ISO/TR 27912:2016-05 (E)

Carbon dioxide capture - Carbon dioxide capture systems, technologies and processes

Contents

Page

Foreword vii

Introduction viii

1 Scope 1

2 Normative references 1

3 Termsanddefinitions 1

4 Symbols and abbreviated terms 8

5 Carbon dioxide (CO2) capture system 12
5.1 General 12
5.2 Classification of CO2 capture systems 14
5.3 System boundary 16

6 Review and documentation 16
6.1 General 16
6.2 Separation processes 18
6.2.1 Separation with sorbents/solvents 18
6.2.2 Separation with membranes 21
6.2.3 Separation by cryogenics or flash evaporation 22

7 Post-combustion capture in the power industry 22
7.1 System boundary 22
7.1.1 Boundary with power plant or other process stream (cooling water, steam, flue gas, product CO2) 22
7.1.2 Boundary of the PCC plant 25
7.1.3 Boundary with transport and storage of CO2 25
7.2 Technologies, equipment and processes 25
7.2.1 Chemical absorption process based on (alkanol-) amines (amine process) (A) 25
7.2.2 Chilled ammonia process (CAP) (B) 26
7.2.3 Amino acid salts (AAS) process (C) 27
7.3 Carbon dioxide streams, flue gas streams and emissions, process and waste products 28
7.3.1 Flue Gas streams 28
7.3.2 Composition of carbon dioxide streams 32
7.3.3 Solvent streams, reclaiming waste products 34
7.3.4 Waste (process) water streams 35
7.3.5 Emission determination and calculation 36
7.3.6 Process by-products 37
7.4 Evaluation procedure for capture performance 37
7.4.1 Clarification of the evaluation basis 38
7.4.2 Basic performance 38
7.4.3 Utility consumption 40
7.4.4 Operability (operational requirements) 41
7.4.5 Economic evaluation index 42
7.5 Safety issues 43
7.5.1 Safety categories 43
7.5.2 Relevant equipment and manifestations 44
7.5.3 Chemical substances and their behaviours 46

7.5.4 Environmental Impact Assessment (EIA) 49
7.5.5 Preventive measures 49
7.6 Reliability issues 52
7.6.1 Need for reliability assessment 52
7.6.2 Operational reliability 53
7.6.3 Reliability evaluation methods 54
7.6.4 Parameters of reliability 54
7.7 Management system 57
7.7.1 Management system between capture plant and emission source 57

7.7.2 Operational management 58
7.7.3 Relationship with other areas for CCS standardization 59
7.8 Reference plants 59

8 Pre-combustion capture in power industry 60
8.1 General 60
8.2 System boundary 61
8.3 Technologies, equipment and processes 62
8.3.1 Establishment of CO2 capture rate 62
8.3.2 CO2 capture process 62
8.4 Carbon dioxide streams, gas streams and emissions, process and waste products 65
8.4.1 CO2 streams 66
8.4.2 Synthetic gas streams 68
8.4.3 Waste products 69
8.5 Evaluation procedure for capture performance 69
8.5.1 Definition of greenhouse gas (GHG) capture rate 69
8.5.2 Evaluation procedure for capture performance[96] 70
8.6 Safety issues 73
8.7 Reliability issues 74
8.8 Management system 74
8.8.1 Management system between capture plant and emission source 74
8.8.2 Operational management 75
8.8.3 Relationship with other areas for CCS standardization 76

9 Oxyfuel combustion power plant with CO2 capture 76
9.1 System boundary 77
9.2 Technology, processes and equipment 78
9.2.1 Boiler island and auxiliary equipment 78
9.2.2 Steam turbine island and generators 79
9.2.3 Air separation unit (ASU) 80
9.2.4 Flue gas processing units (environmental island) 86
9.2.5 Flue gas condenser (flue gas cooler) 89
9.2.6 CO2 processing unit (CPU) 91
9.2.7 Balance of plant 110
9.3 Product CO2, other major gas streams, emissions and waste products 111
9.3.1 Product CO2 111
9.3.2 Other gas streams 114
9.3.3 Emissions and waste products from oxyfuel combustion power plant 118
9.4 Evaluation procedure for CO2 capture performance 119
9.5 Safety issues 119
9.5.1 Safe operation of the ASU and handling of oxygen on site 120
9.5.2 Prevention procedure of known risks to fire and/or explosion in the boiler or mills should be revisited for oxyfuel combustion operation 121
9.5.3 Accidental release of CO2, flue gases, or other inert gases including liquid gas products 121
9.5.4 Prevention of any low temperature corrosion that could compromise the structural integrity of equipment 121

10 Capture from cement production processes[176][177] 121
10.1 System boundary 122
10.2 Technologies, equipment and processes 123
10.2.1 Post-combustion method (PCC) 125
10.2.2 Oxy-combustion method 125

10.3 Carbon dioxide streams, gas streams and emissions, process and waste products 126
10.3.1 NOx 129
10.3.2 SOx 129
10.3.3 Dust 129
10.3.4 HCl (Hydrogen chloride) 130
10.4 Evaluation procedure for capture performance 130
10.5 Safety issues 130
10.6 Reliability issues 131
10.7 Management system 132

11 CO2 Capture in the iron and steel industry 132
11.1 Overview -- Global steel production 132
11.2 Point sources of CO2 emissions within the iron and steel production 133
11.2.1 Calculation of CO2 emissions from the steel mill 133
11.2.2 Direct CO2 emissions in an integrated mill producing steel through the BF-BOF route ...133
11.2.3 Overview of CO2 emissions from alternative steel making processes 136
11.3 CO2 reduction and CCS deployment strategy in the steel industry 138
11.4 Review of major CO2 breakthrough programmes worldwide 139
11.4.1 ULCOS programme 139
11.4.2 COURSE50 programme 140
11.4.3 POSCO/RIST programme 141
11.5 System boundary 141
11.6 Capture of CO2 from blast furnace gas 142
11.6.1 Development of chemical absorption technology under the COURSE50 programme 142
11.6.2 Development of chemical absorption technology under the POSCO/ RIST programme ...144
11.6.3 Development of physical adsorption technology under COURSE50 programme 145
11.6.4 ULCOS BF -- Oxygen-blown BF with top gas recycle 146
11.6.5 Other commercial development 148
11.7 Specific energy consumption of CO2 captured 150
11.8 Gas streams 153
11.8.1 Conventional blast furnace gas (BFG) 153
11.8.2 BFG from an oxygen-blown BF with top gas recycle (ULCOS BF) 153
11.9 CO2 capture from alternative ironmaking process 154
11.9.1 Direct reduction ironmaking process 154
11.9.2 Smelting reduction ironmaking process 160
11.10 Evaluation procedures for capture processes 166
11.11 Reliability issues 166
11.12 Safety issues 166

12 Capture from industrial gas production processes 167
12.1 System boundary 168
12.1.1 Natural gas sweetening process 168
12.1.2 Ammonia production process 169
12.1.3 Hydrogen production process 169
12.2 Technologies, equipment and processes 171
12.3 Carbon dioxide streams, gas streams and emissions, process and waste products 172
12.3.1 Chemical absorption 172
12.3.2 Physical absorption process 173
12.3.3 Membrane separation 173
12.3.4 Evaluation procedure for capture performance 173
12.4 Safety issues 174
12.5 Reliability issues 175
12.6 Management system 175
12.6.1 Management system between capture plant and emission source 175
12.6.2 Operational management 177
12.6.3 Relationship with other areas for CCS standardization 177

13 Discussion on possible future direction 177
13.1 General 177
13.2 Possible area of standardization 178
13.3 Discussion 178

Annex A (informative) Chemical absorption processes 181

Annex B (informative)Examplesoffluegascompositions 186

Annex C (informative) Physical absorption processes 190

Annex D (informative) CO2captureterms anddefinitionslist 193

Bibliography 209