CO_2 capture from industry and offshore: Opportunities and challenges

Rahul Anantharaman* and Morten Seljeskog
SINTEF Energy Research, Sem Sælands vei 11, Trondheim, Norway

***email: rahul.anantharaman@sintef.no**

Keywords Industrial point sources, End-of-pipe capture, Novel technologies, Process design

Introduction

Carbon Capture and Storage (CCS) is an important part of a carbon-constrained energy scenario to reduce global emissions. Although the power (and heat) sector has been the focus of much research related to CO_2 capture, industries account for one third of world energy use and 40% of worldwide CO_2 emissions (IEA2010). It must be noted that these figures do not include the refining industry. From a Norwegian perspective, the largest sources of CO_2 emissions by sector (in decreasing order of magnitude) are (KILF2010):

- Petroleum (including natural gas) extraction and processing offshore and onshore
- Oil refineries
- Cement industry
- Aluminium industry
- Fertilizer industry

CO_2 capture in large point sources of the most energy (and CO_2 emission) intensive industries could potentially result in considerable CO_2 emission reductions. The IEA CCS Roadmap (IEA2009) envisages 5.5 Gt CO_2 captured from the power sector and 4.5 Gt CO_2 captured from industries in 2050. CO_2 capture from industrial sources is technically challenging as the emissions are, in most case, an inherent part of the manufacture process. Each industry thus presents a different challenge and opportunity for CO_2 capture that needs to be analyzed in detail. Cement, steel and gas processing industries have been the source of attention for cost effective sources of CO_2 capture from large point sources. Despite the ongoing research, no overall general solution exists, which can be applied to other types of industries. Thus, each specific industrial plant requires tailored solutions for the full potential of CCS to be unlocked.

An important aspect of the work in the BIGCCS center involves evaluating CCS as an option for other CO_2 sources than only power plants. This presentation focuses on mapping alternative methods and technologies for reducing emissions from industrial and offshore sources through the definition of specific case studies.

Case studies

The industrial partners in the international consortium of BIGCCS center proposed relevant case studies for evaluation. Four case studies were selected for detailed techno-economic analysis of options for CO_2 capture. The case studies were selected to be of interest both to the industrial partners and in the broader Norwegian perspective.

1. *Offshore CO_2 capture associated with FPSO's (Floating Production Storage and Offloading):* Much of Norway's total CO_2 emissions comes from offshore installations. It is therefore natural to consider the possibility to capture this CO_2.
2. *CO_2 capture from crackers and reformers in oil refineries:* Oil refineries are another large source of CO_2 emissions in Norway as discussed earlier. Among the various sources of emissions in an oil refinery, crackers and reformers contribute to around 35% of the total emissions.
3. *CO_2 capture from Aluminium smelters:* Aluminum is an important industry in Norway and is among the large emitters of CO_2.
4. *CO_2 capture from Natural gas processing plant:* Natural gas treatment and refining are one of the ten largest emitters in Norway.

Methodology

Each of the case studies poses specific challenges. Space, weight and stability constraints (FPSO case study) and presence of impurities and dust (Aluminium plant case study) are examples of the challenges in the case studies that require a novel approach to developing solutions.

This work presents the characterization the CO_2 emissions from these industries and a preliminary qualitative analysis of potential process concepts (CO_2 capture technologies and routes) for each of the case studies. The qualitative analysis incorporates the following considerations: CO_2 partial pressure, the potential effect of impurities in CO_2 stream on separation technology, physical or material limitations, integration possibilities and maturity.

The solutions proposed for the specific challenges involved in each case study are evaluated for their use as a basis for application to other industries.

The qualitative analysis is a requisite first step prior to detail techno-economic analysis that will form part of the work in this project. An important part of the work will be to identify and document critical components, their level of maturity and bottlenecks for "promising" process concepts to realize CO_2 capture for each of the case studies.

References

[IEA, 2009] Technology roadmap – carbon capture and storage. International Energy Agency Publications. Paris, France.

[IEA2010] Energy Technology Perspectives 2010. International Energy Agency Publications. Paris, France.

[KILF2010] Norwegian Climate and Pollution Agency website http://www.klif.no/no/Aktuelt/Nyheter/2010/Mai-2010/Norges-ti-storste-CO2-utslipp/ (In Norwegian)