Concrete Ideas

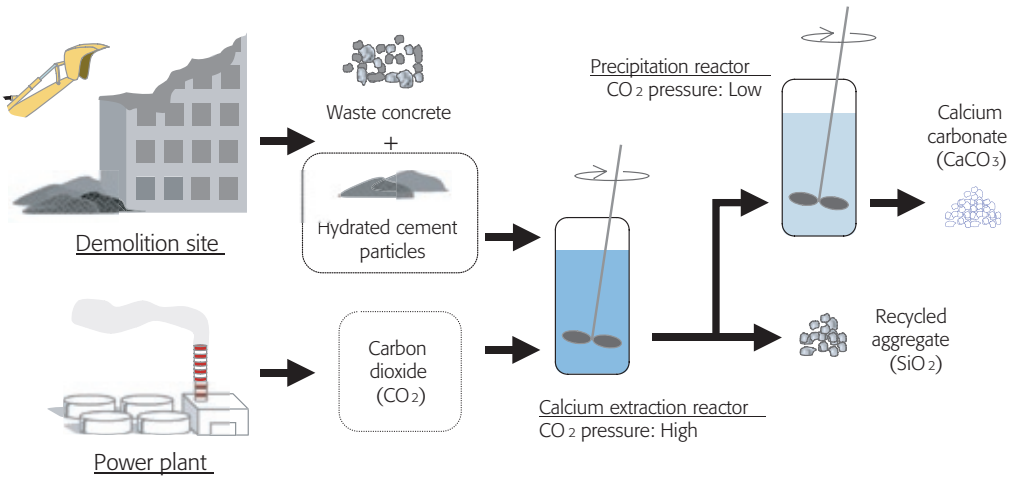
Promising technologies developed by researchers at the University of Tokyo to reduce the burden on the environment imposed by waste concrete are about to enter the trial phase. ***The Japan Journal*** reports.

Concrete is made from cement, aggregates (gravel and crushed stones) and water. It is relatively cheap and offers impressive strength and workability. For this reason, it has been used around the world with all types of structures, including buildings, roads, bridges and dams. Concrete output reaches 10 billion tons worldwide each year, with production of 500 million tons in Japan alone.

However, concrete places a heavy burden on the environment. When the cement that comprises concrete is manufactured, an enormous amount of energy is used and carbon dioxide (CO_2) emitted. The amount of CO_2 emitted during cement production accounts for several percent of CO_2 emissions in Japan. Also, the service life of concrete constructs is said to be fifty to sixty years, and 35 million tons of waste concrete is generated each year in Japan alone. Most of the waste concrete is used as a backfilling material, roadway subgrade material, or in other "one-way" methods.

To reduce the environmental load imposed by concrete, research in Japan is focusing on the reuse of waste concrete. For instance, a group led by Professor Yukio Yanagisawa of the University of Tokyo successfully formed high-purity calcium carbonate ($CaCO_3$) from waste concrete and CO_2.

Waste concrete is crushed when reused as a backfilling material or roadway subgrade material. In the process, cement particles that measure 200 μm or less are generated in addition to large particles that are reused. The cement particles, of which a major component is cement hydrate, are discarded because the strength is too low for reuse as a concrete material. The research group focused on calcium that makes up about 30% of the cement particles, and developed a method called "pressure swing" to form calcium carbonate in a short period of time by allowing calcium to react with CO_2. With this method, the particle is stirred in a stirring vessel filled with water, and CO_2 is infused with a high pressure of about 30 atmospheres to enable the calcium to dissolve in water. Then, the calcium solution is high-pressure filtered and poured into another stirring vessel, where the CO_2 pressure is lowered to 2 atmospheres. Calcium carbonate then settles at the bottom of the solution.



"The process is the same as the natural process whereby calcium dissolves out of rocks by reacting with CO_2 in rainwater, and then travels into rivers and oceans where it forms limestone by a biological reaction," says Yanagisawa. "Since the reaction progresses very slowly in natural settings, we accelerated the reaction using pressure swing."

The purity of calcium carbonate can be more than 99%, and the material can be applied to various products in addition to using it as a cement material. The profit on selling the calcium carbonate produced by processing a ton of waste cement is estimated at about 3,000 yen, corresponding to a profit of about 30,000 yen by converting calcium to calcium carbonate in reaction with a ton of CO_2. Since about 35 million tons of waste concrete is generated in Japan each year, there is the potential to use up about 3.5 million tons of CO_2 each year, assuming all the waste concrete is utilized, because waste concrete contains about 10% calcium.

A bottleneck in the practical application of the technology is the initial investment required in facilities that generate high pressure of 30 atmospheres. The research group hopes that the number of companies that introduce the system will increase as society becomes more environmentally aware. The group has also studied the use of residue left after extracting calcium from cement particles. This residue can be used as fine sand and as a substitute for clay. The group also found the residue has good characteristics as an absorbent of acid materials such as sulfur dioxide.

"Normally, it is costly to recover and discard CO_2, and we pay to have waste concrete and other waste treated," says Yanagisawa. "But using the methods we developed, we can recover CO_2, recycle waste concrete and on top of that generate a profit."

Osamu Sawaji, *The Japan Journal*