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Carbon dioxide capture, transportation and geological storage — Pipeline transportation systems

Captage du dioxide de carbone, transport et stockage géologique du dioxyde de carbone — Systèmes de transport par conduites

FDIS stage

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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 document 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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This document was prepared by Technical Committee ISO/TC 265, *Carbon dioxide capture, transportation, and geological storage*.

This second edition cancels and replaces the first edition (ISO 27913:2016), which has been technically revised.

The main changes are as follows:

— the entire text has been editorially revised;

— normative references have been updated;

— a ~~chapter~~subclause about CO_2 stream flowrate and impurity measurement has been added;

— the level of impurities ~~was~~has been limited to 5 % and a set of 17 requirements are defined ~~in the normative part to assure~~to ensure CO_2 stream pipeline integrity;

— Annex A~~An informative Annex A was~~ has been added to show example compositions of CO_2 streams for gaseous and dense phase CO_2 streams which fulfil the requirements of the normative part of this document;

— Annex D~~Annex D~~ has adopted the latest findings in fracture arrest design.

— Annex F~~Annex F was~~ has been added to describe decompression effects on pressure and temperature versus time.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Field Code Changed

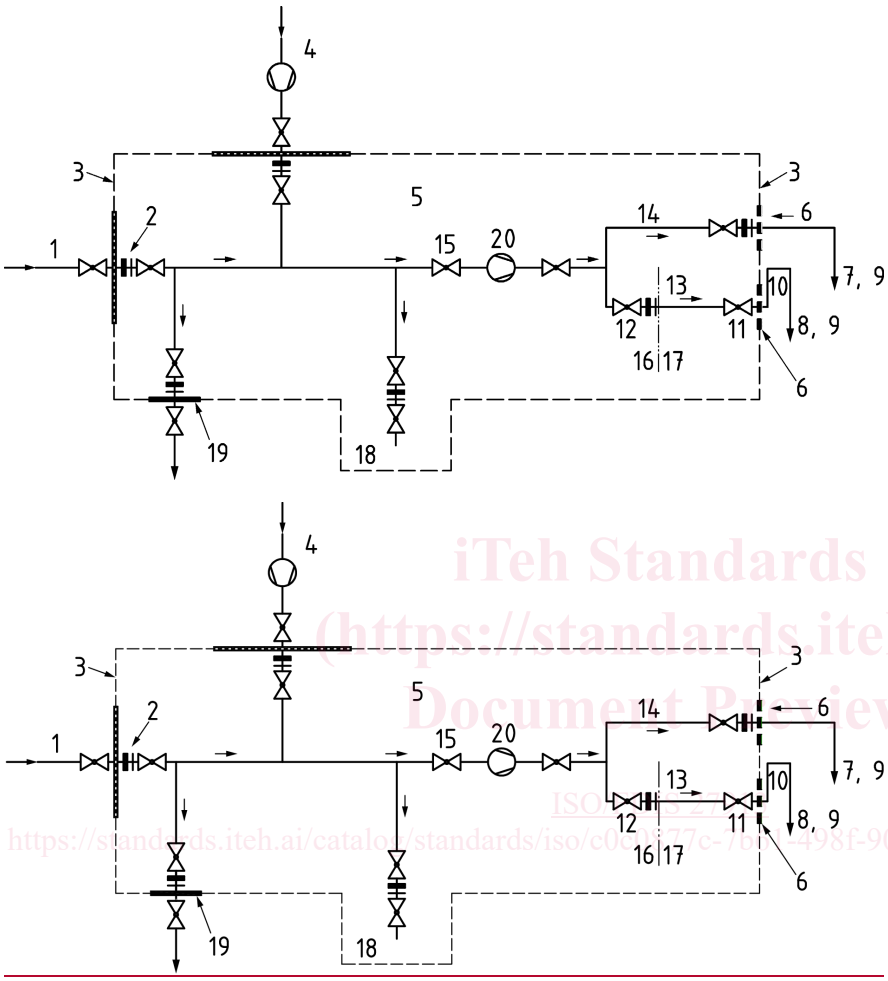
Introduction

Carbon dioxide (CO_2) capture, carbon dioxide use (CCU) and carbon dioxide storage (CCS) have been identified as key abatement technologies for achieving a significant reduction in CO_2 emissions to the atmosphere. Pipelines are likely to be the primary means of transporting CO_2 from the point-of-capture to storage sites (e.g. depleted hydrocarbon formations, deep saline aquifers), or to usage points (e.g. enhanced oil recovery ~~(EOR)~~, or utilization) to avoid its release to the atmosphere. While there is a perception that transporting CO_2 via pipelines does not represent a significant barrier to implementing large-scale CCS, there is significantly less industry experience than there is for hydrocarbon service (e.g. natural gas) and there are a number of issues that need to be adequately understood and the associated risks effectively managed to ensure safe transport of CO_2. In a CCS or CCU context, there is a need for larger CO_2 pipeline systems in more densely populated areas and with CO_2 coming from multiple sources. Also, offshore pipelines for the transportation of CO_2 to offshore storage sites are likely to become common.

The objective of this document is to provide specific requirements and recommendations on certain aspects of safe and reliable design, construction and operation of pipelines intended for the large-scale transportation of CO_2 that are not already covered in existing pipeline standards such as ISO 13623, ASME B31.4, ASME B31.8, EN 1594, AS 2885 or other standards ~~(see~~listed in the Bibliography~~)~~. Existing pipeline standards cover many of the issues related to the design and construction of CO_2 pipelines~~;~~. However, there are some CO_2-specific issues (e.g. fracture arrest, internal corrosion protection~~, etc.)~~ that are not adequately covered in these standards, but is addressed in this ~~standard~~document. The purpose of this document is to cover these issues consistently. Hence, this document is not a standalone standard, but is written to be a supplement to other existing pipeline standards for natural gas or liquids for both onshore and offshore pipelines.

~~Transport of CO_2 via ship, rail and road is not covered in this document.~~

The system boundary (see Figure 1~~Figure 1)~~) between capture and transportation is the point at the inlet valve of the pipeline, where the composition, temperature and pressure of the CO_2 stream is within a certain specified range to meet the requirements for transportation as described in this document.



Key

1	source of CO_2 from capture~~, (~~e.g. from power plant, industry; see ISO/TR 27912 ~~(capture~~)	~~10~~11	~~riser (out of transport~~subsea valve (inside transportation scope)
		~~11~~12	~~subsea~~beach valve ~~(inside transport scope)~~
2	isolating joint	~~12~~13	~~beach valve~~offshore pipeline
3	boundary limit	~~13~~14	~~offshore~~onshore pipeline
4	other source of CO_2	~~14~~15	~~onshore pipeline~~valve
5	~~ISO 27913 (~~transportation system inside~~)~~ given in this document	~~15~~16	~~valve~~landfall
6	boundary to storage facility or utilization	~~16~~17	~~landfall~~open water
7	onshore storage facility	~~17~~18	~~open water/sea~~third party transport system
8	offshore storage facility	~~18~~19	~~third party transport system~~export to other uses than those of Keys 7, 8 and 9

9	~~EOR~~enhanced oil recovery	~~19~~20	~~export to other uses than 7, 8 and 9~~intermediate compression or pumping
10	riser (outside transportation scope)	~~20~~	~~intermediate compression or pumping~~

Figure 1 — Schematic illustration of the system boundaries of this document

The boundary between transportation and storage~~,~~ or utilization is the point where the CO_2 stream leaves the transportation pipeline infrastructure and enters the downstream infrastructure, which can be permanent geological storage, utilization~~,~~ or buffer storage prior to shipping.

Carbon dioxide capture, transportation and geological storage — Pipeline transportation systems

1 Scope

This document specifies the requirements and recommendations for the transportation of CO_2 streams from the capture site to the storage facility where it is primarily stored in a geological formation or used for other purposes (e.g. for ~~EOR~~enhanced oil recovery or CO_2 use).

This document applies to the transportation of CO_2 streams by~~:~~

— rigid metallic pipelines,

— pipeline systems,

— onshore and offshore pipelines for the transportation of CO_2 streams,

— conversion of existing pipelines for the transportation of CO_2 streams, and

— transportation of CO_2 streams in the gaseous and dense phases.

This document also includes aspects of CO_2 stream quality assurance, as well as converging CO_2 streams from different sources.

Health, safety and environment aspects specific to CO_2 transport and monitoring are also considered in this document.

Transportation of CO_2 via ship, rail or on road is not covered in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3183, *Petroleum and natural gas industries — Steel pipe for pipeline transportation systems*

ISO 20765-2, *Natural gas — Calculation of thermodynamic properties — Part 2: Single-phase properties (gas, liquid, and dense fluid) for extended ranges of application*

ISO/TR 27925, *Carbon dioxide capture, transportation, and geological storage — Cross cutting issues — Flow assurance*

API SPEC 5L, *Line Pipe, 46th Edition*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
aqueous phase
liquid phase composed predominantly of water and other impurities that are not dissolved in the gaseous or dense CO_2 phase

3.2
block valve
full-bore valve inserted into a pipeline to reduce the total volume of the *CO_2 stream* (3.4) that would be emitted in the case of planned or unplanned depressurization of that section or in the case of a pipeline rupture

3.3
bubble point pressure
pressure of the saturated liquid at a given composition and temperature ~~(see ISO/TR 27925)~~

3.4
CO_2 stream
stream consisting overwhelmingly of carbon dioxide

Note 1 to entry: usually ~~>~~ ≥95 mol% CO_2

3.5
corrosion allowance
additional wall thickness beyond that required by the mechanical design to compensate for any reduction in wall thickness by corrosion (internal/external) during the design operational life

3.6
critical point
highest temperature and pressure at which a pure substance (e.g. CO_2) can exist as a gas and a liquid in equilibrium

Note 1 to entry: For a multicomponent fluid mixture of a given composition, the critical point is the merge of the bubble point curve~~,~~ and the dew point curve.

Note 2 to entry: The critical point is defined by the *critical pressure* (3.7) and *critical temperature* (3.8).

3.7
critical pressure
vapour pressure at the *critical temperature* (3.8~~(3.8)~~)

Note 1 to entry: The critical pressure for pure CO_2 is 7,38 MPa.

3.8
critical temperature
~~for~~ pure substance temperature above which liquid cannot be formed simply by increasing the pressure

Note 1 to entry: The critical temperature of pure CO_2 is 304,13 K (equivalent to 30,98 °C).

Note 2 to entry: For *CO_2 streams* (3.4), phase transitions can still occur above critical temperature.

3.9
dense phase
<engineering> CO_2 or *CO_2 streams* (3.4) in the single-phase fluid state above a density of 500 kg/~~m^3~~ m^3

Note 1 to entry: For more details, see also ISO/TR 27925.