Making it easier to capture carbon dioxide in the cement industry

December 11 2018

Cement is one of the world's commonest building materials, and its manufacture accounts for seven per cent of our greenhouse gas emissions. We have to do something about this. This photo was taken in Shanghai. Credit: Thinkstock

Cement manufacture accounts for as much as seven percent of global greenhouse gas emissions. A new hybrid technology makes it easier and less expensive to capture and purify CO_2 produced by the industry. And the technology can be retrofitted to existing plant.

Researchers at SINTEF have now upgraded the method used to capture greenhouse gases generated during the cement manufacturing process. The hope is that this technology can be utilised by cement factories and in other industrial processes in coastal areas and along European rivers, because the method is based on the liquefaction of CO_2, allowing it to be transported by ship. It can also be retrofitted to existing plant.

Normally, the flue gases emitted from a cement factory contain about 20 percent CO_2. In order to transport and/or store the CO_2 from these gases, they must first be scrubbed. The current minimum requirement is approx. 95 percent purity. However, this process requires large amounts of heat and is thus energy-demanding.

The team of researchers is now proposing that the sector should utilise a hybrid technology that makes CO_2 capture easier, more energy efficient, and better suited to CO_2 transport by ship.

More than 99 percent pure

"We propose a promising approach using a membrane filter combined with an in-house developed system involving forced concentration of the CO_2 by liquefaction," explains SINTEF researcher David Berstad. "We achieve this by cooling it down under pressure," he says.

The membrane alone concentrates the CO_2gases to approximately 70 percent purity. It is currently standard to employ an additional membrane step to scrub the gas and achieve the necessary purity of 95 percent. However, the research team's method involving CO_2 liquefaction is less energy-demanding, and also results in an even purer gas.

Measurements made by Berstad and his research colleague Stian Trædal during experiments with the new system carried out on a laboratory rig

in Trondheim show levels of purity of at least 99 percent.

"The best results that we have seen are about 99.8 percent, but it is theoretically possible to achieve even higher levels of purity," says Berstad. "The purer the gas the better, because it then requires less capacity to transport and/or store the CO_2 in gas or liquefied form.

Electrical energy "replaces" steam

Another advantage of this process is that, unlike other systems, it uses electrical energy to cool and compress the gas instead of steam to regenerate solvents (chemicals that bind to the CO_2 – ed. note) as is the case using conventional CO_2 capture technologies.

Thus the hybrid CO_2 capture process has no need of steam, which only very few industrial facilities in Norway and Europe have access to without having to construct an additional steam production plant.

Ship transport instead of pipelines

Another important benefit is that the liquefied CO_2 can be transported by ship. This involves making CO_2liquefaction an integral part of the capture process, preparing the $CO_2$for transport by ship, which is the means stipulated in the plans for Norway's full-scale CCS project.

"If CO_2 is not to be transported by ship, but under high pressure in a pipeline, the liquefied CO_2 is pumped to the required pressure at a temperature of minus 50 degrees before later being heated up again," says Berstad.

Multiple lab rig experiments

The CO_2 condensation experiments carried out by the SINTEF

researchers using their laboratory rig were carried out in autumn 2018, resulting in the report "Experimental investigation of CO_2liquefaction for CO_2capture from cement plants."

"During the experiments the lab rig behaved as expected, so now we know that we can be confident that it works and can force the limits of purity even further," says Berstad.

In future, the rig will be made more versatile to enable it to be used for other experiments such as the separation of syngas mixtures, which is relevant in a number of different systems being used for emissions-free hydrogen production.

"We have constructed the rig to be as versatile as possible so that it can meet a number of different experimental needs," says Berstad. "As well as carbon capture and storage applications, we want to use it to find out exactly what level of purity is needed for the liquefaction of CO_2.

Besides, we intend to use it to see how we can efficiently remove and liquefy CO_2 during the production of hydrogen from natural gas," he says.

Provided by SINTEF

Citation: Making it easier to capture carbon dioxide in the cement industry (2018, December 11) retrieved 30 January 2023 from https://phys.org/news/2018-12-easier-capture-carbon-dioxide-cement.html