Recirculating off-gas contributes to carbon capture

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Operators from Elkem Thamshavn are shown tapping liquid silicon from the furnace. Credit: Vegar Andersen

Every ton of silicon produced leads to emissions of around 5 tons of CO?.

Carbon capture offers a possible solution to eliminate this emission, but the CO? concentration in the off-gas from the furnaces is often too low for CO? capture to be cost-effective.

One possible solution to reduce the cost is to increase the CO? concentration by recirculating the off-gas. The silicon manufacturer Elkem has collaborated with NTNU and SINTEF to test this idea in a pilot project.

Ambitions for carbon neutral production

Silicon production is an important industry for Norway. Silicon is used in electronics, solar cells, the polymer silicone and as an alloying element in cast alloys. Silicon is produced using what is called carbothermal reduction of quartz. This process involves relatively large CO? emissions.

Elkem would like attain carbon-neutral metal production and is working on several initiatives to reduce their climate footprint. Energy recovery, increased use of biocarbon materials and improved material yield are all part of this effort.

Finding solutions related to the capture of CO? from the smelters is another challenge that researchers are tackling.

Elkem has conducted an initial carbon capture study supported by the CLIMIT program. The company studied two different capture technologies in collaboration with Aker Carbon Capture and Saipem, respectively. Norsk Energi has contributed to assessing optimal solutions for energy supply and recovery.

Testing known technology in a new field

One of the challenges with carbon capture from smelters is that the CO? concentration in the off-gas is low, typically only a few percent, which makes establishing an integrated carbon capture plant more expensive and technically challenging.

As a possible measure to increase the CO? concentration in the off-gas, Elkem and researchers at NTNU and SINTEF are investigating off-gas recirculating as a possible way to improve the process.

The CO? concentration in the off-gas is increased by replacing some of the fresh air normally supplied to the furnace with recirculated off-gas that is cleaned of dust and cooled.

This is a well-known technology for NO_x reduction in incinerators, but the method has not been tested for silicon melting furnaces.

Pilot experiment a broad collaboration

In order to assess the effects of recirculating CO_2 on the furnace process, a pilot experiment to recirculate the off-gas was carried out in NTNU and SINTEF's pilot laboratories at Gløshaugen in Trondheim.

A unique recirculating plant was built here around an existing 160 kW single-phase smelter. The furnace was set up with a number of instruments and analysis equipment to obtain as much information as possible on the effect of the recirculating experiment and to extract knowledge related to the impact on other products and emissions from the furnace.

The pilot experiment was carried out through a collaboration between Elkem projects Elkem CCS, Elkem Sinoco2 and the two NTNU/SINTEF-led centers FME HighEff and the NTNU Center for Research Based Innovation, SFI Metal Production.

Different recirculating rates were tested and mapped through an 80-hour test run.

Elkem provided skilled operators from Elkem Thamshavn as well as raw materials, and SINTEF and NTNU oversaw control of the furnace and the measurement of off-gases.

Sharply increased CO? concentration

By increasing the proportion of recirculated gas, we achieved CO? concentrations of over 20 percent and also observed lower NO_x production.

A lot of data analysis remains to interpret the results, but the experiments show that gas recirculation has great potential for reducing NO_x emissions and making CO? capture easier for the silicon production process.

The unique infrastructure that has been built up in Trondheim will also prove valuable for future trials and projects with the purpose of contributing to sustainable metal production in Norway and globally.

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