nanocem THE INDUSTRIAL-ACADEMIC NANOSCIENCE RESEARCH NETWORK FOR SUSTAINABLE CEMENT AND CONCRETE

Cement, Concrete & Emissions

The need for research

There are many different ways to reduce CO_2 emissions: switch off the lights when you can, take public transport to work and recycle packaging. Doing all these things can help, but to *really* tackle global emissions, we need to look at practical ways to reduce large emission volumes.

Transport, heating & cooling of buildings and power generation are all obvious choices, but let us not forget cement and concrete. Cement and concrete are low carbon construction materials, but they are produced in very large volumes. Cement production, therefore, accounts for 3 to 8% of global CO_2 emissions and as emerging economies develop, cement use is set to double by 2050. Any reduction will make a substantial difference.

Cement & Emissions

Emissions from cement production come mainly from two sources: energy use and a chemical reaction that happens during the production process.

ENERGY

Energy use represents about 35 to 40% of the emissions related to cement production. Energy is used to produce heat and operate equipment that grinds the raw materials at several stages during the production process.

Over the past decades, the cement industry has steadily reduced its energy use. A modern cement plant will only need about half the energy needed 30 years ago. Continuous improvements are still being made to plants to make them even more energy efficient. Furthermore, cement plants use an increasing proportion of waste, industrial by-products or biomass as fuel sources.

Cement manufacturers and equipment suppliers drive innovation and a continuous improvement in energy efficiency.

DECOMPOSITION OF LIMESTONE

Clinker is an intermediate step in the production of cement. These marble sized lumps are made by heating the raw materials used in cement production (mainly limestone and clay) at high temperatures. During this process, limestone decomposes with emission of CO_2.

$$CaCO_3 + heat = CaO + CO_2$$

A simple formula that is responsible for the majority of the emissions in cement production.

The emissions per tonne of cement vary from plant to plant but are on average around 760 kg of CO_2.

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So what can we do?

The objective is fairly simple. The research is not. Our research focuses on cement at a nano-scale level: fundamental chemistry and physics. We research ways in which we can:

- Reduce or substitute the proportion of limestone in the clinker, i.e. change the formulation of the clinker.
- Mix clinker with other materials (which is already being done at a very large scale in today's cement industry). Less clinker means less decarbonated limestone, and thus reduced emissions.
- Increase the use of waste materials or industrial by-products as a raw material, thus promoting resource efficiency.
- Change the composition of concrete by using less cement without affecting its performance.
- Extend the life of structures by developing concretes that are more resistant to deterioration.

Why is it that hard?

Bags of cement are not used as decorative items. Cement is predominantly mixed with water, sand and gravel to form concrete. Concrete is used to build houses, bridges, roads, hospitals, dams and other things that are supposed to last. Changing the chemical composition of cement affects its properties and its performance. Changing the properties of the cement will have an impact on the concrete it is used in.

One might think, simple: test its strength and you will know. Unfortunately, it's not that easy. As is the case with most materials, time and the environment play a critical role. Concrete is not used in a vacuum, it 'interacts' with air, water and other materials, and this over a period of at least 50 to 100 years.

If we change the chemical composition of cement, we have to make sure that it will perform as well, or better, than what is currently used.

That is what we do. Fundamental research into cement and concrete that will emit less emissions when produced, but will continue to offer the required level of performance, today and fifty years from now.

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