

## CONTENTS

1. Introduction	1
1.1 Definition of continuous gas analyzers	2
1.2 Specifications for continuous gas analyzers	3
1.3 Performance specifications	4
1.4 Installation specifications	11
1.5 Commercially available analyzers	13
1.6 References	13
<b>PART I: INSTRUMENTAL METHODS OF ANALYSIS</b>	<b>15</b>
2. Filament Methods	17
2.1 Thermal conductivity (TC)	17
2.2 Catalytic filaments	31
2.3 References	48
3. Paramagnetic Oxygen Analyzers	49
3.1 Thermomagnetic oxygen analyzers	51
3.2 Susceptibility pressure analyzer	59
3.3 Susceptibility measurement	62
3.4 Comparison of methods for oxygen analysis	65
3.5 References	66
4. Optical Methods	67
4.1 Infrared analyzers	71
4.2 Ultraviolet and visible regions (UV/VIS)	98
4.3 Short wavelength radiation	102
4.4 Emitted radiation	103
4.5 Newer spectrometric methods	108
4.6 Interferometry	110
4.7 References	111
5. Gas Chromatography and Related Methods	113
5.1 Process gas chromatography (PGC)	114
5.2 Chromatographic detectors as continuous analyzers	162
5.3 References	170

6. Water Vapour and Humidity Measurement	171
6.1 Dew point measurement	173
6.2 Electrolytic hygrometry	176
6.3 Absorption methods	179
6.4 Resistance/capacitance methods	182
6.5 Mechanical methods	185
6.6 Wet bulb depression	186
6.7 References	186
7. Electrochemical Methods	187
7.1 Electrical conductivity	187
7.2 Electrolyte Reactions (coulometry)	192
7.3 Galvanic methods	198
7.4 Polarographic cells	204
7.5 Selective cells	206
7.6 Solid electrolyte cells	210
7.7 Semiconductor elements	213
7.8 References	214
8. Other Physical Methods	215
8.1 Mass spectrometry	215
8.2 Pressure/density measurement	218
8.3 Other methods	219
8.4 References	219
9. Other Chemical Methods	220
9.1 Catalytic oxidation	220
9.2 Absorption processes	220
9.3 Colorimetric methods for H <sub>2</sub> S	222
9.4 Colorimetric methods	224
9.5 Specific ion electrodes	227
9.6 Automated chemical analysis	227
9.7 References	229

<b>PART II: APPLICATIONS FOR CONTINUOUS ANALYSERS</b>	<b>231</b>
10. Explosive Hazards	233
10.1 Explosive limits	233
10.2 Detecting explosive gases	236
10.3 Gas, chemical and petroleum manufacturing	237
10.4 Distribution of gas, chemical and petroleum products	237
10.5 Gas and LPG storage	242
10.6 Methane hazards	243
10.7 Petrol and aviation spirit	245
10.8 Combustion systems	246
10.9 Miscellaneous manufacturing processes	247
10.10 Research activities	247
10.11 Excess oxygen	248
10.12 References	248
11. Toxic Hazards	249
11.1 Carbon monoxide	252
11.2 Nitrogen oxides	254
11.3 Solvents and chemicals	254
11.4 Highly toxic compounds	255
11.5 Closed systems	257
11.6 Oxygen deficiency	257
11.7 References	258
12. Air Pollution	259
12.1 Pollution from cars	263
12.2 Other mobile sources	270
12.3 Stationary sources: combustion	270
12.4 Stationary sources: chemical	273
12.5 Water pollution	273
12.6 References	274
13. Controlled Atmospheres	275
13.1 Drying ovens	275
13.2 Solvent recovery	276
13.3 Metal producing	277
13.4 Metal processing	279
13.5 Inert atmospheres	288
13.6 Horticultural atmospheres	290
13.7 Fermentation	291
13.8 References	291

14. Combustion Control	292
14.1 Boiler furnaces	292
14.2 Cement and glass	295
14.3 Combustion efficiency of domestic appliances	296
14.4 References	296
15. Process Control	297
15.1 Refineries	298
15.2 Natural gas processing	301
15.3 Reforming plants	301
15.4 Olefines and acetylenes	304
15.5 Aromatics	306
15.6 Monomers and polymers	307
15.7 Chlorinated hydrocarbons	308
15.8 Air fractionation	309
15.9 Chlorine production	311
15.10 Other processes	312
15.11 References	312
16. Testing, Detection and Investigation	313
16.1 Oil well drilling	313
16.2 Fire detection	313
16.3 Leak detection	314
16.4 Ventilation studies	314
16.5 Gas filters	314
16.6 Liquid and solid analyzers	315
16.7 References	315
17. Medical and Biological	316
17.1 Breath analysis	316
17.2 Metabolic and plant physiology studies	318
17.3 Anaesthetics	318
17.4 Experimental techniques	319
17.5 Sterilisation procedures	319
17.6 References	319

<b>PART III: GENERAL CONSIDERATIONS</b>	<b>321</b>
18. Sample Handling	323
18.1 Components of a sample system	324
18.2 Sample systems	342
18.3 Effect of sample system on accuracy	358
18.4 References	362
19. Calibration and Maintenance	363
19.1 Static methods	364
19.2 Dynamic calibration methods	368
19.3 Maintenance	373
19.4 References	374
20. Safety Considerations	375
20.1 Definitions	376
20.2 Intrinsic safety	380
20.3 Flameproof and explosionproof enclosures	381
20.4 Purging	382
20.5 Non-sparking or increased safety	387
20.6 Output circuits and barriers	387
20.7 Other safety considerations	388
20.8 References and standards	388
21. Future Trends in Analysis Instrumentation	390