

DIN EN ISO 17349



ICS 75.020

**Erdöl- und Erdgasindustrie –
Offshore-Plattformen, von denen Ströme mit hohem CO₂-Gehalt
bei hohen Drücken zu handhaben sind (ISO 17349:2016);
Englische Fassung EN ISO 17349:2016**

Petroleum and natural gas industries –
Offshore platforms handling streams with high content of CO₂ at high pressures
(ISO 17349:2016);
English version EN ISO 17349:2016

Industries du pétrole et du gaz naturel –
Plates-formes en mer traitant des courants à fort teneur en CO₂ à haute pression
(ISO 17349:2016);
Version anglaise EN ISO 17349:2016

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DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG)

Nationales Vorwort

Dieses Dokument (EN ISO 17349:2016) wurde vom Technischen Komitee ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 12 „Materialien, Ausrüstungen und Offshore-Bauwerke für die Erdöl-, petrochemische und Erdgasindustrie“ (Sekretariat: NEN, Niederlande) erarbeitet.

Für Deutschland hat hieran der Arbeitskreis NA 109-00-01-12 AK „CO₂ Aspekte“ im DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

Diese europäische Norm enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung der ISO Norm.

Diese Norm enthält neben den gesetzlichen Einheiten auch die Einheiten „°F“, „atm“, „BTU/scf“, „ft“, „lb (pound)“ und „psi (psig)“ die in Deutschland nicht zugelassen sind. Es wird ausdrücklich darauf hingewiesen, dass die Anwendung dieser Einheiten im nationalen amtlichen und geschäftlichen Verkehr aufgrund des Gesetzes über Einheiten im Messwesen nicht zulässig ist. Die Angabe dieser Einheiten dient lediglich als Hilfe im amtlichen und geschäftlichen Verkehr (z. B. bei Einfuhr und Ausfuhr) mit solchen Staaten, die diese Einheiten anwenden.

Umrechnung

Nicht-SI-Einheit	SI-Einheit	Umrechnung	
°F	°C	°C	$= (5/9) (°F - 32)$
atm	Pa	1 atm	$= 1,013\,25 \cdot 10^5 \text{ Pa}$
BTU/scf	kJ/Nm ³	1 BTU/scf	$= 37,25 \text{ kJ/Nm}^3$
ft	m	1 ft	$= 0,304\,8 \text{ m}$
lb (pound)	kg	1 lb	$= 0,453\,592\,37 \text{ kg}$
psi (psig)	kPa	1 psi	$= 6,894\,757 \text{ kPa}$

Für die in diesem Dokument zitierten Internationalen Normen wird im Folgenden auf die entsprechenden Deutschen Normen hingewiesen:

ISO 13702	siehe	DIN EN ISO 13702
ISO 15156 (all parts)	siehe	DIN EN ISO 15156 (alle Teile)
ISO 21457	siehe	DIN EN ISO 21457
ISO 23936-1	siehe	DIN EN ISO 23936-1
ISO 23936-2	siehe	DIN EN ISO 23936-2

Nationaler Anhang NA (informativ)

Begriffe und Abkürzungen

Die Benummerung der folgenden Begriffe und Abkürzungen ist identisch mit der Benummerung in der englischen Fassung.

3 Begriffe und Abkürzungen

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.1

Realgasfaktor

Kompressibilitätsfaktor

Z

thermodynamische Eigenschaft, für die Anpassung des idealen Gasgesetzes, um das Verhalten realer Gase zu berücksichtigen

3.2

korrosionsbeständige Legierung

CRA

(en: corrosion-resistant alloy)

Legierung, die beständig gegen allgemeine und örtliche Korrosion in solchen Ölfeldumgebungen sein soll, in denen unlegierte Stähle korrodieren

[QUELLE: ISO 15156-1:2015, 3.6]

3.3

dichte Phase

Dichtphase

fluider Zustand (überkritisch oder flüssig) oberhalb des kritischen Drucks

3.4

Zustandsgleichung

EOS

thermodynamische Gleichung zur Beschreibung des Zustands von Stoffen unter bestimmten physikalischen Bedingungen

3.5

freies Wasser

im CO₂-reichen Strom nicht gelöstes Wasser

Anmerkung 1 zum Begriff: Freies Wasser kann sein: reines Wasser, Wasser mit gelösten Salzen, wassernasse Salze, Wasser-Glykol-Gemische oder andere wasserhaltige Gemische.

3.6

gasunterstützt abfackeln

abfackeln mit Gasunterstützungssystem zwecks Steigerung des Heizwerts

3.7

abfackeln mit hoher Spitzengeschwindigkeit

abfackeln mit Gasaustrittsgeschwindigkeiten über 122 m/s

3.8

abblasen mit hoher Geschwindigkeit

abblasen mit Gasaustrittsgeschwindigkeiten über 150 m/s

3.9

Hydrat

festе, kristalline Verbindung aus Wasser und leichten Kohlenwasserstoffen oder CO₂, in welcher durch die Verbindung von Wasser- und Gasmolekülen ein Feststoff gebildet wird

3.10

CRA-Auskleidung

metallischer Überzug auf einer CRA mit metallurgischer Bindung zwischen Grundwerkstoff und Auskleidung

3.11

abfackeln mit niedriger Spitzengeschwindigkeit

abfackeln mit Gasaustrittsgeschwindigkeiten unter 122 m/s

3.12

abblasen mit niedriger Geschwindigkeit

abblasen mit Gasaustrittsgeschwindigkeiten unter 150 m/s

3.13

Mindest-Auslegungstemperatur

niedrigste Temperatur, unter der die Anwendungsgrenzen für die involvierten Werkstoffe überschritten werden

3.14

Plattform

vollständiges Bauwerk einschließlich des Tragwerks, der Überwasser-Aufbauten, der Fundamente und der Systeme zur Beibehaltung der Position

[QUELLE: ISO 19900:2013, 3.35]

3.1.15

rasche Gasdekompression

RGD

(en: rapid gas decompression)

Gasdruckentlastung

explosionsartige Druckentlastung

schneller Druckabfall in einem unter hohem Druck stehenden System, wobei das Gleichgewicht zwischen dem äußeren Gasdruck und der Konzentration des in einem Polymer gelösten Gases mit dem Ergebnis gestört wird, dass das überschüssige Gas in der Lösung versucht, an bestimmten, über das gesamte Material verteilten Stellen zu entweichen und eine Expansion verursacht

Anmerkung 1 zum Begriff: Falls die Expansion groß genug und die Geschwindigkeit des Druckabfalls höher ist als die natürliche Diffusionsgeschwindigkeit des Gases, können Blasen oder Brüche auftreten.

[QUELLE: ISO 23936-2:2011, 3.1.10]

3.16

überkritische Phase

fluider Zustand oberhalb des kritischen Drucks und der kritischen Temperatur

3.17**Überwasserbauten****Aufbauten****Deck**

Bauten und Einrichtungen, die zur Ermöglichung einiger oder aller Funktionen einer Plattform auf einer (feststehenden oder schwimmenden) Stützkonstruktion angeordnet sind

Anmerkung 1 zum Begriff: Bei schiffartigen schwimmenden Plattformen ist das Deck nicht Teil der Aufbauten.

Anmerkung 2 zum Begriff: Bei einer Hubplattform ist der Tragwerkskörper nicht Teil der Aufbauten.

Anmerkung 3 zum Begriff: Ein separat hergestelltes Deck oder ein Modul-Tragrahmen ist Teil der Aufbauten.

[QUELLE: ISO 19900:2013, 3.52]

3.18**Tripelpunkt****Dreiphasenpunkt**

Druck und Temperatur bei denen CO₂ gleichzeitig als Gas, Flüssigkeit und Feststoff vorliegt

4 Abkürzungen

AIV	akustisch induzierte Schwingungen	(en: acoustically induced vibration)
BLEVE	Dampfexplosion einer expandierenden siedenden Flüssigkeit	(en: boiling liquid expanding vapor explosion)
BDV	Abschlammentil	(en: blow down valve)
CH ₄	Methan	(en: methane)
CO ₂	Kohlenstoffdioxid	(en: carbon dioxide)
CCR	zentrale Leitwarte	(en: central control room)
CRA	korrosionsbeständige Legierung	(en: corrosion resistant alloy)
EERS	Strategie zur Evakuierung, Flucht und Rettung	(en: evacuation, escape and rescue strategy)
EOS	Zustandsgleichung	(en: equation of state)
ESD	Notabschaltung; Notentlastung	(en: emergency shut down)
FES	Strategie für den Brand- und Explosionsschutz	(en: fire and explosion strategy)
GDU	Gastrocknungseinheit	(en: gas dehydration unit)
H ₂ S	Schwefelwasserstoff	(en: hydrogen sulfide)
HC	Kohlenwasserstoff	(en: hydrocarbon)

HP	hoher Druck	(en: high pressure)
HSE	Gesundheit, Sicherheit und Umwelt	(en: health, safety and environment)
IDLH	unmittelbare Gefahr für Leben und Gesundheit	(en: immediately dangerous to life or health)
LP	niedriger Druck	(en: low pressure)
MMSCF	Million Normalkubikmeter Gas (60 °F und 1 atm)	(en: million standard cubic feet gas (60 °F and 1 atm))
NHV	Heizwert	(en: net heating value)
NIOSH	nationales (amerikanisches) Institut für Arbeitssicherheit und Gesundheit	(en: National Institute for Occupational Safety and Health)
NIST	Nationales (amerikanisches) Institut für Normung und Technologie	(en: National Institute of Standards and Technology)
OSHA	(Amerikanische) Arbeitsschutzorganisation	(en: Occupational Safety and Health Administration)
Pa	Umgebungsdruck	(en: ambient pressure)
Pc	kritischer Druck	(en: critical pressure)
PEL	zulässige Belastungsgrenze	(en: permissible exposure limit)
PHA	vorläufige Untersuchung von Gefährdungen	(en: Preliminary Hazard Analysis)
ppmv	Teilchen pro Million, auf volumetrischer Basis	(en: parts per million, volumetric basis)
PR	Zustandsgleichung von Peng-Robinson	(en: Peng-Robinson EOS)
PR-HV	Zustandsgleichung von Peng-Robinson, modifiziert nach der Mischungsregel von Huron-Vidal unter Anwendung des Peneloux-Faktors	(en: Peng-Robinson EOS modified by using mixing rule of Huron-Vidal and Peneloux factor)
PR-SV	Zustandsgleichung von Peng-Robinson, modifiziert von Stryjek-Vera	(en: Peng-Robinson-Stryjek-Vera)
PSV	Druck-Sicherheitsventil	(en: pressure safety valve)
RGD	rasche Gasdruckentlastung	(en: rapid gas decompression)
RO	Drosselblende	(en: restriction orifice)
SCF	Normalkubikmeter; Standardkubikfuß	(en: standard cubic feet)
SVLE	Feststoff-Flüssigkeit-Dampf-Gleichgewicht	(en: Solid-liquid-vapor equilibrium)
STEL	Kurzzeitbelastungsgrenzwert	(en: short term exposure limit)

SRK	Zustandgleichung von Soave-Redlich-Kwong	(en: EOS Soave-Redlich-Kwong)
T _c	kritische Temperatur	(en: critical temperature)
TWA	zeitgewichteter Mittelwert	(en: time weighed average)
v _{max}	maximal zulässige Geschwindigkeit, in m/s	(en: maximum permitted velocity, expressed in m/s)
Z	Realgasfaktor	(en: compressibility factor)

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN EN ISO 13702, *Erdöl und Erdgasindustrie — Überwachung und Eindämmung von Feuer und Explosionen auf Offshore-Produktionsplattformen — Anforderungen und Leitlinien*

DIN EN ISO 15156 (alle Teile), *Erdöl- und Erdgasindustrie — Werkstoffe für den Einsatz in H₂S-haltiger Umgebung bei der Öl- und Gasgewinnung*

DIN EN ISO 21457, *Erdöl-, petrochemische und Erdgasindustrie — Werkstoffauswahl und Korrosionsschutzmaßnahmen für Öl- und Gasproduktionssysteme*

DIN EN ISO 23936-1, *Erdöl-, petrochemische und Erdgasindustrie — Nichtmetallische Werkstoffe mit Medienkontakt bei der Öl- und Gasproduktion — Teil 1: Thermoplaste*

DIN EN ISO 23936-2, *Erdöl-, petrochemische und Erdgasindustrie — Nichtmetallische Werkstoffe mit Medienkontakt bei der Öl- und Gasproduktion — Teil 2: Elastomere*

English Version

Petroleum and natural gas industries —
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Erdöl- und Erdgasindustrie —
Offshore-Plattformen, von denen Ströme mit hohem
CO₂-Gehalt bei hohen Drücken zu handhaben sind
(ISO 17349:2016)

This European Standard was approved by CEN on 10 January 2016.

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COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN ISO 17349:2016) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee CEN/TC 12 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2016, and conflicting national standards shall be withdrawn at the latest by September 2016.

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Endorsement notice

The text of ISO 17349:2016 has been approved by CEN as EN ISO 17349:2016 without any modification.

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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).

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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 WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

Introduction

In recent years, the oil industry has been facing challenges in developing and operating high-CO₂ content offshore fields. The CO₂-rich streams, separated from the produced natural gas, can be injected to enhance oil recovery from the reservoirs. Even in cases where the oil recovery increase is not so significant, operators have to consider the CO₂-rich stream compression and injection, in order to avoid its venting to the atmosphere.

Main concerns comprise surface safety system and material selection areas, which lack specific standards and regulations for this scenario. The commercial tools available, for instance, to model the dispersion of gases, need to be validated for CO₂ and CO₂/hydrocarbon mixtures, which have distinctive thermodynamic behaviour. This will affect the choice of materials and plant design.

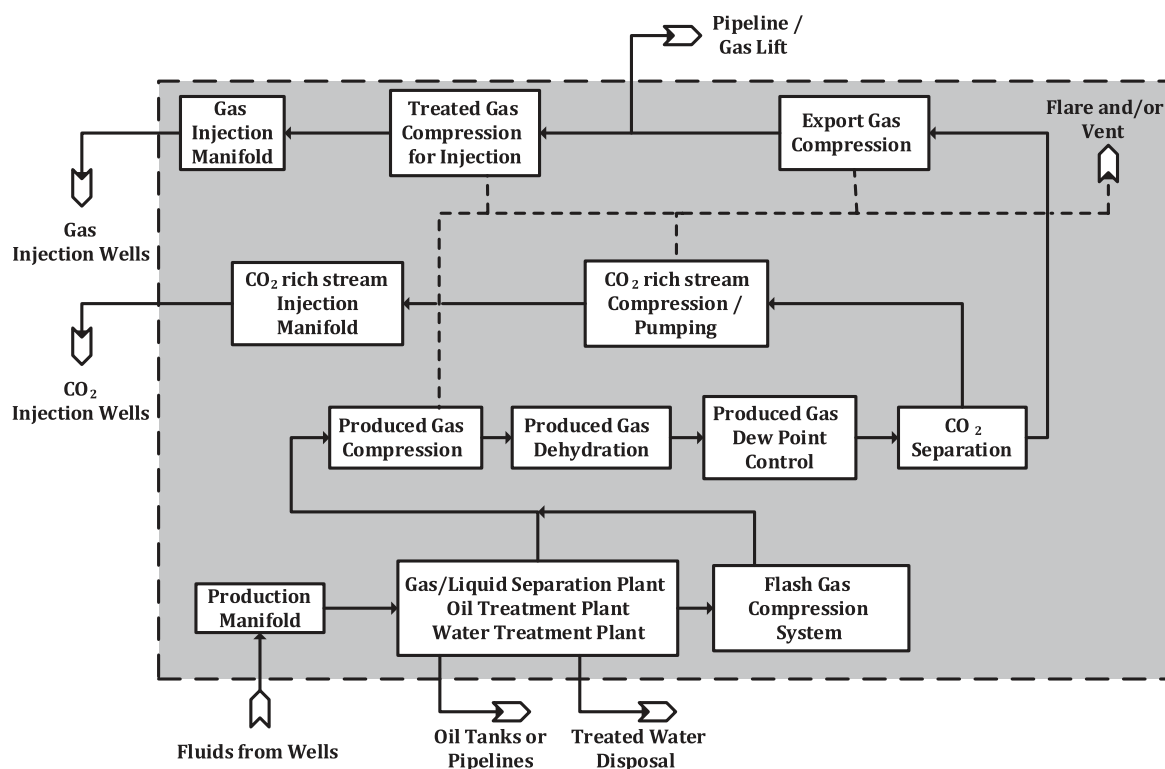
This International Standard addresses concepts and criteria for processing CO₂-rich streams, as a supplement to existing standards for offshore installations.

Petroleum and natural gas industries — Offshore platforms handling streams with high content of CO₂ at high pressures

1 Scope

This International Standard contains provisions for design of topside facilities for offshore plants handling CO₂-rich streams at high pressures; i.e. CO₂ molar concentration above 10 %. The surface systems include usual offshore process unit operations, as shown in Figure 1.

This International Standard is applicable only to topside facilities of fixed and floating oil and gas production offshore units up to the last barrier, such as an ESDV. Subsea production systems and Cryogenic CO₂ separation are not covered.



NOTE This example is within the scope of this International Standard.

Figure 1 — Example of a Process Flow Diagram (in grey zone)

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies..

ISO 13702, *Petroleum and natural gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines*

ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H₂S-containing environments in oil and gas production*

ISO 21457, *Petroleum, petrochemical and natural gas industries — Materials selection and corrosion control for oil and gas production systems*

ISO 23936-1, *Petroleum, petrochemical and natural gas industries — Non-metallic materials in contact with media related to oil and gas production — Part 1: Thermoplastics*

ISO 23936-2:2011, *Petroleum, petrochemical and natural gas industries — Non-metallic materials in contact with media related to oil and gas production — Part 2: Elastomers*

API STD 521, *Pressure-relieving and Depressuring Systems, API Standard, January 2014*

3 Terms and definitions

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

3.1 compressibility factor

Z

thermodynamic property for modifying the ideal gas law to account for the real gas behaviour

3.2 corrosion resistant alloy

CRA

alloy intended to be resistant to general and localized corrosion by oil field environments that are corrosive to carbon steels

[SOURCE: ISO 15156-1:2015, 3.6]

3.3 dense phase

fluid state (supercritical or liquid) above critical pressure

3.4 equation of state

EOS

thermodynamic equation describing the state of matter under a given set of physical conditions

3.5 free water

water not dissolved in the CO₂-rich stream

Note 1 to entry: This can be pure water, water with dissolved salts, water wet salts, water glycol mixtures or other mixtures containing water.

3.6 gas-assisted flare

flare with gas assistance system in order to increase gas net heating value

3.7 high-velocity tip flare

flare with gas exit velocities higher than 122 m/s

3.8 high-velocity vent

vent with gas exit velocities higher than 150 m/s

3.9

hydrate

solid, crystalline compound of water and light hydrocarbons or CO₂, in which the water molecules combine with the gas molecules to form a solid

3.10

CRA clad

metallic coating of CRA in which the bond between the parent metal and liner is metallurgical

3.11

low-velocity tip flare

flare with gas exit velocities lower than 122 m/s

3.12

low-velocity vent

vent with gas exit velocities lower than 150 m/s

3.13

minimum design temperature

minimum temperature below which the application limits for the materials involved are exceeded

3.14

platform

complete assembly, including structure, topsides, foundations and stationkeeping systems

[SOURCE: ISO 19900:2013, 3.35]

3.15

rapid gas decompression

RGD

depressurization

explosive decompression

rapid pressure-drop in a high pressure gas-containing system which disrupts the equilibrium between external gas pressure and the concentration of gas dissolved inside any polymer, with the result that excess gas tries to escape from the solution at points throughout the material, causing expansion

[SOURCE: ISO 23936-2:2011, 3.1.10]

3.16

supercritical phase

fluid state above critical pressure and temperature

3.17

topsides

structures and equipment placed on a supporting structure (fixed or floating) to provide some or all of a platform's functions

Note 1 to entry: For a ship-shaped floating structure, the deck is not part of the topsides.

Note 2 to entry: For a jack-up, the hull is not part of the topsides.

Note 3 to entry: A separate fabricated deck or module support frame is part of the topsides.

[SOURCE: ISO 19900:2013, 3.52]

3.18

triple point

temperature and pressure where CO₂ exists as a gas, liquid and solid simultaneously

4 Abbreviated terms

AIV	acoustically induced vibration
BLEVE	boiling liquid expanding vapour explosion
BDV	blow down valve
CH ₄	methane
CO ₂	carbon dioxide
CCR	central control room
CRA	corrosion resistant alloy
EERS	evacuation, escape and rescue strategy
EOS	equation of state
ESD	emergency shut down
FES	fire and explosion strategy
GDU	gas dehydration unit
H ₂ S	hydrogen sulfide
HC	hydrocarbon
HP	high pressure
HSE	health, safety and environment
IDLH	immediately dangerous to life or health
LP	low pressure
MMSCF	million standard cubic feet gas (60 °F and 1 atm)
NHV	net heating value
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
Pa	ambient pressure
P _c	critical pressure
PEL	permissible exposure limit
PHA	Preliminary Hazard Analysis
ppmv	parts per million, volumetric basis
PR	Peng-Robinson EOS
PR-HV	Peng-Robinson EOS modified by using mixing rule of Huron-Vidal and Peneloux factor

PR-SV	Peng-Robinson-Stryjek-Vera EOS
PSV	pressure safety valve
RGD	rapid gas decompression
RO	restriction orifice
SCF	standard cubic feet
SVLE	solid-liquid-vapour equilibrium
STEL	short-term exposure limit
SRK	Soave-Redlich-Kwong EOS
T _c	critical temperature
TWA	time weighted average
v _{max}	maximum permitted velocity, expressed in m/s
Z	compressibility factor

5 Overview of CO₂-rich streams behaviour

5.1 General

In an offshore plant design, CO₂-rich streams can be handled close to or above its critical pressure (dense phase) or above its critical pressure and temperature (supercritical phase).^[8] In the latter, some of its properties are similar to that of a liquid (e.g. density) and other similar to that of a gas (e.g. viscosity). The physical and thermodynamic properties of the CO₂-rich streams will have an impact on issues like hydrate formation and depressuring.

The design of a plant handling CO₂-rich streams at high pressures should be conducted using an EOS supported by experimental data in the range of operations. Examples of this approach are shown in Annex A. If experimental data are not available, data from thermodynamic based models, including readily available EOS, should be used taking into account any related uncertainties therefore allowing for sufficient safety margins.

Particular attention should be given when performing simulations near the critical point due to strong variation on stream properties and uncertainty on the description of the existing phases. For that reason, equipment normal operation envelope should avoid critical point region.

5.2 Hydrate formation

CO₂-rich streams can present a potential risk for hydrate formation similar to sweet natural gas, if water is present (as free water or in gas phase).

For high pressures, CO₂ has an inhibitor effect on hydrate formation, since an increase on the CO₂ concentration shifts the hydrate equilibrium curve towards low temperatures, as it can be seen in Annex B.

Dehydration unit design should take into account all operational conditions, including low temperatures that might occur in process systems and pipeline segments downstream from the offshore plant. Special attention should be given to the fact that CO₂ tends to increase water-holding capacity at higher pressures.

For that reason, depending on CO₂ content in the stream, it is not safe to set a water dew point specification based on higher pressure requirements only, since water condensation can occur at lower pressures (see Figure B.1).

As a first approach, a margin of 10 °C on water dew point or a reduction down to 50 % of the water saturation content should be considered.

An example of moisture content specification for Dehydration Unit is presented in Annex C.

5.3 CO₂ solid formation

Solid formation can be observed in a CO₂-rich stream depending on temperature and pressure. Low temperatures that lead to solid formation can be achieved during planned and unplanned depressuring operations, for equipment maintenance purposes and emergency conditions as well. Annex D presents phase diagram for CO₂-rich streams and discusses solid formation based on experimental and theoretical calculations.

The influence of methane content in solid formation temperature can be found in Reference [9]. The frost point is presented for a CO₂-CH₄ mixture in a wide range of concentrations, showing that increasing CH₄ content shifts the frost point curve toward lower temperatures, as shown in Annex D.

According to References [9] and [10], there is an indication that solid formed from a CO₂-rich stream in low temperature operations may be considered as composed of pure CO₂. Therefore, in the absence of experimental data and specific phase diagrams for mixtures with the solid region represented, available phase diagrams for pure CO₂ may be used as conservative approach, in order to predict the low temperatures in which solid formation is expected in an offshore plant design.

Process plant design should take into account the predicted low temperatures with additional design margin in order to specify suitable mitigation measures to avoid or deal with solid formation. More details are presented in Clause 6.

5.4 Flow metering

Design of metering systems shall take into account the peculiarities of behaviour of CO₂-rich streams. Preferably, metering systems should be located in plant sections where physical and transport properties are stable and predictable, i.e. far from critical point or phase transitions. Depending on the process, this means some meters may be designed for gas phase, while others for liquid phase.^[11]

Flow computers with input for composition as well as temperature and pressure online measurements using the AGA-8 method, commonly used for natural gas, may be extended to CO₂-rich streams as long as conditions guarantee gas phase.^[12] AGA-8 method also shows good predictability of supercritical phase as shown in Annex A.

Differential pressure flow meters such as orifice plates, Venturi or V-Cone are well suitable and robust, especially when working at very high pressures. Coriolis meters, being mass flow meters, are less susceptible to the variation of fluid properties or phase changes as long as no solids are formed but can be limited to operational pressures due to meter body construction.

Special care should be taken regarding changes in the CO₂-rich stream properties and potential flashing, so meter sizing and location should be properly selected.

6 Blow down, depressuring and relieving of plant and equipment

Temperature decrease observed in CO₂-rich streams during depressuring depends upon the initial and final pressures, initial temperature and stream composition.

In order to avoid brittle fracture, minimum temperatures achieved during an isenthalpic depressuring should be considered for material selection of let-down pressure devices (PSVs, BDVs, ROs) and for the