

# Contents

<b>1</b>	<b>Introduction</b>	1
1.1	Why Porous Materials?	1
1.2	Aims and Scopes	2
1.3	Book Contents and Structure	3
	Reference	4
<b>2</b>	<b>Fundamentals of Porous Structures</b>	5
2.1	Introduction	5
2.2	Cell Models	5
2.3	Digital Reconstruction (Lattice Boltzmann Method) of the Porous Structure	9
2.3.1	Porous Media Generation	10
2.4	Stochastic Modeling	11
2.4.1	The Pore Space	13
2.4.2	Transport Properties	17
	References	18
<b>3</b>	<b>Flow in Porous Media</b>	23
3.1	Introduction	23
3.1.1	Macroscopic Description	24
3.1.2	Microscopic Description	25
3.2	Analytical Solutions for Single Phase Flow in Cell Models	25
3.2.1	Sphere-in-Cell Models: Kuwabara's Approach	26
3.2.2	Sphere-in-Cell Models: Happel's Approach	27
3.2.3	Cylinder-in-Cell Models	29
3.2.4	Spheroid-in-Cell Model	29
3.3	Single Phase Flow in Granular Structures	33
3.3.1	Representation of 3-D Sphere Assemblages	33
3.3.2	The Flow Field	34
3.3.3	Results and Discussion	37
	References	37

<b>4</b>	<b>Transport Phenomena in Porous Structures</b>	<b>39</b>
4.1	Introduction	39
4.2	Diffusion	41
4.2.1	Constrictivity Factor	41
4.2.2	Tortuosity Factor	42
4.2.3	Porosity Factor	43
4.2.4	Diffusion in Semi-Infinite Porous Media	43
4.2.5	Diffusion in a Plane Sheet	44
4.2.6	Diffusion in a Cylinder	45
4.2.7	Diffusion in a Sphere	46
4.3	Axial Dispersion	47
4.3.1	Parameters Influencing Axial Dispersion: Porous Medium	48
4.3.2	Parameters Influencing Axial Dispersion: Fluid Properties	53
4.4	Radial Dispersion	58
4.4.1	Parameters Influencing Radial Dispersion: Porous Medium	60
4.4.2	Parameters Influencing Radial Dispersion: Fluid Properties	63
4.5	Dispersion in Packed Beds Flowing by Non-Newtonian Fluids	65
4.6	Correlations	67
4.6.1	New Correlations: Axial Dispersion	74
4.6.2	New Correlations: Radial Dispersion	76
	References	80
<b>5</b>	<b>Modeling of Transport Processes in Porous Materials</b>	<b>87</b>
5.1	Introduction	87
5.2	Single Phase Transport in Unit Cells	87
5.2.1	Fundamental Quantities	88
5.2.2	Adsorption Mechanisms	89
5.2.3	Mass Transport Through Spheres	91
5.2.4	Mass Transport Through Cylinders	98
5.2.5	Mass Transport Through Spheroids	98
5.2.6	Single Phase Mass Transport in Other-Type Unit Cells	106
5.3	Single Phase Flow in Granular Structures	106
5.4	Macroscopic Quantities for Single Phase Transport	112
5.4.1	Stochastically Constructed 3-D Sphere Assemblage	113
5.4.2	The Flow Field (Single Phase Flow)	113
5.4.3	Mathematical Formulation	114
5.4.4	The Volume-Averaging Procedure	114

5.4.5	Simulations . . . . .	116
5.4.6	Results and Discussion . . . . .	117
	References . . . . .	120
<b>6</b>	<b>Experimental and Numerical Investigation of Mass Transport in Porous Media . . . . .</b>	<b>123</b>
6.1	Measurement of Molecular Diffusion Coefficients . . . . .	123
6.1.1	Diffusion Alone . . . . .	124
6.1.2	Diffusion with Convection . . . . .	125
6.1.3	Experiments . . . . .	126
6.2	Measurement of Dispersion Coefficients (Axial and Radial) . . . . .	128
6.2.1	Measurement of Axial Dispersion Coefficients . . . . .	128
6.2.2	Measurement of Radial Dispersion Coefficients . . . . .	131
6.3	Measurement of Solubility at Different Temperatures . . . . .	141
6.3.1	Mass Transfer Around a Buried Soluble Sphere . . . . .	142
6.3.2	Experimental Set-Up . . . . .	143
6.4	Measurement of Tortuosity in Porous Media . . . . .	145
6.4.1	Experimental Example . . . . .	148
6.5	Mass Transfer Around Active Solids . . . . .	149
6.5.1	Mass Transfer From a Soluble Flat Slab . . . . .	149
6.5.2	Mass Transfer From a Soluble a Cylinder Aligned With Flow . . . . .	154
6.5.3	Mass Transfer From a Soluble Sphere . . . . .	157
6.5.4	Mass Transfer From a Cylinder in Cross Flow . . . . .	159
6.5.5	Mass Transfer From a Prolate Spheroid . . . . .	162
6.5.6	Mass Transfer From an Oblate Spheroid . . . . .	167
	References . . . . .	171
<b>7</b>	<b>Applications and Examples . . . . .</b>	<b>175</b>
7.1	Contaminant Plume Sizes Associated to Different Active Solids . . . . .	175
7.1.1	Concentration Profiles From a Soluble Flat Slab . . . . .	176
7.1.2	Concentration Profiles From a Cylinder Aligned With Flow . . . . .	178
7.1.3	Concentration Profiles From a Soluble Sphere . . . . .	178
7.1.4	Concentration Profiles From a Cylinder in Cross Flow . . . . .	179
7.1.5	Concentration Profiles From a Prolate Spheroid . . . . .	180
7.1.6	Concentration Profiles From an Oblate Spheroid . . . . .	181
7.2	Rising Damp in Building Walls . . . . .	182
7.2.1	Rising Damp Theory . . . . .	183
7.2.2	The Wall Base Ventilation System . . . . .	184
7.2.3	Numerical Simulation . . . . .	187
7.2.4	Rising Damp Analysis . . . . .	187

7.3	Bubbles and Drops in Porous Structures . . . . .	194
7.3.1	Moments of Distribution ( $S\gamma$ ) . . . . .	195
7.3.2	Determination of Source Terms . . . . .	197
7.3.3	Simulations . . . . .	198
7.3.4	Algorithm Validation and Findings . . . . .	202
7.4	Fluid Flows Through Porous Media in Fuel Cells . . . . .	206
7.4.1	Solid Oxide Fuel Cell Configuration . . . . .	208
7.4.2	Electrochemical and Surface Reactions . . . . .	208
7.4.3	Transport Phenomena in Gas Channels . . . . .	210
7.4.4	Transport Phenomena in Porous Media . . . . .	211
7.4.5	Simulations . . . . .	214
7.4.6	Results and Discussion . . . . .	215
7.5	Multi Phase Transport in Porous Media . . . . .	217
7.5.1	Theoretical Background . . . . .	218
7.5.2	Formulation of the Problem . . . . .	220
7.5.3	The Closure Problems . . . . .	221
7.5.4	Results and Discussion . . . . .	223
	References . . . . .	229
	<b>Index</b> . . . . .	<b>235</b>



<http://www.springer.com/978-3-642-27909-6>

Transport Processes in Porous Media

Coutelieris, F.A.; Delgado, J.M.P.Q.

2012, XII, 236 p., Hardcover

ISBN: 978-3-642-27909-6