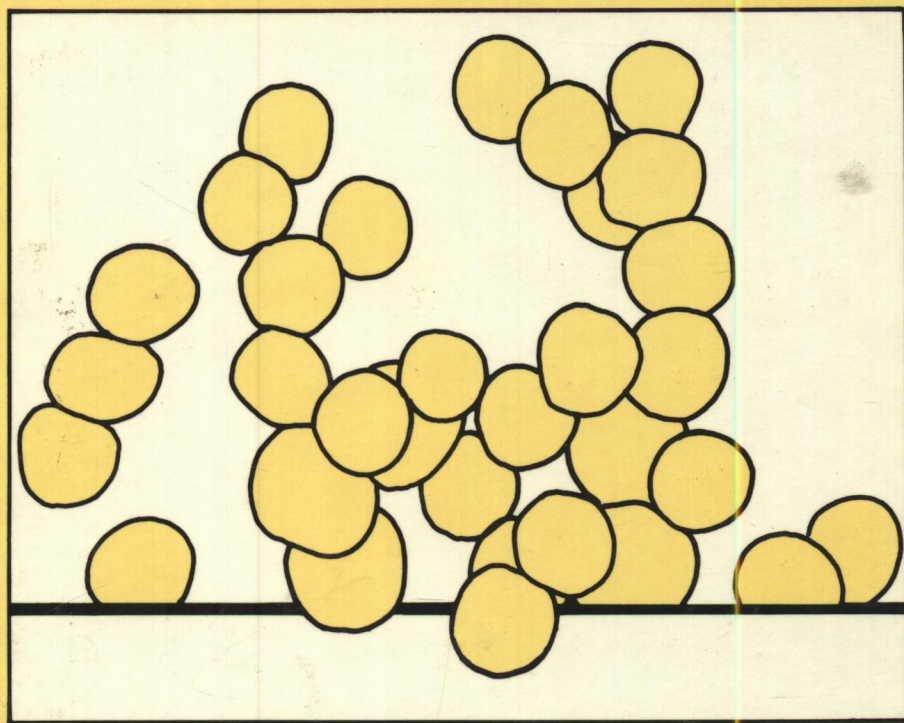


AIR POLLUTION CONTROL ENGINEERING

**BASIC CALCULATIONS FOR
PARTICULATE COLLECTION**

SECOND EDITION



WILLIAM LIGHT

Contents

Preface to the Second Edition	iii
Preface to the First Edition	v
Chapter 1. PARTICULATE COLLECTION IN AIR POLLUTION CONTROL	1
I. Air Quality Standards	1
II. Emission Regulations	3
A. Fossil Fuel-Fired Steam Generators	4
B. Incinerators	5
C. Portland Cement Plants	5
III. Selection of Collection System	7
PART I. GENERAL PRINCIPLES	
Chapter 2. CHARACTERIZATION OF PARTICLES AND AEROSOLS	13
I. Description of Individual Particles	14
A. Particle size and shape	16
B. Other particle properties	18
II. Size Distribution in Aerosols	20
A. Raw data for grades	22
B. Frequency and cumulative fractions	23
C. Density functions	26
D. Mode, median, and mean values	32
III. Size Distribution Functions	37
A. Recurring patterns	37
B. Special functions	39

References	65
Problems	66
Chapter 3. GENERAL CONCEPTS OF PARTICULATE COLLECTION	71
I. Mechanisms for Collection	71
II. Expressing the Effectiveness of Collection	75
A. Overall performance	75
B. Grade or fractional efficiency	80
C. Relation between grade efficiency and overall efficiency	86
D. Interrelationships among particle-size functions	92
E. Multiple collectors	99
III. Basic Modelling Concepts	102
A. Residence time of particles	102
B. Elementary models	105
IV. Energy Requirements and Efficiency	115
V. General Survey of Collectors	119
A. Comparison of performance	119
B. Cost estimation	126
C. Considerations in selection of collectors	128
D. Summary	131
References	132
Problems	133
Chapter 4. ELEMENTARY PARTICLE MECHANICS: MOVEMENT OF AEROSOL PARTICLES IN STILL GAS	137
I. Particle Trajectories	137
A. Newton's law	138
B. Forces on particles	138
II. Motion Due to Diffusion	178
A. Brownian motion	178
B. Diffusiophoresis	184
References	186
Problems	187
Chapter 5. TRAJECTORIES OF PARTICLES IN MOVING GAS - AERODYNAMIC CAPTURE	191
I. Particle Trajectories	191
A. The role of the gas velocity	191
B. Trajectories within containment zones	195
C. Inertial trajectories	205
II. Aerodynamic Capture on Isolated Single Targets	210
A. Single target efficiency	210

B.	Capture by inertial impaction	212
C.	The interception effect	221
D.	Impaction and particle bounce	223
E.	Capture by flux forces	224
F.	Collection by electrostatic attraction	233
G.	Capture by gravity	239
H.	Capture by combinations of forces	240
I.	Capture mechanisms and parameters	248
J.	Growth of deposited particles	255
III.	Aerodynamic Capture in Arrays of Targets	259
A.	Modified fluid velocity patterns	260
B.	Single target behavior in arrays	262
C.	Overall behavior of array	266
	References	270
	Problems	273

PART II. COLLECTOR MODELLING

Chapter 6.	CENTRIFUGAL COLLECTORS	277
I.	Fundamental Features of Cyclones	277
A.	Basic concept and applicability	277
B.	Internal flow patterns	280
C.	Design approach	286
II.	Modelling Cyclone Performance	287
A.	Various approaches to efficiency	287
B.	Shortcomings, comparison, and testing of models	296
C.	Pressure drop	305
III.	Design for Gas Cleaning or Particulate Recovery	307
A.	General procedure	307
B.	Detailed suggestions	308
C.	Example of design	316
IV.	Special Designs and Systems	323
	References	326
	Problems	328
Chapter 7.	ELECTROSTATIC PRECIPITATION	331
I.	The Electrostatic Precipitation System	331
II.	Modelling the System	335
A.	General aspects	335
B.	Elementary model for particle collection	339
C.	Particle charging	342
D.	Grade-efficiency equations	345
E.	Deutsch-Anderson equation	347
F.	Overall efficiency	349
III.	Corrections to the Model	353

	A. Incremental length calculations	354
	B. Non-uniform velocity distribution	354
	C. Gas sneakage and dust reentrainment	357
	D. Turbulence effects	358
IV.	Design example	363
V.	Cost Estimation	368
	References	369
	Problems	370
Chapter 8.	FILTRATION	373
	I. General Concepts	373
	II. Fibrous Filters	376
	A. Collection efficiency	376
	B. Pressure drop	382
	C. Design example	385
III.	Granular Bed Filters	388
	A. Fixed beds	389
	B. Fluidized beds	391
	C. Fabric Filters	392
	A. Fiber array model	394
	B. System analysis model	397
	C. Design example	409
	References	414
	Problems	416
Chapter 9.	WET SCRUBBING	419
	I. Scrubber Characteristics	419
	A. General features	419
	B. Spray scrubbers	420
II.	Non-Venturi Scrubbers	422
	A. Gravity chambers	422
	B. The L/G ratio	426
	C. Tower design	429
	D. Other tower/spray scrubbers	430
III.	Venturi Scrubbers	432
	A. Basic Aspects	432
	B. Modelling	433
	C. Design Procedures	457
	References	463
	Problems	465
Appendix:	Answers to Selected Problems	467
Index		471