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Demonstrating Large Scale Industrial CCS through CCU – A Case Study for Methanol Production

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Abstract

Methanol is a basic chemical building block used in producing other commodities that we used in our daily lives. In the last decade, due to regulation and policy framework in the transport sector, there is also a significant growth in the use of methanol as fuel (i.e. additives to gasoline, production of MTBE, bio-diesel, synthetic gasoline, etc…).

Methanol is produced by reacting CO and CO_2 with H_2. Traditionally, this is produced in a two-steps process – i.e. syngas production and methanol synthesis. Most of the CO_2 is emitted at the syngas production side of the operation. The question arises if CO_2 is captured, what is its potential for the CO_2 to be used in the methanol synthesis? What is the limitation of CCU on-site? How could this support the deployment and economics of industrial CCS?

This paper aims to present:

- Techno-economic evaluation of deploying CO_2 capture in a mega-methanol plant using NG as feedstock. This plant include a combine reforming process (SMR-ATR configuration) to produce the syngas; methanol synloop and methanol purification unit producing AA grade methanol.
- Concept of on-site CCU as a possible route to expand future methanol production capacity and at the same time promote the deployment of industrial CCS.

Keywords: industrial CCS, on-site CCU, methanol production, syngas production, SMR, ATR, post-combustion CO_2 capture, MEA

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1. Introduction

Methanol (MeOH) is a basic chemical building block used in the production of other commodities. This is an important feedstock in the production of acetic acid, formaldehydes, acrylics, methylamine, dimethyl terephthalate, olefins, and many others. These chemicals are imbedded into several things that we normally use or see in our households or in our daily lives (i.e. paints, furniture, windshield, car parts, carpet, plastic, etc…).

In the last decade, due to regulations and policy framework in the transport sector, there is also a significant growth in the use of methanol as fuel (i.e. blends to gasoline, production of MTBE, DME, bio-diesel, synthetic gasoline, etc…).

Globally, there are more than 100 methanol plants operating worldwide with a cumulative annual production capacity of nearly 100 million metric tonnes (2015 data). Growth in capacity of around 13-15% AAGR is expected in the coming decade. Predominantly, methanol produced outside China are based on NG as feedstocks. Typically, the CO_2 emissions from natural gas based production is around 0.3 – 0.4 tonne/tonne of MeOH.

Methanol is produced mainly from the reaction of CO and CO_2 with H_2. This involves a 2-steps process - i.e. syngas production and methanol synthesis. Most of the CO_2 is emitted from the syngas production side of the operation. The question arises if the CO_2 is to be captured, what is the potential for the captured CO_2 to be used in the methanol plant? What is the limitation of "on-site CCU"? How could this support the deployment and economics of industrial CCS?

This paper attempts to explore these opportunities by evaluating how much CO_2 could be captured in a methanol plant and at what cost. This exercise should provide the baseline information for future studies in the area of industrial CCS and CCU.

Specifically, this paper aims to present:

- Techno-economic evaluation of deploying CO_2 capture in a mega-methanol plant using NG as feedstock.
- Concepts of "on-site CCU" as a possible route to expand future methanol production capacity and at the same time identify synergies with the deployment of industrial CCS.

The first part of this paper presents the techno-economic evaluation of a mega-methanol plant which include a two-step reforming process (SMR-ATR configuration), methanol synloop and methanol purification unit producing 5000 MTPD of AA grade methanol. The methanol plant with CCS captures the CO_2 from the flue gas of the SMR using amine solvent.

The second part of this paper explores how CCU and CCS could work hand in hand within the environment of the methanol plant. The discussion will evolved around the concept of using CO_2 as feedstock to the methanol plant and identify what could be the challenges when integrating CCU with CCS. One of the objectives of this discussion is to raise awareness and understanding of the limitations of the technology when CCU is considered. In particular, this paper would recommend what could be the next step in developing the concept of CCU and in an industrial CCS setting.

<u>Note:</u>

The discussion presented in this paper will be valid only to the production of methanol from NG or other light hydrocarbon as feedstock.