Transportation of Carbon Dioxide by Pipeline

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Introduction

While transportation of CO_2 may be completed by truck, train, or pipeline, pipelines hold advantages when it comes to achieving large-scale networked transportation of fluids [1, 2] including:

— established safety protocols, engineering standards, and regulatory oversight;

— reliable means of transportation of captured emissions consistently and continuously (this is crucial for industries that depend on steady operations);

— most efficient means of safe high-volume transport of CO_2;

— seamless integration with various industrial processes, such as power plants, cement manufacture, and chemical facilities (this integration streamlines the carbon capture, utilization, and storage [CCUS] process and minimizes logistical complexities).

The design and operation of pipelines transporting supercritical CO_2 in the United States are subject to regulation by the Pipeline and Hazardous Materials Safety Administration (PHMSA), a federal agency under the Department of Transportation, Title 49 of the *Code of Federal Regulations* (*CFR*) as defined in Part 195 for hazardous liquid pipelines [3]. The regulations provide standards for the design, construction, and testing of new CO_2 pipelines, many of which are the same as those applied to other pipelines, including those carrying chemicals, oil, and natural gas, although the risks in the event of release vary. Individual states also provide regulations to CO_2 pipelines on state lands and private lands within the state. Some information related to the historical and forecast demand for CO_2 pipelines is presented in Annex C.

NOTE This recommended practice (RP) does not provide guidance on compliance with regulations.

The objective of this document is to identify the distinct characteristics of CO_2 pipelines not found in hazardous liquid and gas pipelines and provide guidance on these factors. This document identifies many of these unique features and provides guidance and best practices for the design, operation, and maintenance of CO_2 pipelines. It covers aspects such as operating pressure ranges, ductile fracture control, pressure fluctuations, corrosion challenges, nonmetallic component interactions, blowdown stack design, and emergency response plans in case of accidental releases.

This RP adopts some simplifying terminology including:

— where information is specifically intended for transmission pipelines operating with CO_2 in a defined phase, recommendations are explicitly identified as either “gas-phase CO_2 pipelines” or “dense-phase CO_2 pipelines” (in this document, dense-phase CO_2 includes both liquid and supercritical conditions).

— any mention of CO_2 is for a fluid mixture of CO_2 molecules and other constituents, except when the document needs to identify CO_2 as a molecule, it is referred to as “pure CO_2.”

Transportation of Carbon Dioxide by Pipeline

1 Scope

This document provides guidance for the design, construction, operation, maintenance, integrity management, and emergency response for both dense-phase (including liquid and supercritical state) and gas-phase carbon dioxide (CO_2) related to pipelines and related appurtenances and facilities.

The provisions are applicable to onshore gathering and transmission pipelines and related facilities used to convey CO_2 in gas- and dense-phase conditions. Offshore pipelines and sequestration facilities were considered in the development of this document, and it provides some guidance to support these applications. The guidance provided herein is based on the physical, regulatory, and social environment of the United States but could be applied in other countries with due consideration for their regulatory requirements and unique circumstances.

The intent of this document is to provide operators, contractors, regulators, consultants, and the public with guidance. The document focuses on issues of unique concern to CO_2 pipelines. Where issues of concern do not differ from those for hazardous liquid or gas pipelines, a lower level of detail is provided.

Carbon capture and sequestration involves collection, transportation, and storage of CO_2; however, this document does not specifically address processes and procedures associated with capture, injection, utilization, or storage.

NOTE This document covers mature methodologies, enhancements, technologies, and issues specific to CO_2 pipelines. Where possible, supporting references are provided for additional details regarding useful data, practices, and tools for CO_2 pipeline design, construction, operation, maintenance, security, and integrity management.

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 addenda) applies.

API Recommended Practice 1162, *Public Awareness Programs for Pipeline Operators*

API Recommended Practice 1185, *Pipeline Public Engagement*

3 Terms, Definitions, Acronyms, Abbreviations, and Symbols

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

3.1 Terms and Definitions

3.1.1
anthropogenic CO_2
CO_2 that originates directly from human activities.

3.1.2
asphyxiation
A condition of deficient supply of oxygen to the body.

3.1.3
bubble point
Pressure and temperature at which the first bubble of vapor forms from a liquid mixture at equilibrium.