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Carbon dioxide capture, transportation, and geological storage — Cross Cutting Issues — CO_2 stream composition

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National foreword

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Foreword

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Introduction

ISO Technical Committee (TC) 265 is developing standards and technical reports related to carbon dioxide (CO_2) capture, transportation and geological storage (CCS). This technology is a technically viable solution to reduce CO_2 emissions of large stationary point sources and therefore to limit future global temperature increases. A special report by the International Panel on Climate Change (IPCC, 2005) extensively described the fundamental technical, scientific, environmental, economic and societal dimensions of CCS and its potential role in the portfolio of climate change mitigation measures.

Depending among other things on the feedstock and the CO_2 generating and capture processes, CO_2 streams captured from industrial sources or power generation contain various impurities (that is, stream components other than CO_2). The impurities differ in their concentrations but also in their physical and chemical properties. Therefore, the composition of the originally captured CO_2 stream is a key starting point in ensuring the safety and reliability of the transport and geological storage of CO_2. Compositional information may assist operators in evaluating the need for treating a CO_2 stream, based on the intended transportation options (including mixing with other CO_2 streams), usage options (EOR or other), or dedicated storage in geologic formations.

Understanding CO_2 stream composition is also important for the commerciality of CCS activities because additional purification of the CO_2 stream increases CO_2 capture costs. In addition, CO_2 stream composition is an important input factor in quantifying the amount of CO_2 stored, for the purpose of greenhouse gas emissions reporting and crediting. Because capture and purification processes are continuously evolving, it is relevant to expose the range of impurities in CO_2 streams and their concentrations, including recent publications.

This document provides up-to-date consideration of CO_2 stream quality issues for operators, regulators and stakeholders based on research results and the experience of various pilot and industrial scale CCS projects. The first part of this report summarises existing information related to CO_2 stream composition that generally results from particular capture processes. Then this report describes possible impacts and effects of the various impurities that may occur in the CO_2 stream on various downstream elements of a CCS chain, including operational aspects, potential implications for health, safety and environmental issues, and quantification of greenhouse gas emissions.

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Carbon dioxide capture, transportation, and geological storage — Cross Cutting Issues — CO_2 stream composition

1 Scope

The primary aim of this document is to describe the main compositional characteristics of the CO_2 stream downstream of the capture unit, taking into account common purification options. Accordingly, this document will characterize the different types of impurities and present examples of concentrations determined in recent capture pilot projects as well as through literature review. It identifies ranges of concentrations, giving priority to in situ measurements when available.

The second aim of this document is to identify potential impacts of impurities on all components of the CCS chain, from surface installations (including transport) to the storage complex. For example, impurities can have a significant effect on the phase behaviour of CO_2 streams in relation to their concentration. Chemical effects also include the corrosion of metals. The composition of the CO_2 stream can also influence the injectivity and the storage capacity, due to physical effects (such as density or viscosity changes) and geochemical reactions in the reservoir. In case of a leakage, toxic and ecotoxic effects of impurities contained in the leaking CO_2 stream could also impact the environment surrounding the storage complex.

In order to ensure energy efficiency, proper operation of the whole CCS chain and not to affect its surrounding environment, operators usually limit the concentrations of some impurities, which can, in-turn, influence the design of the capture equipment and purification steps. Such limits are case specific and cannot be described in this report; however, some examples of CO_2 stream specifications discussed in the literature are presented in Annex A.

The required purity of the CO_2 stream delivered from the capture plant will to a large degree depend on the impurity levels that can be accepted and managed by the transport, injection and storage operations. The capture plant operators will therefore most probably need to purify the CO_2 stream to comply with the required transport, injection, storage specifications or with legal requirements.

Monitoring of the CO_2 stream composition plays an important role in the management of the entire CCS process. Methods of measuring the composition of the CO_2 stream and in particular the concentrations of impurities are described and other parameters relevant for monitoring at the various steps of the CCS chain are described.

The interplay between the set CO_2 stream specifications and the efficiency of the entire CCS process is also explained. Finally, the mixing of CO_2 streams coming from different sources before transport or storage is addressed, and the main benefits, risks and operational constraints are presented.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

3.1
CO_2 stream
stream consisting overwhelmingly of carbon dioxide

Note 1 to entry: The CO_2 stream typically includes impurities and may include substances added to the stream to improve performance of CCS and/or to enable CO_2 detection.

[SOURCE: ISO 27917:2017, 3.2.10]

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