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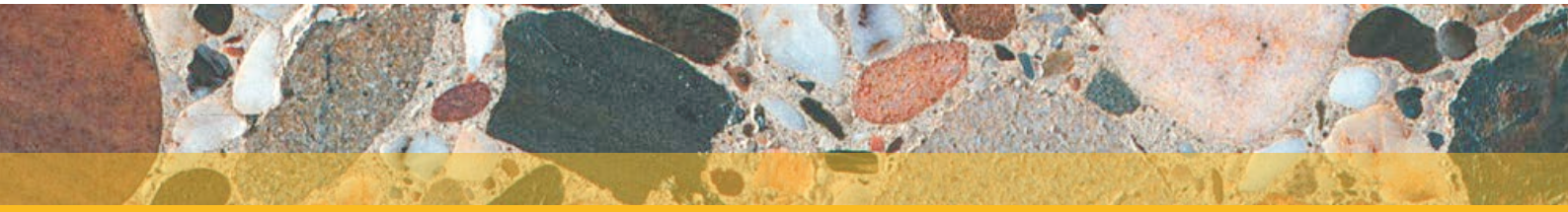
european cement research academy



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# NEWSLETTER

## Contents



## Next ECRA events:

- Emissions Abatement
  1–2 September 2015

# International Norcem/ECRA Conference: Highlights in CCS research

## Current status of different CCS technologies summarised

**ECRA and Norcem have long been cooperating on CCS. In May 2015 they organised their first joint international conference on CCS in Norway. Around 140 participants from the cement industry, the Norwegian Ministry of Petroleum and Energy, research institutes, governmental organisations, NGOs and other process industries participated in this two-day expert meeting. The first results of pilot tests at the Norcem plant in Brevik were presented by the different technology providers, and ECRA highlighted its path towards the construction of an industrial-scale oxyfuel kiln. The conference successfully underlined the progress that the cement industry together with its partners has made in CCS research. It is now important to continue the different projects and maintain the focus on the technical and economic feasibility of carbon capture.**

Tord Lien, the Norwegian Minister of Petroleum and Energy, opened the conference and in his presentation emphasised that Norway will continue on its course towards carbon capture, highlighting the additional focus on storage as a main instrument to substantially reduce $CO_2$. The Minister's main message was that Norway wants to maintain its leading position in CCS. CCS in the industry is regarded as an important tool to reach the country's ambitious goals, which include the realisation of one full-scale CCS demonstration project in Norway by 2020. He described the Norcem project as one of the most promising, and congratulated Norcem on its achievements so far.

### CCS in the cement industry

Daniel Gauthier, the Chairman of ECRA's Technical Advisory Board and a member of the Board of HeidelbergCement, highlighted the cement industry's road towards a low carbon economy, comprising the reduction of the industry's carbon footprint by 32 % compared to the 1990 level by conventional means, as has already been achieved, and the envisaged potential further reduction through new break-through technologies such as CCS. In this context the industry has put a strong focus on $CO_2$ reduction in the downstream use of cement and has also initiated joint research within ECRA on carbon capture.

**From left to right: Daniel Gauthier, Chairman of the ECRA Technical Advisory Board and member of the Board of HeidelbergCement; Liv Bjerge, CCS project manager, Norcem; Gunnar Syvertsen, General Manager HeidelbergCement Northern Europe; Tord Lien, Norwegian Minister of Petroleum and Energy; Per Brevik, Director Alternative Fuels HCNE, Norcem**

The Norcem project consists of four individual technologies which have been tested at the Brevik plant:

- Solid sorbent technology by RTI
- Amine technology by Aker Solutions
- Membrane technologies by a consortium under the lead of the Norwegian University of Science and Technology
- Carbonate looping by Alstom Power

### Post-combustion technologies

Although research is on-going, post-combustion absorption by amines as demonstrated by Aker Solutions is from a technical point of view today the most advanced technology. In this context it was shown that a special approach in the cement industry could take advantage of excess heat from the clinker burning process. The available waste heat could cover the heat demand of an amine scrubber capturing 40-50 % of the total $CO_2$ emissions. In this case no additional energy would be needed for the desorption process, with a corresponding reduction in the specific abatement costs. While the technology is seen to be in principle ready for full-scale demonstration, application to the cement process still requires further investigations, particularly with regard to layout, practical integration and cost estimates.

The results of adsorption using a solid sorbent technology were presented by RTI. The results are very promising and fairly well on track towards the next phase, but are not yet at demonstration scale.

Membrane absorption is definitely in the early phase of R&D. While progress is expected due to new membranes and a new set-up in the subsequent path of the project, it is too early to give any outlook on a potential application in the cement industry.

Alstom presented carbonate looping technology which could achieve 95 % of capture. The set-up might appear more complicated, but the clinker production process with its calcination and its inherent handling of $CaCO_3$ and CaO provides promising potential to further improve this technology in the cement industry. The final gas stream is expected to have a high $CO_2$ content which would

not require dedicated capturing but only gas cleaning and subsequent $CO_2$ processing.

Martin Schneider from ECRA explained ECRA's road towards an oxyfuel kiln at industrial scale. Based on its research so far, ECRA has decided to further continue its work, which is now ready for full scale testing of the oxyfuel process. It has emerged that the best size for such a kiln would be from 500 – 1,000 t/d. This would allow operating the kiln under real conditions and at the same time would limit the operating costs in the test phase. ECRA is currently evaluating potential sites, examining so-called brownfield and blackfield sites. Both sites can take advantage of existing plant infrastructure characteristics such as raw meal and coal. The brownfield scenario would be a new kiln next to an existing one whilst in the blackfield scenario an existing kiln would be retrofitted for oxyfuel combustion. Both options have their particular advantages and disadvantages. An opportunity study as the first step towards a preengineering study was recently finalized which looked at the feasibility of the scenarios and the corresponding investment costs as well as the potential risks in setting up and commissioning the respective kiln. The main question within the whole concept is the use of the kiln after the test phase. This has a tremendous effect on the overall costs and as a consequence also on future funding. ECRA's Technical Advisory Board will evaluate the outcome of the opportunity study and the potential business cases. The progress of the project will then depend on the funding that can be raised to initiate this industrial-scale trial.

The conference in Norway underlined the industry's current state of knowledge and research on CCS. Many speakers – in addition to those mentioned – shared their expertise and knowledge and demonstrated the broad overall scope of the technologies currently being developed by many institutes and universities, technology providers and cement producers.

All presentations held at the conference are available at:
www.norcem.no/no/CCS-conference

# Current developments in emission abatement technologies

## Special challenges spur reduction projects beyond IED requirements

**Achieving sustainable production with low environmental impact is one of the main objectives of the cement industry today. In this respect, the industry has a long track record in lowering its emissions, also taking into account the technical and economic viability of appropriate emission abatement measures. National and European requirements as well as the progress in abatement technologies provide the framework in which new technologies for emission control are being introduced.**

Environmental regulations for industrial production facilities go hand in hand with the installation of efficient emission abatement technologies, especially legislation on air pollution control. Emission limit values for several industrial activities, including cement kilns co-processing alternative fuels, have been set in the European Industrial Emissions Directive (IED). The so-called BAT conclusions under the IED, which were published in March 2013, contain a list of Best Available Techniques (BATs) via which an environmentally compatible cement production and furthermore the associated emission levels (BAT-AELs) can be attained. The BAT documents are reviewed and updated regularly so that technical progress and further developments in abatement technologies can be taken into account.

### $NO_x$ abatement

Although the IED and the BAT conclusions have established a framework for $NO_x$ reduction in the cement industry, there is an enduring discussion about the appropriateness of the potential reduction measures. According to the BAT reference document for the cement industry, secondary abatement measures like SNCR and SCR (Selective Catalytic Reduction) are efficient $NO_x$ abatement technologies for achieving low emission levels. The SNCR process is cost-effective but entails the risk of additional $NH_3$ emissions ($NH_3$ slip) due to an overstoichiometric injection of ammonia solution. This can be of importance because individual countries have set an emission limit value for ammonia. In particular, this is based on the National Emissions Ceiling Directive (NEC Directive), the ammonia limits of which have been exceeded in some countries.

The performance of the SNCR process has been improved more and more during the past years to comply with all environmental requirements. The application of the so-called „high-efficiency SNCR" process (he-SNCR) seems to be a promising approach for minimising the proportion of unreacted ammonia which would lead to lower $NH_3$ emissions and a lower consumption of reducing agents.

The catalytic SCR process, which is state-of-the-art in the power sector, was not investigated in the cement sector until a few years ago. This technology was therefore classified as BAT subject to appropriate catalyst and process developments. In

**Figure 1: SCR facility in a cement works**

**Figure 2: RTO facility in a cement works**

the meantime, experiences from several full-scale SCR projects in Italy, Austria and Germany (Fig. 1) have been gained. These projects included different SCR variants, such as high-dust, semi-dust and tail-end solutions. As a result, certain authorities are of the opinion that SCR is now an available technology to meet challenging $NO_x$ and $NH_3$ abatement targets. It should be pointed out however, that SCR technology is very costly and due to the additional pressure drop the electrical energy demand of the plant increases by about 5 kWh/t of clinker.

## Dust abatement systems

Electrostatic precipitators, fabric filters and also hybrid filters are established technologies which exhibit high dedusting efficiencies to meet the current environmental requirements. A new approach in emission abatement technologies is the combination of dust and $NO_x$ abatement. Ceramic or fabric filter bags containing catalysts for $NO_x$ reduction could be an interesting alternative to SCR facilities. However, this technology is still in a very early stage of development and not yet ready for commercial application.

Another emerging technology is the installation of high-temperature bag filters (HT filters) which can be used, for example, for the dedusting of cooler exit air without cooling it. Afterwards the exit air can be used for different waste heat utilisation options.

## TOC emissions

Basically, the clinker burning process possesses inherent and appropriate conditions to destroy organic compounds which are fed with fuels or raw materials into the hot section of the kiln system. However, organic constituents in the raw material can be evaporated on its way down the preheater, resulting in corresponding emissions. In this context the utilisation of alternative raw materials and the right feeding points are of particular importance.

The BAT for the limitation of TOC emissions is to avoid the feeding of raw materials with high contents of volatile organic compounds into the kiln systems via the raw mill route and to carefully control the input of organic compounds via the raw materials. However, in individual cases further measures have to be applied. An emerging emission abatement technology in the cement sector is the so-called Regenerative Thermal Oxidation (RTO) (Fig. 2), by which the emissions of CO, total organic carbon and odour can be significantly reduced. Furthermore, the integration of a SNCR or SCR facility is possible, which can lead in addition to a reduction in $NO_x$ emissions.

## Mercury reduction

Mercury emissions are the subject of global environmental discussions and binding obligations to further reduce these are being discussed at UN level. European emission limit values can be met by process-integrated measures (e.g. input control or dust shuttling), further measures could be required in specific cases. In this case, alternative measures for mercury abatement would be applied, e.g. the improvement of the efficiency of dust shuttling through the injection of appropriate sorbents into the flue gas stream. As there are only limited operational experiences available – mainly for limiting emission peaks during direct operation – research projects are being carried out in the cement industry aiming at significant mercury abatement.

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