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Carbon dioxide capture

~~-~~ Key performance parameters and characterization methods of absorption liquids for post-combustion CO2 capture

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

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Introduction

Carbon dioxide capture and storage (CCS) is a suite of technologies to reduce carbon dioxide (CO_2) emissions into the atmosphere, as a central aspect of reducing overall greenhouse gas emissions that are causing climate change. CCS is widely recognized to play a crucial role in achieving deep and large-scale decarbonization in a short time frame in the power and industrial sectors. Among several CO_2 capture pathways, post-combustion CO_2 capture (PCC) is the most mature and viable, capable of reducing CO_2 emissions from combustion processes in the energy-related and industrial sectors. Chemical absorption using reactive liquids is a proven technology, and has been widely developed in numerous PCC facilities. Various absorption liquids, such as amines, potassium carbonate, aqueous ammonia solutions, amino-acid salt solutions, and mixtures of these reactants, have been adopted for PCC applications.

The performance of absorption liquids is one of the key factors influencing the cost and the energy consumption in a PCC process, thereby influencing its commercial application and its net greenhouse gas impact. Understanding the key performance parameters and physical and chemical properties of absorption liquid is essential, not only for screening of promising absorption liquids, but also for process engineering design and evaluating PCC plant performance during operation.

Specifically, accurate monitoring of CO_2 loading and absorbent concentration in the absorption liquid will guide parametric measurement, optimization, commissioning and operation of the PCC plant. Understanding the absorption capacity helps in selecting the appropriate absorption liquid for CO_2 capture, and optimizing the process conditions using information from ~~vapor~~vapour-liquid equilibria. A larger cyclic loading of CO_2 in the absorption liquid means that less absorption liquid needs to be circulated, leading to lower energy consumption for pumping, heating and cooling. Absorbent volatility is one of the factors leading to absorbent loss. The heat of absorption of CO_2 is a primary factor influencing the energy required for regenerating absorption liquids. The viscosity of absorption liquids can affect absorber flooding, and electricity consumption for pumping. A higher viscosity of the absorption liquid also reduces the heat transfer coefficient for the heat exchanger, meaning more heat exchanger area is required to achieve the same heat duty. It also decreases the absorption and mass transfer between gas and liquid. The absorption rate of absorption liquids impacts the capital costs of the PCC process. A higher absorption rate of the absorption liquids enables a shorter packing height in CO_2 capture, which reduces the sizes of the absorber and desorber. The density and viscosity are physical and chemical properties of absorption liquids. The thermal conductivity and specific heat capacity are important thermophysical properties to understand the heat transfer process in absorption liquid-based CO_2 capture process.

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Given the large and diverse impact of absorption liquids on various aspects of PCC plant performance, an ISO standard for evaluating and characterizing the key performance parameters of absorption liquids is required. ~~Such a standard is part of a series of~~ and that would complement the standards for CO_2 capture, ~~complementing the~~ ISO 27919-1 and ISO 27919-2. Previously, ISO 27919-1 was developed as a guideline for measuring, evaluating and reporting the performance of a PCC plant integrated into a power plant. It provides a general methodology for calculating specific key performance indicators for the PCC process within the entire power system. ISO 27919-2 was developed to specify an evaluation procedure to ensure and maintain the stable performance of the PCC process integrated into a power plant during operation, from a commissioning perspective.

The measurement and evaluation of the key physical and chemical characteristics of absorption liquids, as defined in this document, are essential. This will benefit technology developers for the subsequent PCC process design, optimization, performance monitoring, and plant operation.

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Carbon dioxide capture — Key performance parameters and characterization methods of absorption liquids for post-combustion CO2 capture

1 Scope

1.1 This document provides definitions, guidelines and supportive information for the key performance parameters and their characterization methods of absorption liquids used in post-combustion CO_2 capture. It covers common methodologies to measure and calculate specific key performance parameters of the absorption liquids.

The absorption liquids for post-combustion CO_2 capture covered by this document are chemically reactive liquids, such as amine solutions, potassium carbonate solutions, aqueous ammonia, amino-acid salt solutions, and mixtures of these reactants. Other absorption liquids based on different principles for CO_2 capture are not covered.

1.2 The key performance parameters considered in this standard document relate to the design and operation of absorption liquid-based post-combustion CO_2 capture processes, as well as equipment such as absorber and desorber columns, reboilers, and other heat exchangers.

The key performance parameters are as follows:

a) a) primary parameters, such as rich and lean CO_2 loading, absorbent concentration, absorption capacity, heat of absorption, absorption rate, and absorbent volatility;

b) b) secondary parameters, such as cyclic loading, that are directly derived from the primary parameters, or combined with other physical measurements, as in the case for the absorbent loss rate.

In addition, physical and chemical properties such as density, viscosity, pH, thermal conductivity, and specific heat capacity are described. These properties are essential for understanding the key performance parameters of the absorption liquids.

1.3 The following items are included in This document also:

a) a) Definitions ofestablishes key performance parameters (see 4Clause 4) specifies the set of key performance parameters and), physical and chemical properties, of absorption liquids, and their calculation methods, and provides a common way of reporting them;

b) b) Generalspecifies the general requirements for the absorption liquid characterization (Clause 5) specifies the definition ofin laboratory measurement and field testing (see 5, and):

provides general requirements for characterization methods in laboratory measurement and field testing;

b)c) c) Instrument and characterization methods (Clause 6) presentsthe requirements for the instrumentation to be installed or used, and provides guidelines for the characterization methods (see 6:);

c)d) d) Technicalprovides information (Annexes) provides measurementon the characterization methods of absorption liquids, describing all stages of test preparation, set-up and execution (see Annexes A to I. Additionally,), as well as guidance on sampling absorption liquids is introduced.

It is noted thatNOTE While key performance parameters of absorption liquids are important process indicators for post-combustion CO_2 capture. However, factors such as process design, equipment design and manufacturing, economics, and safety are also considered for a comprehensive evaluation of post-combustion CO_2 capture technology.

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