A matter of scale

While significant advances have been made in carbon capture technology for the cement industry, the issues of scale and cost loom large over the sector. A modular approach to the introduction and development of carbon capture systems could well be the solution to tackle both.

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In recent decades we have seen a worldwide construction boom, with an historic rise in economic development and urbanisation in many corners of the world increasing demand for new buildings and infrastructure. This activity has accelerated the need for cement – in the USA, for instance, low interest rates combined with numerous stimulus programmes have fuelled strong demand for cement products over the past 18 months. Even with ongoing supply chain concerns, there is little reason to suspect a long-term shift in this momentum. According to recent analysis, cement demand worldwide is forecast to rise by 2.9 per cent annually up to 2025.

Given that concrete is the second most-used substance in the world after water, it is critical to address its contribution to global carbon emissions. The cement industry contributes around seven per cent of global anthropogenic CO_2 emissions and the International Energy Agency (IEA) states that: "the direct CO_2 intensity of cement production increased 1.8 per cent per year during 2015-2020". However, to reach net zero by 2050, there needs to be a three per cent annual decline in direct CO_2 intensity to 2030, according to the IEA.

The case for carbon capture: meeting the challenges

The chemistry used in cement productionaccounts for up to 60 per cent of cement's carbon emissions, making decarbonisation hard to achieve. Carbon capture technology that can be retrofitted to an existing plant is currently one of the few decarbonisation options commercially available.

Point source carbon capture technology is able to separate and capture the CO_2 that is emitted from cement kilns, making it available for either re-use or storage. This kind of carbon capture is an ideal solution for the cement industry. The concentration of CO_2 in the cement plants' flue gas makes it easier to extract and results in high-purity CO_2 that is ready for conditioning, export and utilisation or storage.

Carbon Clean recently awarded a FEED contract to KBR for a pioneering carbon capture project at CEMEX's Rüdersdorf plant in Germany

You might think there is nothing new about the concept of carbon capture utilisation and storage (CCUS), and to some extent rightfully so. For many years, application of the technology has been a challenge. Historically, the two biggest barriers to widespread deployment in hard-to-abate industries have been cost and space. The conventional building of on-site carbon capture technology at a cement plant required bespoke design, an area approximately the size of a football field and the installation of a tall stack – a scenario that simply was not workable for many cement facilities. Innovation in carbon capture technology was required to make on-site carbon capture feasible.

Reducing the physical footprint and cost of carbon capture

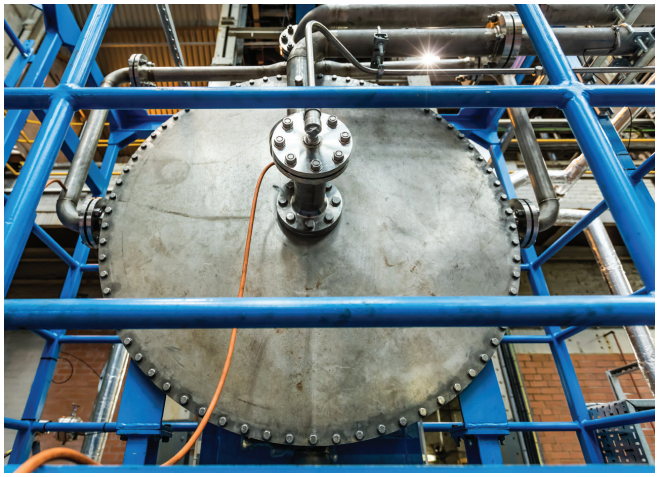
Carbon Clean has been focussed on this challenge for the past decade and is now seeing a huge uptick in demand for its innovative carbon capture technologies which offer cost-effective and practical solutions for decarbonising cement plants.

One of its key innovations, CycloneCC, is specifically designed to reduce the physical footprint required for carbon capture. As the world's smallest industrial carbon capture solution, CycloneCC is poised to revolutionise carbon capture. Prefabricated and skid-mounted to ease installation issues, this technology is up to five times smaller than conventional carbon capture units and can be installed in less than eight weeks. Crucially, CycloneCC will reduce the overall cost of carbon capture by up to 50 per cent.

This innovation is perfectly suited for the cement sector. CycloneCC units are standardised and making their deployment across a company's plants simpler. Given that most plants have common features, it will be possible to mass produce CycloneCC units for installation in many cement plants at the same time to keep pace with a company's decarbonisation ambitions.

Carbon capture systems need to be close to the emissions point source, which in a cement plant is near the smoke stack.

Reducing the footprint and cost of carbon capture technology is key to its successful and widespread application



Cement plants can start with one model and scale up over time, achieving a small on-site footprint and deployment flexibility without sacrificing production.

Case study: ECCO2, Almeria, Spain

Leaders in the cement sector are already embracing this important solution as the industry transitions to the net zero economy. ECCO2 – a joint venture between Holcim-owned LafargeHolcim España, Carbon Clean and Sistemas de Calor – is developing a novel large-scale CCUS project in Almeria, Spain. To deliver Holcim's net zero roadmap and its 2030 science-based targets, the multinational is piloting more than 30 CCUS projects in Europe and North America. The Lighthouse project will see CO_2 captured from the Carboneras cement plant using Carbon Clean's semi-modular CDRMax technology, cleaned and transported locally to be used in the region's greenhouses. Here, it will improve crop productivity through a process known as carbon fertilisation – a good example of a circular carbon economy project that will reduce CO_2 emissions and offer a sustainable future.

The carbon capture plant will be commissioned in 2024, initially capturing 10 per cent of the Carboneras plant's CO_2 emissions. It is expected that this circular carbon economy business model will result in the capture and utilisation of 600,000tpa of CO_2.

Case study: CEMEX, USA

Last year, CEMEX's US operations were awarded a grant from the US Department of Energy to develop a pilot for a breakthrough carbon capture unit. The project, anchored to CEMEX's cement plant in Victorville, California, will work in tandem with Carbon Clean on cost-competitive solutions to completely close the loop on current carbon emissions. Additional partners include RTI International and Oak Ridge National Laboratory.

Meanwhile, Carbon Clean recently awarded a front-end engineering design (FEED) contract to KBR for a ground-breaking carbon capture project at CEMEX's Rüdersdorf plant in Germany. The initial stage of the project aims to develop and deploy CycloneCC to initially capture 100tpd of CO_2 at the plant. The captured CO_2 will be combined with green hydrogen to produce synthetic hydrocarbons that can be used in other industries.

CEMEX is planning to increase the carbon capture by an additional 300tpd by 2026 and ultimately capture up to 2000tpd as part of its strategy to achieve carbon neutrality at the plant by 2030.

Semi-modular systems are also proven, fully-scalable solutions, with around 80 per cent of the carbon capture plant contained and modularised. Compared to an open-plant construction, the benefits of this model include a simple and safe installation, as semi-modular systems are also pre-fabricated and standardised. The reduced project timeline minimises site disruption and swift permitting.

These are just a few examples of how carbon capture provides cement producers with a usable and cost-effective option for reducing carbon emissions.

In addition to CEMEX and LafargeHolcim España, Carbon Clean is also working with Dalmia Cement (India) and Taiheiyo Cement Corp (Japan) where the company has just commissioned a semi-modular plant to capture CO_2 from the flue gas of rotary kilns. Carbon Clean's modular and semi-modular technologies are already demonstrating how carbon capture technology can work for different cement companies, with installation creating minimal operational impact.

Look ahead, act now

The years ahead will be key to accelerating the decarbonisation of the cement industry, particularly as industrial hubs and other clusters achieve economies of scale so multiple facilities can combine efforts to utilise and transport captured carbon. Still, the time to act is now. Starting small and subsequently adding capacity down the road is cost effective. On the other hand, delaying the deployment of carbon capture is almost certainly going to cost companies more.

As the circular carbon economy continues to expand, opportunities for the cement industry to decarbonise are only increasing – both from an economic and environmental standpoint, there has never been more upside.

That is why, by utilising a standardised carbon capture solution and framework, the cement industry can maintain its important role in the ongoing surge of construction development while also contributing to global industrial decarbonisation in a way that it is scalable and cost-effective. ■

LafargeHolcim España's Carboneras plant is the site of a novel large-scale CCUS project by ECCO2