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Carbon dioxide capture, transportation and storage — Carbon dioxide capture — Performance evaluation methods for CO_2 capture connected to a CO_2 intensive plant

Capture, transport et stockage du dioxyde de carbone — Capture du dioxyde de carbone — Méthodes d'évaluation des performances pour la capture du CO_2 des installations à fortes émissions de CO_2

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Foreword

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

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Introduction

It is very important to reduce atmospheric carbon dioxide (CO_2) emissions in order to meet climate change mitigation targets. The inclusion of carbon dioxide capture and storage (CCS) among the variety of available emission reduction approaches enhances the probability of meeting these targets at the lowest cost to the global economy. CCS captures CO_2 from industrial and energy-related sources and stores it underground in geological formations. CCS can capture CO_2 emissions from carbonaceous fuel-based combustion processes, including power generation, and is at present the most effective technology capable of dealing directly with emissions from several CO_2 intensive industries, such as steel, cement etc.

As a standard for CO_2 capture, ISO 27919-1 presents an evaluation method of key performance indicators (KPIs) for post-combustion CO_2 capture (PCC) from a power plant. On the other hand, this document covers an evaluation method of KPIs for CO_2 capture from various CO_2 intensive plants. It is noted that ISO 27919-1 and this document are mutually independent; similar terms and symbols used in both the standards are valid only in the respective standards. CO_2 intensive plants suggest industries such as steel, cement, ferro alloys, aluminium and other metals. It is also intended for CCS enabled hydrogen as well as refineries, chemical processing industries such as fertilizer. The CO_2 capture plant takes in the exhaust gas from the CO_2 intensive plant without further integration, i.e. not impacting on the production of the CO_2 intensive plant.

CO_2 intensive industries are characterized by the production of significant volumes of CO_2 as a by-product. In many cases, the CO_2 amounts are comparable or even larger than the amount of the main product. The two largest of such industries, steel and cement manufacture, are responsible for 7 % to 8 % each of global CO_2 production. Typically, the CO_2 intensive industries produce large amounts of CO_2 at each production site, often in the range from some hundred thousand to million tonnes per annum. CO_2 intensive industries, such as steel, cement, etc. are using carbon or carbon-containing raw materials, which often cannot readily be replaced. For example, cement needs limestone and silicon metal needs carbon as the chemical reductant.

In steel production, the dominant CO_2 sources are the iron-making blast furnace and the steel converter, while other production steps (ore sintering, rolling mills, etc.) are producing smaller amounts. A modern, integrated steel plant, making finished steel bars, beams or plates from iron ore emits around two tonnes of CO_2 per tonne of finished product. In contrast, steel produced from scrap in an electric arc furnace emits about 350 kg CO_2 per tonne of steel. However, scrap availability is seriously limited. The exhaust gases from the blast furnace have extra high content of CO_2 (typically 25 % by volume) and high pressure [2 atmospheres (atm) to 4 atm]. The steel converter produces intermittently smaller amounts of flue gas with some lower CO_2 content and at ambient pressure. Other CO_2 producing steps on the way from iron ore to finished products typically produce flue gases with lower CO_2 content (10 % to 15 %), like most fuel combustion and at ambient pressure.

CO_2 capture on the blast furnace exhaust gas can take advantage of the high CO_2 content, pressure and volume of this exhaust gas, typically 75 % of the total CO_2 from the integrated mill. This has been pilot tested with pressure swing adsorption (PSA) on a semi-industrial blast furnace. The adsorbents were zeolites and active carbon. The results showed low energy consumption.

In cement production, there are two main steps producing CO_2:

a) Calcination of limestone by heating the main raw material, limestone to 900 °C, after grinding the rock limestone to a fine powder. Heating of the materials occurs in counter current flow with hot exhaust gases from step b). The process equipment can vary from plant to plant.

b) Clinker burning of a mixture of burnt lime from step a) together with silica containing raw materials occur in a long, rotary kiln. The kiln is normally fired from the material exit end with solid, liquid or gaseous fuel (e.g. coal, oil, gas, biomass and waste). The clinker mix is heated up to 1 450 °C and the clinker is semi-fused to round plum size pellets. A part of the exhaust gases is sent to step a); the rest is sent to the exhaust gas stack. The clinker leaving the rotary kiln passes through a clinker cooler, where combustion air is pre-heated for the kiln.

In lime production, CO_2 generation includes only step a).