



**ATMOSPHERIC  
POLLUTION**

**Its History, Origins  
and Prevention**

**Fourth Revised Edition (In SI Units)**

**A R MEETHAM**

in collaboration with

**D W BOTTOM A HENDERSON-SELLERS**

**S CAYTON D CHAMBERS**

**Pergamon Press**

392

**PERGAMON INTERNATIONAL LIBRARY**  
**of Science, Technology, Engineering and Social Studies**

*The 1000-volume original paperback library in aid of education,  
industrial training and the enjoyment of leisure*

Publisher: Robert Maxwell, M.C.

---

# ATMOSPHERIC POLLUTION

*Its History, Origins and Prevention*

FOURTH EDITION



## THE PERGAMON TEXTBOOK INSPECTION COPY SERVICE

An inspection copy of any book published in the Pergamon International Library will gladly be sent to academic staff without obligation for their consideration for course adoption or recommendation. Copies may be retained for a period of 60 days from receipt and returned if not suitable. When a particular title is adopted or recommended for adoption for class use and the recommendation results in a sale of 12 or more copies, the inspection copy may be retained with our compliments. The Publishers will be pleased to receive suggestions for revised editions and new titles to be published in this important International Library.

# ATMOSPHERIC POLLUTION

*Its History, Origins and Prevention*

BY

A. R. MEETHAM      D. W. BOTTOM

S. CAYTON      A. HENDERSON-SELLERS

D. CHAMBERS

FOURTH (REVISED) EDITION IN S. I. UNITS

Previously entitled  
**Atmospheric Pollution**  
**Its Origins and Prevention**



PERGAMON PRESS

OXFORD • NEW YORK • TORONTO • SYDNEY • PARIS • FRANKFURT

U.K.	Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 0BW, England
U.S.A.	Pergamon Press Inc., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A.
CANADA	Pergamon of Canada Ltd., Suite 104, 150 Consumers Road, Willowdale, Ontario M2J 1P9, Canada
AUSTRALIA	Pergamon Press (Aust.) Pty. Ltd., P.O. Box 544, Potts Point, N. S. W. 2011, Australia
FRANCE	Pergamon Press SARL, 24 rue des Ecoles, 75240 Paris, Cedex 05, France
FEDERAL REPUBLIC OF GERMANY	Pergamon Press GmbH, 6242 Kronberg-Taunus, Hammerweg 6, Federal Republic of Germany

Copyright © 1981 A. R. Meetham, D. W. Bottom  
S. Cayton, A. Henderson-Sellers, D. Chambers

**BIBLIOTECA**  
**CENTRO NACIONAL PATAGÓNICO**

**Nº 0605**

*All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means: electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the publishers*

First edition 1952  
Second (revised) edition 1956  
Third (revised) edition 1964  
Fourth edition 1981

**British Library Cataloguing in Publication Data**

Atmospheric pollution. — 4th revised ed (S. I. units). —  
(Pergamon international library).

1. Air — Pollution

I. Meetham, Alfred Roger

614.71 TD 883 79-42852

ISBN 0-08-024003-8 (Hardcover)

ISBN 0-08-024002-X (Flexicover)

No. access	1224
Fecha	4-9-84
Signatura	363-1
Empl.	

Printed in Hungary by Franklin Printing House

# Contents

<b>1. Introduction</b>	1
<i>Growth of pollution</i>	3
<i>Control of pollution</i>	4
<i>Scope of the book</i>	5
<b>2. Origin of Fuel</b>	6
Energy and the origin of the Earth	6
<i>Fossil fuels</i>	7
Energy value of fuels	8
<i>Calorific value</i>	8
<i>Gross and net calorific value</i>	10
<i>World reserves and annual output</i>	11
<b>3. Natural Solid Fuels</b>	14
<i>Wood</i>	14
<i>Wood charcoal</i>	15
<i>Peat</i>	16
The coal series	16
<i>Lignite</i>	18
<i>Bituminous coal</i>	18
Ash and sulphur in coal	19
<i>Washed coal</i>	20
Coal hazards	21
<b>4. Mineral Oils and Gases</b>	23
Petroleum	23
The refining process	24
Characteristics of fuel oils	28
Preparation for burning: burners	30
<i>Vaporizing burners</i>	30
<i>Pressure jet burners</i>	30
Natural gas	33
<b>5. Manufactured Fuels</b>	34
<i>History</i>	34
Coke	35
Coal tar and tar oils	38
Hydrogenation and hydrocarbon synthesis	38

Liquefaction and gasification	39
Alcohol	39
Manufactured gaseous fuels	40
<i>Historical note</i>	42
<b>6. Combustion and Power Generation</b>	<b>44</b>
<i>Internal combustion engine</i>	47
Atmospheric pollution from engines	48
<i>Cooling towers</i>	50
Electricity	51
<b>Uses of electricity</b>	<b>53</b>
<i>Conclusion</i>	56
<b>7. Industrial Boilers</b>	<b>57</b>
<i>Coal-fired boilers</i>	57
<i>Vertical boiler</i>	58
<i>Lancashire boiler</i>	59
<i>Economic boiler</i>	60
<i>Thermal storage boiler</i>	61
<i>Water-tube boilers</i>	62
Industrial hot water boilers	64
Boiler instruments	67
<i>Carbon dioxide</i>	69
<i>Smoke as an index of efficiency</i>	71
Alternatives to coal	72
Mechanical stokers	73
Pulverized fuel	76
Boiler availability	78
<i>Soot blowing</i>	79
<i>Fluidized beds</i>	79
<b>8. Industrial Furnaces</b>	<b>80</b>
Group (1) furnaces	81
<i>Horizontal retorts</i>	82
<i>Coke ovens</i>	83
<i>Vertical retorts</i>	84
<i>Static vertical retorts</i>	85
<i>Electric furnaces</i>	85
<i>Oil refineries</i>	85
Group (2) furnaces	86
Atmospheric pollution from furnaces in Groups (1) and (2)	88
Group (3) furnaces	90
<i>Steel industry</i>	90
<i>Clay industries</i>	90
<i>Lime and cement kilns</i>	92
Atmospheric pollution from furnaces in Group (3)	94
<i>Smoke in the steel industry</i>	94
<i>Sulphur dioxide and grit</i>	94
<i>Summary</i>	95
<b>9. Domestic Heat Services</b>	<b>96</b>
Choosing a domestic heating system	97
<i>Solid fuel</i>	98
<i>Central heating</i>	100

<i>Gas and electric fires</i>	102
<i>Thermal storage electric heating</i>	102
<i>Thermal insulation</i>	102
Hot water and cooking	104
<i>Coal economy</i>	106
<b>10. Atmospheric Pollution</b>	<b>108</b>
Smoke	109
Ash	110
Sulphur dioxide	111
<i>Carbon monoxide and carbon dioxide</i>	112
<i>Nitrogen oxides (NO<sub>x</sub>)</i>	113
<i>Lead, chlorine and fluorine compounds</i>	113
<b>Pollution from petroleum products</b>	<b>114</b>
Odours	115
<b>Radioactive air pollutants</b>	<b>115</b>
Pollution from other sources	117
<i>Gases from chemical works</i>	117
<i>Burning spoilbanks</i>	119
<i>Incineration of refuse</i>	120
<i>The offensive trades</i>	121
<i>Particles</i>	121
<b>11. Measurement of Atmospheric Pollution</b>	<b>123</b>
Measurement of smoke	124
<i>Smoke filter</i>	126
<i>Self-changing smoke filters</i>	128
<i>Portable smoke filters</i>	128
<i>Weighable smoke filter</i>	129
Measurement of ash and other deposited pollution	130
<i>Deposit gauge</i>	130
<i>Rapid surveys of deposited matter</i>	133
Measurement of sulphur dioxide	135
<i>Volumetric estimation of sulphur dioxide</i>	136
<i>Portable instruments for sulphur dioxide</i>	137
<i>Automatic monitoring</i>	137
<i>Sulphur dioxide by the lead dioxide instrument</i>	138
Pollution roses	140
Microscopic examination of grit	140
<i>Microscopic examination of suspended matter</i>	142
<i>Other pollutants</i>	145
Measurement of daylight	146
<i>Use of measurements of atmospheric pollution</i>	146
<b>12. Distribution of Pollution</b>	<b>147</b>
Historical perspective	147
Distribution in Britain as a whole	147
<i>Deposited matter</i>	147
<i>Smoke and sulphur dioxide</i>	150
Distribution within a town	153
<i>Deposited matter</i>	153
<i>Smoke and sulphur dioxide</i>	153
Recent surveys	157

The National Survey of Air Pollution	160
<i>Smoke</i>	160
<i>Sulphur dioxide</i>	160
<i>Concluding remarks</i>	161
<b>13. Variability of Pollution</b>	<b>162</b>
Changes in deposited matter	164
<i>Yearly cycle</i>	165
Changes in smoke and sulphur dioxide	165
Irregular variation	169
Air pollution meteorology	169
<i>Chimney plumes</i>	171
Fogs	172
<i>Constituents of the London fog, December 1952</i>	173
<i>Quantities</i>	174
<i>Heat balance</i>	175
<i>Water balance</i>	175
<i>Smoke balance</i>	176
<i>Sulphur balance</i>	176
<i>Halogens</i>	177
<i>Oxides of carbon</i>	177
Ground level concentrations	177
<i>Summary</i>	180
<b>14. Effects of Pollution</b>	<b>181</b>
Biological effects	181
<i>Health</i>	181
Threshold limit values	184
<i>Smog disasters</i>	184
<i>Mortality attributed to smog</i>	185
<i>Effects on animals</i>	188
<i>Effects on vegetation</i>	188
Physico-chemical effects	189
<i>Insulators</i>	189
<i>Metals</i>	189
<i>Materials</i>	189
<i>Fog, visibility and sunlight</i>	191
The cost of pollution	192
<i>Conclusion</i>	193
<b>15. Prevention of Atmospheric Pollution</b>	<b>194</b>
Prevention of smoke	194
Prevention of ash and grit	195
<i>Selection of fuel</i>	196
<i>Design and operation of furnace</i>	196
<i>Particulate removal</i>	197
<i>Air conditioning</i>	201
Prevention of sulphur dioxide	201
<i>Removal of sulphur from fuel</i>	202
<i>Removing of sulphur dioxide from flue gases</i>	203
<i>Chimney height</i>	204

<b>16. Air Pollution Control—Law and Administration</b>	207
The United Kingdom system	207
The Alkali Inspectorate—structure and responsibilities	208
Local Government administration and control	209
The Clean Air Acts	209
Smoke emissions	210
The control of chimney heights	211
Grit and dust from furnaces	212
Smoke-control areas	213
Air pollution legislation throughout the world	214
Air pollution control within the member states of the European Economic Community	214
<i>Belgium</i>	214
<i>Denmark</i>	215
<i>France</i>	215
<i>Federal Republic of Germany</i>	215
<i>Ireland</i>	216
<i>Italy</i>	216
<i>Luxembourg</i>	216
<i>Netherlands</i>	216
<i>United States of America</i>	217
Motor vehicle pollution	218
Appendix A. Conversions	220
Appendix B. British Standards	222
BIBLIOGRAPHY	223
INDEX	227

# Index

- Acid
  - rain 112
- Aga cooker 106
- Air
  - composition of 108
  - conditioning 201
  - pollution (*see* Atmospheric pollution)
- Aircraft 50
- Alcohol 39
- Alkali
  - Acts 207
  - Inspectorate 207
- Animals 185, 188
- Anthracite 19
- Approved list of domestic appliances 98
- Ash
  - distribution in Britain 147
  - emission 111
  - measurement 130
  - prevention 195
  - spheres in grit 141
- Atmosphere
  - origin of 6
- Atmospheric
  - gases 108
  - pollution 1
    - and climate 113
    - changes 164
    - control 4
    - cost 192
    - deposit 163
    - distribution 147
    - effects 181
    - emitted 109
    - from cooling towers 50
    - from engines 48
    - from furnaces 88
    - from kilns 94
    - from paint particles 117
    - from motor vehicles 218
    - from soot blowing 79
    - from spoilbanks 119
    - history 3
    - law 207
    - measurement 123
    - National Survey 160
    - odours 115
    - prevention 194
    - radioactive 115
    - rate of production 2
    - statistics 162
    - surveys 157
    - suspended matter 110
    - trends 160
    - types 2
    - variability 162
- Automatic filter 128
- Belgium 214
- Best practicable means 207
- Bitumen 18
- Bituminous coal 18
- Blast furnace 86
  - checks and slips 87
  - gas 41
- Boghead 19
- Boiler
  - coal-fired 57
  - deposits 78
  - instruments 67
- Boilers
  - Cochran 58
  - Economic 60
  - hot water 64
  - Lancashire 59
  - shell 57
  - thermal storage 61
  - vertical 58
  - water-tube 57, 62
- Brick kilns 90
- Briquettes 18, 38
- British standards 222
- British thermal unit 8
- Bronchitis 182
- Brown coal 18
- Burner
  - for oil 30
  - for pulverised fuel 77
- Calorie 8
- Calorific value 8
  - gross 10

- Calorific value
  - net 10
  - of some fuels 11
- Calorimeter 8, 10
- Cancer of the lung 183
- Cannel 19
- Carbon 7, 11
- Carbon bisulphide 118
- Carbon dioxide 69, 112
  - in flue gases 69
  - in smog 175, 177
- Carbonization 35, 84
- Carbon monoxide 112
  - from engines 49
  - in blast furnace gases 87
- Cascade impactor 143
- Cellulose 7
- Cement kiln 92
- Central heating 97, 100
  - Roman 96
- Chain-grate stoker 73
- Charcoal 15
- Chemical works 117
- Chimney height 178, 204, 211
- Chlorine
  - in coal 114
  - in smog 117
- Chlorofluorocarbons 50
- CHP 101
- Chromatography 146
- Cigarette smoking 183
- Clay industries 90
- Clean Air
  - Act 208, 209
  - Zones, 97, 213
- Coal
  - analysis 16
  - ash from 19
  - bituminous 17, 18
  - economy 106
  - equivalent 44
  - gas 40
  - hazards 21
  - macerals 16
  - mineral matter in 20
  - production 12
  - rank 16
  - stored 21
  - sulphur in 20
  - tar 38
  - used 49
  - varieties 17
  - washed 20
- Cochran boiler 58
- Coke 11, 35
  - gas 36
  - low-temperature 37
  - metallurgical 35
  - oven 83
  - spheres in grit 141
- Coking stoker 74
- Combustion 44, 69
- Comfort zones 102
- Conversions 220
- Cooling towers 50
- Corner tube boilers 66
- Cupola 88
- Cyclone 93, 121, 198
- Daily cycle
  - of smoke 166
  - of sulphur dioxide 166
- Daylight
  - measurement 146
- Denmark 215
- Deposited pollution 130
  - changes 164
  - distribution 153
  - rapid surveys 133
- Deposit gauge 130
- District heating 101
- Domestic
  - cooking 104
  - heating 96
  - hot water 100
- Downdraught 171
- Downdraught kiln 91
- Downwash 171
- Draeger tubes 145
- Dust
  - hazard in industry 121
- Economic boiler 60
- Electric
  - furnace 80, 85
  - heaters 102
  - lighting 53
- Electricity
  - demand 55
  - generation of 52
  - hydro- 52
  - uses 53
- Electrolysis 54
- Electrostatic precipitator 93, 121, 199
- Energy 6
  - consumption 44
- Fats 7
- Filters
  - fabric 198
  - high efficiency 198
- Flue gas
  - scrubbers 121, 191

- Flue gas
  - velocity 111
- Fluidised beds 79
- Fluorine 113
  - from chemical works 118
  - in smog 177
- Fly ash 141
- Fog 172
- Fossil fuel 7
- France 215
- Fuel
  - artificial 34
  - calorific value 11
  - consumption 69
  - fossil 7
  - in World 11, 12
  - measurement 8
  - origin 6
  - smokeless 15
- Furnaces 80
  
- Gas
  - blast furnace 41
  - coal 30
  - fires 102
  - natural 11, 12, 24, 33
  - producer 40
  - sewage sludge 41
  - town 42, 81
  - water 41
  - works 81
- Gasification 39
- Germany 215
- Gravity settling chambers 198
- Greenhouse effect 113
- Grit
  - examination 140
  - from coal 111
  - from furnaces 89
  - from industries 94
  - prevention 195
- Ground level concentrations 127, 170, 205
  
- Hand firing 72
- Health and Safety Executive 208
- Heat
  - balance 69
    - in smog 175
  - engine 46
  - loss from houses 102
  - storage cooker 106
- Horizontal retort 82
- Hot-water boilers 64
- Homefire 38
- House of the Future 103
- Hydrocarbons 25
  - synthesis 38
- Hydrochloric acid 114, 117
- Hydroelectricity 52
- Hydrogen 11
- Hydrogenation 38
- Hydrogen sulphide
  - from chemical works 118
  - from furnaces 89
  - offensive trades 121
  
- Incinerators 120
- Industrial
  - boilers 59
  - furnaces 80
- Instantaneous water heaters 104
- Insulation 102
- Insulators 189
- Internal combustion engine 47
- Inversion 170
- Ireland 216
- Iron and steel works 86
- Italy 216
  
- Kenya 15
- Kiln 91
  
- Lagging 103
- Lancashire boiler 59
- Law and administration 207
- Lead in petrol 113, 183
- Lead dioxide instrument 138
- Lighting 53
- Lignin 7
- Lignite 18
- Lime kiln 92
- Liquefaction 39
- Los Angeles 114
- Luxembourg 216
  
- Materials damage 189
- Mechanical stokers 73
- Metallurgical coke 35
- Metals damage 189
- Meteorology 169, 205
- Methane 33
- Microscopic examination 140
- Mining hazards 21
- Motor vehicles 218
  
- Natural gas 11, 12, 24, 33
- Netherlands 216
- Nitrogen oxides 51, 113, 114, 118
- North Sea 24, 25

- Nuclear
  - plants 116
  - power 115
- Odours 115, 117
- Offensive trades 121
- Oil 12
  - burner 30
  - exploration 24
  - fuel
    - ash 28
    - grades 29
    - sulphur 28
  - gasifier 32
  - nozzle 31
  - refinery 85
  - storage 30
  - trap 24
- Open fire 98
  - convector 99
  - smokeless 98
- Open-hearth furnace 90
- Ovoids 38
- Ozone 50, 114
  
- Paint particles 117
- PAN 115
- Particles 121
  - respirable 144
- Peak load 56
- Petroleum 23
  - composition 25
  - cracking 27
  - distillation 26
  - refining 24
  - separation 26
  - sulphur in 28
- Photochemical smog 114
- Photoelectric
  - daylight instrument 146
  - smoke reader 126
- Phuracite 19, 38
- Plumes 109, 121, 171, 178, 204
- Pneumoconiosis 182
- Pollution rose 140
- Portable
  - smoke filter 128
  - sulphur dioxide instrument 137
- Power distribution 54
- Primary pollutant 114
- Producer gas 40
- Public Health Act 207
- Pulverized fuel 76
- Pyrites 11
  
- Radiation
  - solar 6, 110
- Radiators 100
- Radioactive
  - isotopes 6
  - pollution 115
- Railway engines 195
- Rain 117, 169
- Reciprocating steam engine 45
- Recording instruments
  - smoke 128
  - sulphur dioxide 138
- Recuperators 82
- Refinery flare 85
- Regenerators 83
- Reheating furnaces 90
- Respirable particulates 144
- Retort
  - horizontal 82
  - vertical 84
- Ringelmann chart 124, 210
- Roomheater 99
  
- Secondary pollutant 114
- Sewage sludge gas 41
- Shale oil 23
- Ships 210
- Significance tests 162
- Smog
  - and mortality 185
  - constituents 173
  - disasters 184
  - Los Angeles 114
  - photochemical 114
- Smoke 109
  - adhesion 110
  - and daylight 156
  - as an index of efficiency 71
  - balance in smog 176
  - control areas 213
    - appliance grant 213
  - deposition 110
  - distribution
    - by district 149
    - in a town 153
  - emission 109, 160, 210
  - examination
    - by microscope 140
    - by electron microscope 143
  - filter 126
    - portable 128
    - self-changing 128
    - weighable 129
  - from draught kilns 91
  - from spoilbanks 119
  - from steel industry 94
  - in country districts 149

- Smoke 109  
 in flue gases 71  
 in smog 173  
 irregular variation 169  
 measurement 124  
 particles 110  
 penetration 110  
 prevention 194  
 stain on filter paper 129  
 upward diffusion 156  
 weekly cycle 166  
 yearly cycle 166
- Solid fuels 98, 105
- Soot blowing 79
- Space heating 54
- Spectroscopy 146
- Spoilbanks 22, 119
- Spontaneous ignition 21
- Sprinkler stoker 74
- SST 50
- Statistical methods 162
- Steam  
 engine 45  
 pressure gauge 67
- Steel industry 90
- Stokers 73
- Storage water heater 105
- Strontium-90 117
- Sulphate  
 deposited 132  
 distribution 148
- Sulphur  
 balance in smog 176  
 in coal 111, 202  
 in fuel oil 28  
 in petroleum 25  
 removal from fuel 202
- Sulphur dioxide 111  
 distribution  
 by district 149  
 in a town 153  
 in the United Kingdom 158, 159  
 emission 109, 160  
 from chemical works 118  
 from clay industries 94  
 from oil refineries 85  
 from spoilbanks 119  
 from tall chimneys 112, 205  
 in country districts 112  
 in smog 173  
 irregular variations 169  
 measurement 135  
 natural removal 112  
 prevention 201  
 removal from flue gases 203  
 smell 112  
 upward diffusion 156  
 volumetric estimation 136  
 weekly cycle 166  
 yearly cycle 166
- Sulphuretted hydrogen (*see* Hydrogen sulphide)
- Sunshine 192
- Suspended matter (*see* Smoke)  
 examination by microscope 142
- Television 56
- Temperature 169
- Thermal  
 efficiency 69  
 insulation 102  
 precipitator 143  
 storage  
 boiler 61  
 heating 102
- Threshold limit value 113, 184, 209
- Tidal power 53
- Turbine  
 gas 47  
 steam 46
- Turbulence 170
- Tuyères 87
- Ultraviolet radiation 50
- Underfeed stoker 74
- Uranium 12, 45
- U.S.A. 219
- Vegetation 188
- Ventilating hoods 122
- Vertical  
 boiler 58  
 retort 84
- Viscosity 28
- Visibility 191
- Volatile matter 17
- Wall  
 cavity 103  
 insulation 103
- Washed coal 20
- Water  
 balance in smog 175  
 gas 41  
 heater  
 domestic 104  
 industrial 64  
 tube boiler 57, 62  
 vapour 50  
 Weekly cycle 166
- West Germany 215
- Wet scrubber 121, 199

Wind  
  direction 169  
  velocity 170  
Wobbe number 42  
Wood 11, 14

smoke 15  
Works of art 190  
  
Yearly cycle 166

C. E. N. P. A. T.	
D. L. L. G. P. F. M. C. N. O.	
CUENTA No.	810
SUB CUENTA	00048
ANEXO	
FECHA	4-9-84
	INTERVINO

*[Handwritten signature]*

# **ATMOSPHERIC POLLUTION**

## **Its History, Origins and Prevention**

**Fourth Revised Edition (in SI Units)**

This book (previously entitled **ATMOSPHERIC POLLUTION Its Origins and Prevention**) is an authoritative description of Britain's concern with the understanding and control of air pollution and the only text including an extensive history of air pollution control. Completely revised and updated, it is a review and fresh look at the origins of atmospheric pollution on an international scale and in the light of industrial developments. It covers both the history of smoke control and the scientific identification of pollutants which remain troublesome or harmful today and gives a technical description and explanation of the many appliances in use or available for the detection and prevention of pollution. Also included is a statement and consideration of the law as it now stands and the procedures in use by government and local authorities in tackling pollution and its effects.

Independent Opinion of the Third Edition

"This book provides an excellent general account of air pollution."

**THE METEOROLOGICAL MAGAZINE**

"... will undoubtedly be helpful to and valued by many in the field of air pollution study."

**NATIONAL SOCIETY FOR CLEAN AIR**

0 08 024002