IEAGHG Information Paper; 2014-IP7: Pilot Plant Trial of Oxy-combustion at a Cement Plant

A pilot plant trial to investigate CO_2 capture by oxy-combustion for cement plants has recently been revealed (1). Information about this plant was not available at the time when IEAGHG's most recent report 'Deployment of CCS in the cement industry' (2) was written. This trial has significantly moved forward the technology of oxy-combustion capture at cement plants.

In 2008 IEAGHG published its report 'CO_2 capture in the cement industry' (3) which was one of the first techno-economic assessments of CO_2 capture at cement plants. A new technology option proposed and evaluated in that study was oxy-combustion firing of the pre-calciner. About 80% of the CO_2 produced in a cement plant is produced in the pre-calciner (about 60% of the CO_2 from fuel combustion and 90% of the CO_2 from carbonate mineral decomposition). This technology was shown to have significantly lower costs than post combustion capture using MEA.

In 2009 FLSmidth (a cement plant manufacturer), Lafarge (a cement producer) and Air Liquide (a gas supplier) decided to cooperate and jointly study this pre-calciner oxy-combustion configuration. This project included performing pilot plant trials at the FLSmidth pre-calciner/preheater pilot plant in Dania, Denmark. This plant is capable of processing 2-3 t/h of raw meal feed, which corresponds to capture of approximately 1t/h of CO_2. The project also included evaluation of the feasibility and cost of retrofitting the technology to a commercial cement plant operated by Lafarge in Le Havre, France. This research project is now coming to an end and the main results have recently been made available in an article published in the May 2014 edition of International Cement Review (1).

The trials results enabled researchers to draw the following conclusions:

- It proved possible to obtain stable operation of the pilot plant working in oxy-combustion pre-calciner mode.
- High meal calcination levels were reached (>92%) when the calciner temperature increased around 60-70C compared to air firing mode. The higher temperature is necessary to overcome the effects of the higher CO_2 partial pressure on the reaction $CaCO_3 \leftrightarrow CaO + CO_2$.
- No hotspots or build ups were formed when the calciner operated with appropriate burning configuration.
- XRD analysis of calcined raw meal showed no difference between air and oxy-combustion and no impact on clinkering behaviour.
- The measured CO_2 concentration in the calciner did not exceed 66% volume dry, compared to a target of 85%, due to air in-leakage and other factors related to the small size of the plant.
- Some trials were hindered by poor raw meal flow in the lower part of the preheater thus limiting the time with stabilised operating conditions.
- Results showed that an existing preheater or calciner cement kiln line can be retrofitted to oxy-combustion by implementing a separate line and recycling of preheater exhaust gases with reheating.

The cost of retrofitting oxy-combustion capture at Lafarge's Le Havre plant was estimated to be €62/t CO_2 captured, which could be reduced to €50/t by optimisation. These costs are in line with the cost of €54/t estimated in IEAGHG report 2013/19.

It is reported that “this new technology is now ready to move into the demonstration phase and could be re-activated if needed in future, starting with a one-to-two year full front end engineering and design study but at present there is no viable business model for European cement plants”.

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22/5/2014

References

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2. Deployment of CCS in the cement industry. IEAGHG report 2013/19, December 2013.
3. CO_2 capture in the cement industry. IEAGHG report 2003/3, July 2008.