

Contents

List of abbreviations	10	3.1.7 Gases	32
1. INTRODUCTION	13	3.1.8 Flue Gas Cleaning	32
2. WHAT IS A WASTE INCINERATION?	15	3.1.8.1 Dust (particulate matter) removal	34
2.1 Municipal solid waste incineration (MSWI)	17	3.1.8.2 Acid gas removal.....	35
2.2 Hazardous waste incineration (HWI)	17	3.1.8.3 Nitrogen oxides (NOx) removal techniques	36
2.3 Medical waste incineration (MedWI)	18	3.1.8.4 Reduction of organic compounds including PCDD/F and PCBs	37
2.4 Gasification and Pyrolysis	19	3.1.8.5 VOC removal.....	37
2.4.1 Gasification	20	3.1.9 Transportation Emissions.....	38
2.4.2 Pyrolysis	20	3.1.10 Fugitive Emissions	39
2.5 Chemical recycling	22	3.2 Emissions to Water	40
3. ENVIRONMENTAL IMPACTS OF INCINERATORS	25	3.2.1 Waste Incineration Wastewater Treatment	40
3.1 Air emissions	25	3.2.2 Emergency Water Leaks	40
3.1.1 Air emission limits applied for waste incinerators in EU	26	3.3 Waste or Solid Residues from Waste Incineration ..	42
3.1.1.1 Long-term sampling of dioxins and mercury	28	3.3.1 Processing Waste Containing POPs	47
3.1.1.1.1 Long-term sampling of dioxins	28	3.3.2 Are residues from incinerators hazardous waste?	49
3.1.1.1.2 Long-term sampling of mercury	29	3.3.2.1 Leachate tests' deficiencies.....	51
3.1.2 Air emission limits for waste incineration in USA	29	3.3.3 Where do residues from waste incineration end up?	52
3.1.3 Emission limits, case study: Czech Republic	30	3.3.3.1 Case study: Netherlands	54
3.1.4 Mercury	31	3.4 Soil	57
3.1.5 Other Metals	31	3.4.1 Case Studies.....	59
3.1.6 Particulate Matter	31	3.4.1.1 Lausanne (Switzerland).....	59
		3.4.1.2 Maincy (France)	61
		3.4.1.3 Harlingen (The Netherlands).....	61
		3.4.1.4 Small Medical Waste Incinerators	63

4. INCINERATORS AND THE PLANETARY ECOSYSTEM.....	67
4.1 Climate Change.....	67
4.2 Chemical Pollution (Novel Entities).....	73
4.3 Biodiversity	76
4.4 Biogeochemical flows of phosphorus and nitrogen ...	79
5. TOXIC SUBSTANCES FROM INCINERATORS, THEIR FLOWS, AND HEALTH IMPACTS	84
5.1 Persistent Organic Pollutants (POPs)	84
5.1.1 Chlorinated dioxins	85
5.1.1.1 Air	86
5.1.1.2 Soil	90
5.1.1.3 Solid residues from incineration	91
5.1.1.3.1 Pollutant Release and Transfer Register (PRTR) as Source of Information about Dioxin in Ash.....	92
5.1.1.3.2 Data from the Reporting to the Stockholm Convention	93
5.1.1.3.3 Deficiencies in Leaching Tests.....	94
5.1.1.3.4 Case Study - Jan Šverma Mine, Czech Republic.....	96
5.1.1.3.5 Case Study Newcastle	96
5.1.1.4 Wastewater.....	97
5.1.1.5 How Much Dioxin Does an Incinerator Break Down and Produce?	97
5.1.1.6 Myths Associated with Dioxin Production in Incinerators	100
5.1.2 Brominated Dioxins (PBDD/F)	101
5.1.3 Polychlorinated Biphenyls (PCBs)	103
5.1.3.1 Case Study: Swan Hills – Incidents in POPs Waste Treatment Center	106

5.1.3.1.1 The incidents.....	106
5.1.3.1.2 PCBs, and PCDD/Fs Levels in Biota and People	107
5.1.3.1.3 Economic Considerations.....	108
5.1.3.1.4 Sociological and Health Impacts.....	108
5.1.4 Dioxin-Like Polychlorinated Biphenyls (dl PCB)	110
5.1.5 Hexachlorobenzene (HCB), Pentachlorobenzene (PeCB), and Hexachlorobutadiene (HCBd)	111
5.1.5.1 Case Study: Wietersdorfer Cement Plant (Carinthia, Austria)	113
5.1.6 Polycyclic Aromatic Hydrocarbons (PAHs).....	114
5.1.7 Brominated Flame Retardants	115
5.1.7.1 Polybrominated Diphenyl Ethers (PBDE)	115
5.1.7.2 “Novel” Brominated Flame Retardants (nBFR)	117
5.1.8 Per- and polyfluoroalkyl substances (PFAS)	118
5.1.9 Other POPs.....	124
5.1.9.1 Polychlorinated Naphthalenes (PCN)	124
5.1.9.2 Polychlorinated Dibenzothiophenes (PCDT).....	125
5.1.10 Limits for POPs in Waste	125
5.2 Other Organic Substances	126
5.3 Heavy Metals.....	127
5.3.1 Lead.....	130
5.3.2 Cadmium	131
5.3.3 Arsenic.....	134
5.3.4 Nickel	135
5.3.5 Chromium	136
5.3.6 Mercury.....	138
5.3.7 Copper	140
5.3.8 Zinc	141
5.3.9 Beryllium	143
5.3.10 Limits for heavy metals in waste from incinerators....	144

5.3.10.1 Limits for heavy metals in the Czech Republic	146
--------------------------------------------------------------	-----

6. IMPACTS OF INCINERATORS ON HUMAN HEALTH 148

7. THE ACCIDENTS 158

7.1 Incidents, Fires and Explosions in Municipal Solid Waste Incinerators (MSWI) 158

7.2 Incidents and Fires in Hazardous Waste Incinerators (HWI) 161

7.2.1 Case studies..... 163

7.2.1.1 Explosion in Waste Incinerator in El Dorado, Arkansas.... 163

7.2.1.2 Explosion in Leverkusen..... 164

7.3 Incidents, Fires and Explosions in Pyrolysis and Gasification Technologies 166

7.4 Refused Derived Fuel (RDF) and Fires..... 169

7.4.1 Case studies..... 170

7.4.1.1 Fos-sur-Mer, France 170

7.4.1.2 Fire at Covanta's Doral Incineration Plant in Miami, Florida..... 171

7.5 Analysis of Accidents in Waste Incineration Sector in France 174

7.5.1 Explosion caused by inadequate procedures for controlling and maintaining combustion..... 176

7.5.2 Incineration furnace explosion due to the presence of non-compliant waste 177

7.5.3 Release of toxic substances subsequent to the accidental mix of incompatible products 177

7.5.4 Falling into the waste pit 178

7.6 Summary of the Chapter 178

8. ALTERNATIVES TO INCINERATION 180

8.1 Municipal Waste 180

8.1.1 Treviso, Italy 183

8.1.2 Vrhnika, Slovenia 183

8.1.3 Kamikatsu, Japan 184

8.2 Hazardous Waste 186

8.2.1 Medical Waste 187

8.2.1.1 Low-Temperature Processes 188

8.2.1.2 Chemical Processes 189

8.2.1.3 Radiation Processes 189

8.2.1.4 Biological Processes 189

8.2.1.5 Case Study: Comparison of Non-Incineration Technologies with Incineration 189

8.2.2 Handling Mercury-containing Waste 192

8.2.3 Waste Containing Persistent Organic Compounds (POPs) 192

8.2.3.1 CreaSolv® 193

9. ECONOMICS AND FINANCIAL ASPECTS OF WASTE INCINERATION 195

9.1 Investment in Construction 195

9.1.1 Case Study: WtE Termizo Liberec in Czech Republic .196

9.1.2 Case of the Incinerator in Plzeň – Na Slovanech, Czech Republic 197

9.1.3 Incinerators versus Composting Facilities 198

9.2 Maintenance and Repairs 198

9.3 Operating Costs and Waste Incineration Fees 201

9.4 Associated Costs and Fees 202

9.5 Unaccounted Costs Resulting from Waste Incineration	202
9.6 Summary of the Chapter	203
10. OVERCAPACITY OF WASTE INCINERATION...204	
10.1 Global capacity of waste incineration	204
10.2 Case Studies from Europe	205
10.2.1 European Union	205
10.2.2 Case study: Czech Republic	206
10.2.3 More on overcapacities in Europe.....	210
10.2.4 Copenhagen, Denmark	212
10.2.5 Tallinn, Estonia	214
10.2.6 Ethiopian Reppie Waste to Energy Plant, a Flagship of Next Development in Africa?.....	218
10.3 Challenges in China's Waste-to-Energy Sector	220
10.3.1 Waste Sorting Initiatives and Unintended Consequences.....	220
10.3.2 Overcapacity Issues.....	221
10.3.3 Health, Environmental and Economic Concerns	222
10.3.4 Public protests	223
10.3.5 Waste to Energy Plants and Dioxins and Mercury in China.....	224

11. WASTE INCINERATION AND CIVIL SOCIETY – CASE STUDIES	227
11.1 Spain	228
11.1.1 Coimbra	229
11.2 Ireland.....	229
11.2.1 Galway	229
11.2.2 Carranstown.....	230
11.2.3 Jeremy Irons involvement.....	230
11.3 China	231
11.4 Portugal	232
11.5 South Africa: Durban	232
11.6 Czech Republic	232
11.6.1 Civil Society Engagement in the Case of the Prague – Malešice Municipal Waste Incinerator.....	232
11.6.2 From Opposition to Waste Incineration to Promotion of 3R	234
11.7 India: Zero Waste Kovalam Project	236
11.8 Malaysia: Gabungan Anti-Insinerator Kebangsaan (GAIK).....	239
11.9 Australia	240
12. FINAL SUMMARY	242
References	246