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Can eco-cement green Toronto?

Inventor says his alternative absorbs carbon dioxide, reducing global warming without hurting modern living

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SPECIAL TO THE STAR

LONDON - THERE IS A way to make our city streets as green as the Amazon rain forest. Almost every aspect of the built environment, from bridges to factories to tower blocks and from roads to sea walls, could be turned into structures that soak up carbon dioxide- the main greenhouse gas behind global warming. All we need to do is change the way we make cement.

John Harrison, a technologist from Hobart, Australia, reckons his alternative cement, based on magnesium carbonate rather than calcium carbonate, could reduce climate change without sacrificing modern living. It's a big claim and Harrison has set about trying to convince the building industry to adopt his ideas.

"The Kyoto Protocol was a good effort," says Harrison. "But it got things wrong when it assumed that trees were the only things that could absorb carbon from the air."

Instead, he wants to replace the ubiquitous Portland cement with a substance that he calls "eco-cement." This magnesium-based material, he says, "could be cheaper to manufacture than Portland cement, more durable and soaks up CO{-2} as well." And, claims Harrison, if the building industry listens, cities and their suburbs could turn into CO{-2} sinks as effective as, for example, the natural grass and woodland they replaced.

Our modern world is largely built of Portland cement, invented in the 1820s by a Yorkshire stonemason named Joseph Aspdin. In 1824, he obtained a patent for "an improvement in the modes of producing artificial stone" that involved roasting chalk and clay in a kiln, grinding the resulting "clinker" into a fine power containing mainly calcium silicates and mixing it with water. This starts a complex chemical reaction that forms crystals of calcium silicate hydrate or similar crystals.

Portland cement proved cheap to make and immensely versatile; it soon became the basic ingredient of both concrete and mortar, the building blocks of every city on the planet. Every year, some 1.7 billion tonnes of Portland cement are produced worldwide. But there's a problem.

The manufacture of Portland cement produces massive amounts of CO{-2}. This is partly because of the huge amounts of energy required to raise temperatures inside cement kilns to the 1,450 degrees Celsius needed to roast the calcium carbonate (from chalk or limestone). And it's also because the process of conversion itself creates CO{-2}. For every tonne of Portland cement emerging from the kilns, roughly a tonne of CO{-2} escapes into the atmosphere.

Cement manufacture is responsible for around 7 per cent of total man-made CO{-2} emissions worldwide. That figure rises above 10 per cent in fast-developing countries such as China, which currently manufactures one in every three tonnes of cement made around the world. If we mean to control global warming, this situation can't go on. And, Harrison says, it need not.

His solution, being brought onto the market by his small company **TecEco**, is to replace the calcium carbonate in the kilns with magnesium carbonate- a rock that occurs widely on its own, as the mineral magnesite, or in mixtures with calcium carbonate, such as dolomite. Magnesium-based cements aren't new. They were first developed in 1867, by Frenchman Stanislas Sorel, who made cement from a combination of magnesium oxide and magnesium chloride. However, his mixtures couldn't stand long exposure to water without losing their strength.

Harrison's magnesium carbonate-based "eco-cements," on the other hand, are chemically quite similar to calcium carbonate-based Portland cement and are far more robust than Sorel's material. And, Harrison says, his material has a number of major environmental advantages.

For a start, the kilns don't need to run as hot. Magnesium carbonate converts readily to magnesium oxide at around 650C. This means that emissions of CO{-2} from the energy used to fire kilns are roughly halved. The roasting process for the manufacture of eco-cements produces more CO{-2}. But during setting and hardening, a process called carbonation reabsorbs most of this from the air.

But carbonation is quicker and more efficient in Harrison's eco-cement. Magnesium carbonate crystals are stronger than those of calcium carbonate, so they add to the material's strength. If eco-cement is used to make porous materials like masonry blocks, virtually all the material will eventually carbonate, Harrison says.

"The opportunities to use carbonation processes to sequester carbon from the air are just huge," Harrison says. "It can take conventional cements centuries or even millennia to absorb as much as eco-cements can absorb in just a few months."

This means that eco-cements quietly carbonating in a tower block could be performing much the same atmospheric function as a growing tree. And if eco-cements gained a foothold in our cities, they could immediately reduce the cement industry's contribution to global warming, reabsorbing much of what was emitted in their creation.

By replacing Portland cement with his eco-cement, Harrison estimates that we could eliminate more than one billion tonnes of CO{-2} each year.

The idea is "a world first," says Fred Glasser of the University of Aberdeen's chemistry department, one of the leading authorities on cement technologies.

And eco-cement has another way of proving its greenhouse-friendly status. The material has huge potential for incorporating all sorts of waste matter, including carbon-based organic wastes that would otherwise rot or burn and release CO{-2} into the air.

"Magnesium cements are much less alkaline, and the potential problems are far less," says Glasser, who believes this could be one key to their eventual widespread use.

Organic waste from rice husks to sawdust, plastics and rubbers can all be incorporated as a bulking material in magnesium cement without it losing significant strength, Harrison says, thus turning the cement in buildings, bridges and so on into permanent stores of carbon.

"We have made bricks that are over 90 per cent ash," he says. "We can probably get three to four times more waste into our cement than Portland cement."

This would also massively reduce the amount of cement needed in the first place. His magnesium-based cements may not meet every requirement, he admits. You might not want to replace Portland cement entirely for bridge beams, say. But Harrison says magnesium cements could eventually replace 80 per cent of cement.

This move wouldn't come cheap. Prime sources of magnesium carbonate, such as magnesite and dolomite, cost more to mine than calcium carbonate. But the price should fall with economies of scale, Glasser says.

Harrison has already gone into manufacture. He sold his first eco-cement bricks for a commercial building project in May. But he fears the costs of maintaining his patents could force him out of business before it really gets going.

Industry associations, however, still believe that magnesium-based formulations are unreliable. The main problem, Glasser says, is that "the building materials industry is intensely conservative." It prefers what it knows- Portland cement.

Illustration(s):

TORONTO STAR FILE PHOTO BASIC BUILDING BLOCK: Portland cement, patented in 1824, proved immensely versatile; it soon became the basic ingredient of concrete and mortar, the building blocks of every city on the planet.

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