Technology for a better society

CEMCAP

CO$_2$ capture from cement production

Horizon 2020 project coordinated by SINTEF Energy Research

Duration: May 2015 - October 2018 (3.5 years)

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SINTEF Energy Research
The need for CCS in Cement production

• Cement production constitute ~5% of global anthropogenic CO₂ emissions
• In 2013 approximately 20% of global CO₂ emissions from cement production originated from Europe
• About 60% of the CO₂ emissions originate from the conversion of CaCO₃ to CaO, the rest is from combustion of fossil fuels and electric power generation
• Cement plants typically have a long lifetime (30-50 years or more)

• Consequently:
  • CCS is the only viable measure to significantly reduce CO₂ emissions from the cement industry
  • CO₂ capture must be retrofitted to existing cement plants
Ongoing CCS research projects in the Cement industry

- The **Norcem CCS project** – post-combustion capture (presented by Liv Bjerge in this session)
  - Testing of amines, membranes, solid sorbent, Ca-looping

- The **ECRA CCS project**
  - Reports from phases I-III available on [www.ecra-online.de](http://www.ecra-online.de)
  - Focusing on oxyfuel retrofit in the current phase IV – pilot plant preparation
  - CEMCAP enables testing of three key components before the design of the full oxyfuel pilot plant
CEMCAP – positioned to complement and strengthen the Norcem and ECRA CCS projects

CEMCAP will
- Utilize competence and knowledge from ongoing and concluded CCS projects for power industry
- Complement the Norcem CCS project by testing and evaluating additional post-combustion capture technologies
- Strengthen and advance the ongoing ECRA CCS project for cement industry (component testing for oxyfuel)
CEMCAP Consortium

Cement Producers
CTG (Group Technical Centre of Italcementi) IT
Norcem, NO
HeidelbergCement, DE

Technology Providers
Alstom Carbon Capture (AL-DE), DE
Alstom Power Sweden (AL-SE), SE
IKN, DE
ThyssenKrupp Industrial Solutions, DE

Research Partners
SINTEF Energy Research, NO
ECRA (European Cement Research Academy), DE
TNO, NL
EHTZ, CH
University of Stuttgart, DE
Politecnico di Milano, IT
CSIC, ES
VDZ, DE
Technologies to be tested in CEMCAP, reaching TRL6*

*Technology demonstrated in industrially relevant environment
Technologies to be tested have different characteristics!

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<thead>
<tr>
<th></th>
<th>Oxyfuel capture</th>
<th>Post combustion capture technologies</th>
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<tbody>
<tr>
<td><strong>CO₂ capture principle</strong></td>
<td>Combustion in oxygen (not air) gives a CO₂-rich exhaust. CO₂ is separated through condensation after compression and cooling.</td>
<td>Exhaust passes through a cold NH₃/water mixture, which absorbs CO₂. CO₂ is released as heat is added to the solution in a subsequent vessel.</td>
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<tr>
<td><strong>Required cement plant modifications</strong></td>
<td>Retrofit possible through modification of burner and clinker cooler.</td>
<td>Retrofit appears simple, minor modifications required for heat integration.</td>
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<tr>
<td><strong>Clinker quality</strong></td>
<td>Maintained quality must be confirmed.</td>
<td>Unchanged.</td>
</tr>
<tr>
<td><strong>CO₂ purity and capture rate</strong></td>
<td>CO₂ purification unit (CPU) needed. High capture rate and CO₂ purity possible (trade-off against power consumption).</td>
<td>Very high CO₂ purity, can also capture NOx, SOx. High capture rate possible.</td>
</tr>
<tr>
<td><strong>Energy integration</strong></td>
<td>Fuel demand remains unchanged. Increase in power consumption (vs. integration of waste heat recovery systems).</td>
<td>Auxiliary low-pressure steam boiler required. Can make use of cement plant waste heat. Electricity required for chilling.</td>
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Technologies to be tested - oxyfuel

**Oxyfuel burner**
Existing 500 kWth oxyfuel burner at USTUTT to be modified for CEMCAP

**Calciner test rig**
Existing >50 kWth entrained flow calciner (USTUTT) to be used for oxyfuel calcination tests

**Clinker cooler** To be designed and built for on-site testing at HeidelbergCement Hannover

Partners: USTUTT, TKIS, SINTEF-ER

Partners: USTUTT, VDZ, IKN, CTG

Partners: IKN, HeidelC, IKN, VDZ
Technologies to be tested – post-combustion capture

Chilled Ammonia Process (CAP) (Alstom Power Sweden)
CAP never tested for such high CO₂ concentrations before

Membrane assisted CO₂ liquefaction
Membrane tests: TNO
Liquefaction tests: SINTEF-ER

Ca-looping (USTUTT, CSIC rigs)

Partners: ETHZ, AL-SE, AL-DE

Partners: TNO, SINTEF-ER

Partners: USTUTT, CTG, Polimi, CSIC, IKN
Analytical work

CFD simulations of oxy-combustion
Capture process simulations
Simulations of full cement plants (kilns) with CO₂ capture
Cost estimations on a consistent basis for all investigated technologies + MEA (combine with Norcem public results)
Benchmarking of CO₂ capture from cement plants
Retrofitability analysis
Final deliverable October 2018: Techno-economic decision basis
CEMCAP – aiming to be a visible project with an impact

CEMCAP will deliver strategic conclusions for how to progress CO₂ capture from cement plants from pilot-scale testing to demonstration

Recommendations will be given for different scenarios (i.e. different types of cement plants at different locations in Europe)

Focus is on retrofit – very few new cement plants are foreseen to be built in Europe

CEMCAP progress will be possible to follow for the interested public through blogs, newsletters, website, Facebook, Twitter, conferences and popscience articles
In CEMCAP a pool of CCS expertise is made available to the cement industry.
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Cooperation to prepare the ground for large-scale implementation of CO₂ capture in the European cement industry

- Cement industry commitment to climate protection
- FP6 and FP7 CCS projects for the power sector
- CCS knowledge
To conclude: the CEMCAP objectives

The primary objective of CEMCAP is

*To prepare the ground for large-scale implementation of CO$_2$ capture in the European cement industry*

To achieve this objective, **CEMCAP will**

Leverage to TRL6 for cement plants the oxyfuel capture technology and three fundamentally different post combustion capture technologies, all of them with a targeted capture rate of 90%.

Identify the CO$_2$ capture technologies with the greatest potential to be retrofitted to existing cement plants in a cost- and resource-effective manner, maintaining product quality and environmental compatibility.

Formulate a techno-economic decision-basis for CO$_2$ capture implementation in the cement industry, where the current uncertainty regarding CO$_2$ capture cost is reduced by at least 50%.
Thank you for your attention!

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www.sintef.no/cemcap
Twitter: @CEMCAP_CO2