Contents

1	-	rimental Methods for Investigation of Porous Materials and	1
	Powe		
	-	Mironovich Volfkovich and Vladimir Sergeevich Bagotsky	
	1.1		1
		1.1.1.Methods for Investigation of Structural Properties	1
		1.1.2 Methods for Investigation of Wetting Properties	2
	1.2	The Method of Standard Contact Porosimetry	3
		1.2.1 Principles of the Method	3
		1.2.2 Possibilities of MSCP for the Investigation of Porous	4
		Structure	_
		1.2.3 Investigation of Wetting and Sorption Properties of	5
		Porous Materials	
		References	6
		nical Materials	
2	Pape		9
	•	Mironovich Volfkovich	
	2.1		9
	2.2	Production	11
	2.3	The Structure, Properties, and Applications	12
	2.4	Porosity	13
	2.5	Sorption Properties of the Paper	13
	2.6	Banknote Paper	14
	2.7	Carbon Paper of Fuel Cell	18
	2.8	Gas Diffusion Layer	18
		References	18
3		ponents of Power Sources/(or of Electrochemical Energetics)	19
	Yury	Mironovich Volfkovich and Vladimir Sergeevich Bagotsky	
	3.1	Fuel Cells and Their Components	19
		3.1.1 The Catalytic Layer	20
		3.1.2 Catalysts in Fuel Cells	24
		3.1.3 The Gas-Diffusion Layer (GDL)	31
		3.1.4 Membranes	33
		3.1.5 Membrane-Electrode Assemblies	38
		3.1.6 Conclusions	40
	3.2	Primary and Secondary Batteries	41
		3.2.1 Lead Acid Batteries	42
		3.2.2 Silver–Zinc Batteries	44
		3.2.3 Sealed Alkaline and Acid Batteries	46
		3.2.4 Lithium-Ion Batteries	47
		3.2.5 Lithium Thionyl Chloride Primary Elements	56
		3.2.6 Lithium-Air Batteries	56
	3.3	Electrochemical Supercapacitors	61
		3.3.1 Main Properties of Electric Double-Layer Capacitors	61

		3.3.2 Nanoporous Carbons Obtained by Different Methods	68
		References	78
4	Powe	der Metallurgy	83
	Mikh	ail Mikhailovich Serov	
	4.1	Comparative Analysis of the Properties of the Porous Body	83
	4.2	Processes of Powder Metallurgy for Porous Materials	89
		4.2.1 Methods for Forming Porous Materials	90
	4.3	Sintering of Porous Materials	96
	4.4	Application of Porous Materials	100
		References	101
5	Ther	mal Insulating Materials	103
-		ya Sergeevna Dzyazko and Boris Yakovlevich Konstantinovsky	
	5.1	Functions and Types of Thermal Insulation	103
	5.2	Porosity and Its Measurements	105
	5.3	Functional Properties Affected by Porosity:	111
	0.0	Measurements of Thermal Conductivity	
	5.4	Heat Transfer	113
	5.5	Compressive Strength	119
	5.6	Controlled Pore Formation in Thermal Insulating Materials	122
	5.7	Conclusions	126
	5.1	References	120
6	Char	acteristics and Structure of Powdered Medical Substances Used	127
0		e Pharmaceutical Industry	12)
		ail L'vovich Ezerskiy and Vladimir Sergeevich Bagotsky	
	6.1	Structural Parameters of Medical and Auxiliary Substances and	129
	0.1	Methods for Their Measurements	12)
		6.1.1 Particle Size (Degree of Dispersion)	131
		6.1.2 Adsorption and Wetting Properties	131
		6.1.3 Technological (Rheological and Packing) Properties	131
	6.2	Biopharmaceutical Properties of Some Sulfanilamide Powders,	131
	0.2	Suspensions, and Tablets	132
		References	133
7	Eroo		135
/		Volume and Microporosity in Polymeric Gas Separation brane Materials and Sorbents	133
		imir Vasilievich Volkov and Yury Pavlovich Yampolskii	125
	7.1	Introduction: Concepts of Free Volume and Porosity in	135
	7 2	Polymers Historical Background	126
	7.2	Historical Background	136
	7.3	Free Volume Above and Below Tg	138
		7.3.1 Simha-Boyer Concept	138
		7.3.2 Dual Mode Sorption: Evaluation of Nonequilibrium Free	139
		Volume	1 / 1
		7.3.3 Interrelation Between Free Volume, Tg and Selective	141
	7 4	Permeability of Polymers	1 4 0
	7.4	Characterization of Fractional Free Volume and/or Porosity	142

		7.4.1 Fractional Free Volume Estimations	142
		7.4.2 Probe Methods for Determination of Free Volume	143
		(Advantages and Limitations)	
		7.4.3 Estimation of Polymer Porosity and Free Volume	146
		Fraction by Density Measurements	
		7.4.4 Dynamic Desorption Porometry	148
		7.4.5 Nonequilibrium FVE or Micropore Connectivity	151
	7.5		154
		References	155
Part I	T Natur	ral Materials	
8		nd Gas Bearing Rock	161
-		oly Nikolaevich Filippov and Yury Mironovich Volfkovich	
	8.1	• • •	161
	8.2	-	162
	8.3	Porous Structure of Oil and Gas Bearing Rocks Studied by the	164
	0.5	MSCP	101
	8.4	Porous Structure of Cores Studied by Atomic Force	166
	0	Microscopy	100
	8.5	1.	168
	0.12	Aqueous Suspension Through a Porous Medium	100
	8.6	Laboratory Modeling of Two-Phase Jet Flows	172
	0.0	References	180
9	Deter	rmination of Active Porosity in the Field to Solve Problems	183
,		otection of Groundwater Against Pollution	100
		ander	
		ilinovich Rastorguev	
	9.1	Determination of Active Porosity on the Basis of One Borehole	183
	<i></i>	Experience: The Injection–Pumping of Clean Water into the	100
		Polluted Horizon	
	9.2		187
	7.2	According to Injection of Heated Water into Fractured Rocks	107
	9.3	Determination of Porosity and Residual Oil Saturation	190
	7.5	When Pumping Technological Oil Occurs	170
		References	195
Part I	II Biol	ogical Materials	199
10		Materials	177
10		nail Yurievich Sidorenko	
		Introduction	199
	10.1		200
	10.2	•	200
	10.5	of Bioorganic Nature	201
	10.4	Hygroscopicity of Grain, Flour, and Starch	201
	10.4	10.4.1 General Patterns of Sorption	201
		10.4.2 Sorption and Desorption Isotherms of Starch of	201
		Different Origin	204

		10.4.3 Hygroscopic Properties of Products of Grain Processing	205
		10.4.4 Assessment of the State of Water in the Bio-Organic	206
		Objects by NMR	
		10.4.5 Mathematical Model of Hygroscopicity of the Objects of	209
		Bioorganic Nature	
	10.5		212
	10.6		214
	10.7	Conclusion	218
		References	219
11	Soils	and Plant Roots	221
	Oksa	na Leonidovna Tonkha and Yuliya Sergeevna Dzyazko	
	11.1	Soil Functions	221
	11.2	The Composition and Structure of Soils	224
	11.3	The Pores of Soil	229
	11.4	Functions and Anatomy of the Root System	232
		The Porous Structure of Plant Tissues	236
	11.6	Mass Transfer in Soil-Plant System	240
	11.7	Influence of Soil Porosity on the Formation	245
		of the Root System of Plants	
	11.8	Conclusions	248
		References	248
12	Hide	and Skin of Mammals	251
	Olena	a Romanovna Mokrousova and Yury Mironovich Volfkovich	
	12.1	Features of the Structure of Leather	251
	12.2	Formation of Porous Structure and Properties of the Leather	253
	12.3	Conclusion	262
		References	263
Part IV	/ Matł	nematical Modeling of Filtration Processes in Porous Media	
13	Math	ematical Modeling of Filtration Processes in Porous Media	267
	Anato	oly Nikolaevich Filippov	
	13.1	Darcy's Filtration Law (1856)	267
	13.2	Brinkman Equation (1947)	271
	13.3	Modeling Hydrodynamic Permeability of Porous Media	273
		by the Cell Method	
		13.3.1 Hydrodynamic Permeability of a Porous Medium	280
		Modeled as a Swarm of Partially Porous Spherical Particles	
		with Impermeable Core	
		13.3.2 Hydrodynamic Permeability of a Porous Medium	287
		Modeled as a Swarm of Partially Porous Cylindrical	
		Particles with Impermeable Core (the Flow	
		is Normal to the Axes of Cylinders)	
		13.3.3 Hydrodynamic Permeability of a Porous Medium	293
		Modeled as a Swarm of Partially Porous Cylindrical	
		Particles with Impermeable Core (the Flow	
		is Parallel to the Axes of Cylinders)	

13.4	Comparison of Different Cell Models	298
	13.4.1 Composite Particles with a Porous Layer	299
	13.4.2 Completely Porous Particles	299
	13.4.3 Rigid Impermeable Particles	299
13.5	Comparison of Theoretical and Experimental Data	301
13.6	Observations on the Cell Models	306
13.7	Mathematical Modeling of Microfiltration of Polydisperse	309
	Suspension Through Heterogeneous Membranes	
	13.7.1 Preliminary Remarks	310
	13.7.2 Theoretical Model	312
	13.7.3 Numerical Calculations	314
13.8	Comparison Between the Cell and Probabilistic Models	317
	References	319
	Conclusion	323
	Summary	325
	About the Authors	327