

---

---

## Carbon dioxide capture — Carbon dioxide capture systems, technologies and processes

*Capture du dioxyde de carbone — Systèmes de capture du dioxyde de carbone, technologies et processus*

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO/TR 27912:2016](https://standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bfl e531904/iso-tr-27912-2016)

<https://standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bfl e531904/iso-tr-27912-2016>



**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

ISO/TR 27912:2016

<https://standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bfe531904/iso-tr-27912-2016>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2016, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
copyright@iso.org  
www.iso.org

# Contents

	Page
<b>Foreword</b> .....	<b>vii</b>
<b>Introduction</b> .....	<b>viii</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Symbols and abbreviated terms</b> .....	<b>8</b>
<b>5 Carbon dioxide (CO<sub>2</sub>) capture system</b> .....	<b>12</b>
5.1 General.....	12
5.2 Classification of CO <sub>2</sub> capture systems.....	14
5.3 System boundary.....	16
<b>6 Review and documentation</b> .....	<b>16</b>
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
<b>7 Post-combustion capture in the power industry</b> .....	<b>22</b>
7.1 System boundary.....	22
7.1.1 Boundary with power plant or other process stream (cooling water, steam, flue gas, product CO <sub>2</sub> ).....	22
7.1.2 Boundary of the PCC plant.....	25
7.1.3 Boundary with transport and storage of CO <sub>2</sub> .....	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
<b>8</b>		<b>Pre-combustion capture in power industry.....</b>	<b>60</b>
	8.1	General.....	60
	8.2	System boundary.....	61
	8.3	Technologies, equipment and processes.....	62
	8.3.1	Establishment of CO <sub>2</sub> capture rate.....	62
	8.3.2	CO <sub>2</sub> capture process.....	62
	8.4	Carbon dioxide streams, gas streams and emissions, process and waste products.....	65
	8.4.1	CO <sub>2</sub> 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
<b>9</b>		<b>Oxyfuel combustion power plant with CO<sub>2</sub> capture.....</b>	<b>76</b>
	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	CO <sub>2</sub> processing unit (CPU).....	91
	9.2.7	Balance of plant.....	110
	9.3	Product CO <sub>2</sub> , other major gas streams, emissions and waste products.....	111
	9.3.1	Product CO <sub>2</sub> .....	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 CO <sub>2</sub> 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 CO <sub>2</sub> , 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
<b>10</b>		<b>Capture from cement production processes[176][177].....</b>	<b>121</b>
	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	NO <sub>x</sub> .....	129
	10.3.2	SO <sub>x</sub> .....	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
<b>11</b>	<b>CO<sub>2</sub> Capture in the iron and steel industry.....</b>	<b>132</b>
11.1	Overview — Global steel production.....	132
11.2	Point sources of CO <sub>2</sub> emissions within the iron and steel production.....	133
11.2.1	Calculation of CO <sub>2</sub> emissions from the steel mill.....	133
11.2.2	Direct CO <sub>2</sub> emissions in an integrated mill producing steel through the BF-BOF route.....	133
11.2.3	Overview of CO <sub>2</sub> emissions from alternative steel making processes.....	136
11.3	CO <sub>2</sub> reduction and CCS deployment strategy in the steel industry.....	138
11.4	Review of major CO <sub>2</sub> 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 CO <sub>2</sub> 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 CO <sub>2</sub> 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	CO <sub>2</sub> 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
<b>12</b>	<b>Capture from industrial gas production processes.....</b>	<b>167</b>
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
<b>13</b>	<b>Discussion on possible future direction.....</b>	<b>177</b>
13.1	General.....	177
13.2	Possible area of standardization.....	178
13.3	Discussion.....	178
	<b>Annex A (informative) Chemical absorption processes.....</b>	<b>181</b>

<b>Annex B (informative) Examples of flue gas compositions</b> .....	<b>186</b>
<b>Annex C (informative) Physical absorption processes</b> .....	<b>190</b>
<b>Annex D (informative) CO<sub>2</sub> capture terms and definitions list</b> .....	<b>193</b>
<b>Bibliography</b> .....	<b>209</b>

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO/TR 27912:2016](https://standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bfe531904/iso-tr-27912-2016)

<https://standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bfe531904/iso-tr-27912-2016>

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is ISO/TC 265, *Carbon dioxide capture, transportation, and geological storage*.

ISO/TR 27912:2016

<https://standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bfe531904/iso-tr-27912-2016>

## Introduction

Carbon capture and storage (CCS) is a technology to mitigate climate change. Many demonstration projects have been conducted worldwide, and CO<sub>2</sub> capture is an important process in CCS and is cost and energy intensive.

CO<sub>2</sub> capture in power industry could be classified through pre, post and oxy combustion. Technologies such as chemical and physical absorption, adsorption, and membrane separation are currently under development and are in various stages of maturity from commercial (110 MW)<sup>[1]</sup> large-scale demonstrations to laboratory-scale evaluation, and should be delivered at low cost and low energy consumption.

The objectives of this Technical Report are to specify and review existing capture technologies, equipment and processes and comprehend CO<sub>2</sub> capture systems so that this Technical Report can provide stakeholders with the guidance and knowledge necessary to develop a series of standards for CO<sub>2</sub> capture and build consensus on this standardization work in advance.

This Technical Report describes CO<sub>2</sub> capture systems based on published papers and other documents and then summarizes the different issues deemed most important by ISO/TC 265. This includes the following:

- boundary for CO<sub>2</sub> capture systems;
- technologies, equipment and processes;
- CO<sub>2</sub> streams, gas streams and emissions, processes and waste products;
- evaluation procedures for capture performance;
- safety issues on each capture system;
- reliability issues on each capture system;
- management system.

ITeH STANDARD PREVIEW  
(standards.iteh.ai)

ISO/TR 27912:2016

<https://standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bf1e531904/iso-tr-27912-2016>



# Carbon dioxide capture — Carbon dioxide capture systems, technologies and processes

## 1 Scope

This Technical Report describes the principles and information necessary to clarify the CO<sub>2</sub> capture system and provide stakeholders with the guidance and knowledge necessary for the development of a series of standards for CO<sub>2</sub> capture. This Technical Report also covers technologies, equipment and processes specific to CO<sub>2</sub> capture from the viewpoints of the international standardization for the implementation of CCS.

The purpose of this Technical Report is to provide guidance for the development of an ISO document related to CO<sub>2</sub> capture as part of a CCS chain. This Technical Report covers CO<sub>2</sub> capture systems applicable to CO<sub>2</sub> emission sources and their respective boundaries, as well as capture technologies, equipment and processes. In addition, it can be used for the development of International Standards under TC 265.

The following issues are to be excluded from this Technical Report:

- industrial use of CO<sub>2</sub>;
- compression of CO<sub>2</sub> (not described in detail);
- terminologies not used in this Technical Report.

## 2 Normative references

[ISO/TR 27912:2016](#)

[standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bfl e531904/iso-tr-27912-2016](#)

There are no normative references in this document.

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1

#### **absorbent**

substance able to absorb liquid or gas

### 3.2

#### **affinity**

tendency of substances to react with each other

Note 1 to entry: Also defined as the decrease in Gibbs energy on going from the reactants to the products of a chemical reaction.

[SOURCE: IUPAC Compendium of Chemical Terminology]

### 3.3

#### **air separation unit**

unit separating oxygen, nitrogen and other inert gases from air which delivers the required oxygen for gasification or combustion applications in the context of CCS

### 3.4

#### **alkanolamine**

chemical compound that carries hydroxy (–OH) and amino (–NH<sub>2</sub>, –NHR, and –NR<sub>2</sub>) functional groups on an alkane backbone

3.5

**amine**

chemical compound consisting nitrogen atoms bound to hydrogen and/or carbon atoms having the general formula  $R_3N$

3.6

**amino acid**

any of a class of organic compounds in which a carbon atom has bonds to an amino group, a carboxyl group, a hydrogen atom and an organic side group

3.7

**antioxidant**

substance that inhibits oxidation or reactions promoted by oxygen, peroxides, or free radicals

3.8

**Brayton cycle**

thermodynamic cycle that describes the workings of a constant pressure heat engine such as gas turbine engine

3.9

**capital cost**

sum of direct equipment costs to capture  $CO_2$  which is also known as investment cost or first cost

[SOURCE: IPCC Special Report on Carbon Dioxide Capture and Storage]

3.10

**capital requirement**

sum of direct equipment costs and indirect costs to capture  $CO_2$

iTeh STANDARD PREVIEW  
(standards.itih.ai)

3.11

**catalyst**

substance that increases the rate of reaction without itself being consumed in the reaction

ISO/TR 27912:2016

94b1fe531904/iso-tr-27912-2016

3.12

**CCS energy consumption**

total energy used for the development and operation of a CCS project

3.13

**chemical absorption**

process in which  $CO_2$  is absorbed by chemical reaction

3.14

**circulating dry scrubber**

type of semi-dry FGD using hydrated lime as chemical reagent which is based on a circulating bed reactor set up to desulfurize the flue gas

3.15

**clinker**

mass of incombustible matter fused together

3.16

**$CO_2$  capture**

separation of  $CO_2$  in such a manner as to produce a concentrated stream of  $CO_2$  that can readily be transported for storage

3.17

**$CO_2$  capture rate**

ratio of the captured  $CO_2$  mass flow rate at  $CO_2$  capture system to the inlet  $CO_2$  mass flow rate to  $CO_2$  capture system

**3.18****CO<sub>2</sub> processing unit**

group of processes used in the purification of the CO<sub>2</sub> rich gas to a desired CO<sub>2</sub> specification

Note 1 to entry: Also known as compression and purification unit (CPU), CO<sub>2</sub> purification unit (CPU), cryogenic purification unit, gas processing unit (GPU).

**3.19****critical pressure**

vapour pressure at the critical temperature

**3.20****critical temperature**

temperature above which liquid cannot be formed simply by increasing the pressure

**3.21****decarboxylation reaction**

chemical breakdown of compounds containing carbonates

**3.22****degradation**

act or process of chemical which makes its functional effectiveness or chemical purity decrease towards the failure to meet the performance of the plant through physical and chemical breakdown or reaction with other substances

**3.23****dehydration**

process of removing water from a stream or material

**3.24****demineralized water****demin water**

water of which the mineral matter or salts have been removed

Note 1 to entry: Sometimes designated as demin water.

**3.25****demister**

device, often fitted with vapour-liquid separator vessels, to enhance the removal of liquid droplets or mist entrained in a vapour stream

**3.26****desorption**

release of CO<sub>2</sub> from absorbent or adsorbent

**3.27****direct quench**

process where hot gas is cooled by injection of water, cool gas or water immersion

**3.28****effluent**

flow of waste material discharged into the environment

**3.29****equilibrium**

state of balance between opposing forces or actions that is either static or dynamic

**3.30****flash gas**

gas separated from a liquid by pressure reduction

**3.31**

**flue gas**

gases produced by combustion of a fuel that are normally emitted to the atmosphere

**3.32**

**flue gas condenser**

process of removing water from the flue gas by cooling

**3.33**

**flue gas desulfurization**

equipment normally used in the removal of  $\text{SO}_x$  in the flue gas by using chemical reagents

**3.34**

**flue gas processing unit**

unit of processes used to remove different criteria pollutants ( $\text{SO}_x$ ,  $\text{NO}_x$ , PM, etc.) from flue gas of boilers or fired heaters

Note 1 to entry: Also known as environmental island, air quality control system (AQCS), gas quality control system (GQCS).

**3.35**

**forced oxidation wet flue gas desulfurization**

type of wet FGD using limestone as chemical reagent

**3.36**

**gas turbine**

machine in which a fuel is burned with compressed air or oxygen and mechanical work is recovered by the expansion of the hot products

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

**3.37**

**gasification**

reaction that coal, biomass, petroleum coke, or natural gas is converted into a syngas composed mainly of carbon monoxide (CO) and hydrogen ( $\text{H}_2$ )

ISO/TR 27912:2016

https://standards.iteh.ai/catalog/standards/si/531904/iso-tr-27912-2016

**3.38**

**gasifier**

reactor in which coal, biomass, petroleum coke, or natural gas is converted into a syngas composed mainly of carbon monoxide (CO) and hydrogen ( $\text{H}_2$ )

**3.39**

**membrane**

permeable solid material that selectively separates the components of a fluid mixture

**3.40**

**mist**

stream of liquid in the form of very small drops

**3.41**

**nitrosamine**

any of various organic compounds which are characterized by the grouping  $\text{NNO}$

**3.42**

**nitramine**

any of various organic compounds which are characterized by the grouping  $\text{NNO}_2$

**3.43**

**off-gas**

gas that is produced as a by-product of a process

**3.44****oxy-combustion  
oxyfuel combustion**

process involving combustion of a fuel with pure oxygen or a mixture of oxygen and re-circulated flue gas

**3.45****oxy-CFB boiler**

CFB boiler using technology based on oxyfuel combustion with recycled flue gas

**3.46****oxy-PC boiler**

PC boiler using technology based on oxyfuel combustion with recycled flue gas

**3.47****particulate emission**

solid and liquid particles that are by-products of combustion entrained in flue gas exiting the stack of a fossil fueled boiler

**3.48****permeability rate**

quantity of flow of gas (or liquid) through a membrane per unit of time and area

**3.49****permeance**

measure of gas actually flowing through a membrane per unit of pressure differential

Note 1 to entry: In general, it is expressed in gas permeance units (GPU).

Note 2 to entry: 1 GPU =  $10^{-6}$  cm<sup>3</sup>(STP)/scm<sup>2</sup>(cmHg).

**3.50****physical absorption**

process where a solvent absorbs a gas physically with pressure and without chemical reaction

**3.51****post-combustion capture**

capture of carbon dioxide from flue gas stream produced by fuel air combustion

**3.52****power output**

electricity which is produced or supplied from a power plant

**3.53****pre-combustion capture**

capture of carbon dioxide following the processing of the fuel before combustion

**3.54****pressure swing adsorption**

method of separating gases using the physical adsorption of one gas at high pressure and releasing it at low pressure

**3.55****pulverized coal**

finely ground coal

**3.56****pulverized coal boiler**

utility boilers using pulverized fuel or coal as fuel

**3.57****pulverized fuel**

finely ground solid fuels such as coal or biomass

**3.58**

**quench**

to cool hot gas suddenly

**3.59**

**radiant quench design**

design of the process where hot gas is cooled by radiant cooler

**3.60**

**reaction rate**

speed of a chemical reaction

**3.61**

**reclaimer**

process or unit that regenerates deteriorated absorbent

**3.62**

**recycled flue gas**

flue gas recycled to moderate the combustion temperature

**3.63**

**regenerator**

see *stripper* (3.79)

**3.64**

**reliability**

ability of an item to perform a required function, under given environmental and operational conditions and for a stated period of time

[SOURCE: ISO 8402]

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

[ISO/TR 27912:2016](https://standards.iteh.ai/catalog/standards/sist/3c5e776c-76be-47c2-bd59-94bfe531904/iso-tr-27912-2016)

**3.65**

**retrofit**

modification of the existing equipment to upgrade and incorporate changes after installation

[SOURCE: IPCC Special Report on Carbon Dioxide Capture and Storage]

Note 1 to entry: See IEA Technology Roadmap: Carbon Capture and Storage.

**3.66**

**saturation**

point of a solution condition at which a solution of a substance can dissolve no more of that substance and additional amounts of it will appear as a separate phase at the stable condition

**3.67**

**scrubber**

gas liquid contactor device, normally used to remove gaseous and solid emissions from flue gas streams

**3.68**

**selectivity**

degree that one substance is absorbed in comparison to others

[SOURCE: US Department of Energy/National Energy Technology Laboratory, Advanced Carbon Dioxide Capture R&D Program: Technology Update, February 2013]

**3.69**

**shift conversion**

see *shift reaction* (3.71)

**3.70**

**shift converter**

reactor in which the water-gas shift reaction,  $\text{CO} + \text{H}_2\text{O} = \text{CO}_2 + \text{H}_2$ , takes place

**3.71****shift reaction**

chemical formation of carbon dioxide and hydrogen from carbon monoxide and water

**3.72****sludge**

semi-liquid (or semi-solid) residue or solids separated from suspension in a liquid in industrial processes and treatment of sewage and waste water

**3.73****slurry**

thick, flowable mixture of solids and a liquid, usually water

**3.74****solute**

dissolved substance in a solution

**3.75****solvent**

liquid substance capable of dissolving CO<sub>2</sub>

**3.76****sorbent**

substance that absorbs CO<sub>2</sub> or to which CO<sub>2</sub> is adsorbed

**3.77****sour shift (reaction)**

shift reaction without removing H<sub>2</sub>S or COS

**3.78****steam reforming**

catalytic process in which a hydrocarbon is reacted with steam to produce a mixture of H<sub>2</sub>, CO and CO<sub>2</sub>

**3.79****stripper**

gas-liquid contacting device, in which a component is transferred from liquid phase to the gas phase

Note 1 to entry: Can also be referred to as “regenerator” or “desorber”.

**3.80****sweet shift (reaction)**

shift reaction after removing H<sub>2</sub>S or COS

**3.81****syngas**

synthetic gas produced through gasification process

**3.82****treated gas**

gas finally discharged from the CO<sub>2</sub> capture process in the emission side after being processed to have a lower CO<sub>2</sub> concentration than the feed gas

**3.83****waste water**

water for which there is no use in the process anymore

**3.84****water gas shift**

see *shift reaction* ([3.71](#))