiology	26
3.3. Biofilms	29
3.4. Requirements for Microbial Growth	38
3.5. The Importance of Surfaces	45
3.6. Adhesion of Microbial Cells to Surfaces	46
3.7. Interacting Forces	49
3.8. The Influence of Adsorbed Layers	55
3.9. The Physical Quality of the Surface	58
3.10. Industrial Conditions	61
3.11. The Establishment of Biofilms in Summary	62
3.12. The Influence of Other Fouling Mechanisms	64
3.13. Particle/Biofilm Interactions	64
3.14. The Growth of Biofilms	67
3.15. Structure and Stability of Biofilms	69
3.16. Biofouling Modelling	73
3.17. Biofilms and Corrosion	73
3.18. The Cost of Biofouling	74
3.19. Concluding Remarks	76

<b>4. Biofouling Control</b>	<b>81</b>
4.1. Introduction	82
4.2. Chemical Control	84
4.3. Physical Methods of Control	129
4.4. Potential physical techniques for biofouling control	141
4.5. Combined Use of Physical and Chemical Techniques	147
4.6. Potential Combined Physical and Chemical Control— concluding Remarks	150
<b>5. Cleaning Off-line</b>	<b>155</b>
5.1. Introduction	155
5.2. Application of Cleaning Technologies	155
5.3. Concluding Remarks on Off-line Cleaning	158
<b>6. Biofouling Monitoring</b>	<b>161</b>
6.1. Introduction	161
6.2. Off-line Monitoring	161
6.3. Process Plant Monitoring	165
6.4. Monitoring in the Laboratory	169
6.5. Fouling Measurement Techniques	174
6.6. The Accuracy of Test Data	176
6.7. Concluding Remarks	177
<b>7. Biofilms in Industry</b>	<b>181</b>
7.1. Introduction	181
7.2. The Water Industry	181
7.3. Food Industry	195
7.4. Paper Manufacture	196
7.5. Cooling Water	197
7.6. The problem of <i>Legionella pneumophila</i>	199
<b>8. Concluding Remarks</b>	<b>203</b>
<i>Index</i>	205