Sewage-to-fertilizer solution to be launched in Edmonton

An innovative pollution control process that produces high-quality fertilizer from wastewater treatment systems enters a critical commercialization phase this summer in Edmonton with the first-ever large-scale demonstration of the process.

"Getting Edmonton on board as a launch customer is definitely the most important milestone we've achieved so far," remarked Dr Donald Mavinic, an environmental engineering professor and leader of the pollution control waste management (PCWM) group at the University of British Columbia (UBC).

"We've already worked with other communities in BC (Penticton and Vancouver) to validate the proof-of-concept at a pilot scale. But the Edmonton demonstration project offers us the opportunity to prove the technology can be scaled (by as much as 10-fold) to meet the demands of high-capacity wastewater treatment plants."

There's a lot riding on the project. At least six other cities in Canada and the United States are ready to adopt the solution if the Edmonton demonstration is successful.

UBC's innovative process, recently licensed to a spin-off company known as Ostara Nutrient Recovery Technology Inc, is the culmination of an ongoing, six-year R&D partnership involving the PCWM group, BC Hydro, the City of Penticton, the Greater Vancouver Regional District (GVRD), Ostara, and consulting engineering giant Stantec Inc.

The UBC researchers have secured two grants from the Natural Sciences and Engineering Council (NSERC) under its collaborative R&D (CRD) program, an initiative that promotes technology development partnerships by matching industry contributions to university research projects.

UBC's innovation is based on a high-rate up-flow, fluidized bed reactor, similar to that used in the chemical engineering industry for manufacturing a range of products (see diagram). The wastewater reactor crystallizes magnesium, ammonia and phosphates (MAP) into a compound called struvite, which can be marketed as commercial-grade, slow-release fertilizer.

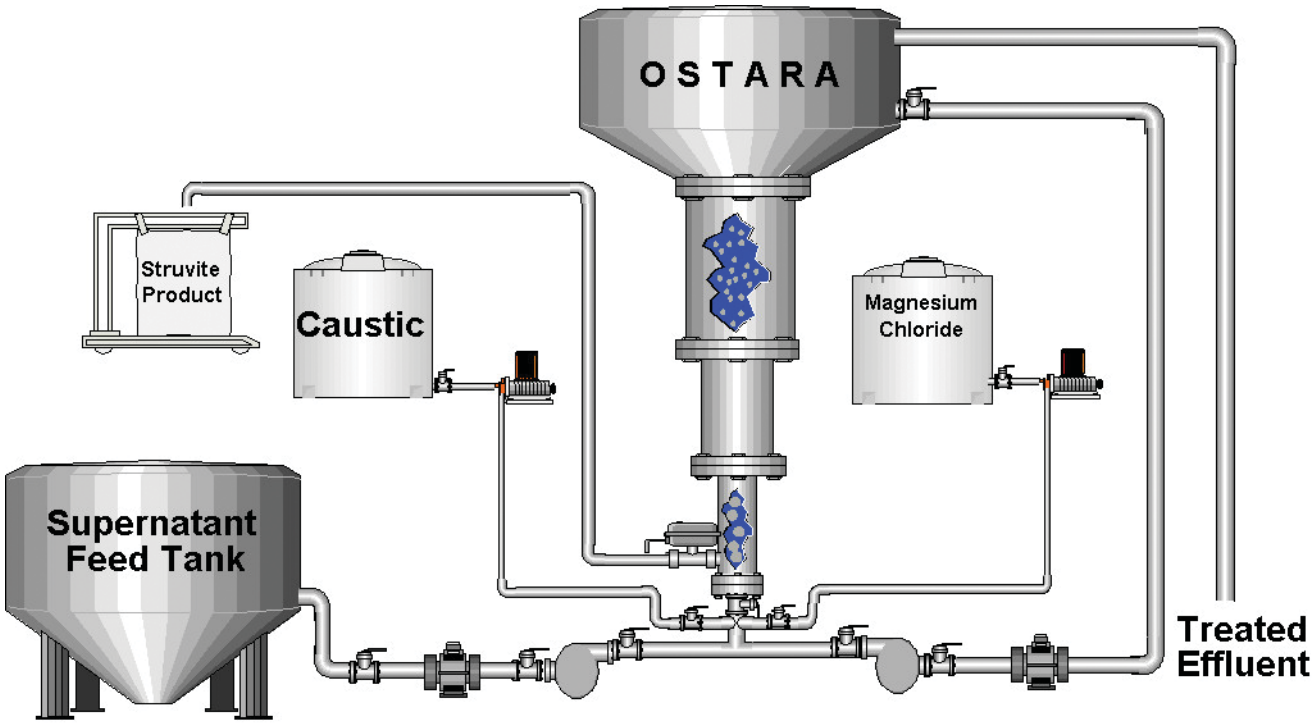
From threat to opportunity

For municipal wastewater treatment, the value proposition of the struvite reactor is four-fold: lower operational and maintenance costs; a cost-effective way of reducing nutrient discharges into receiving waters; a reduction in sludge for disposal; and, a new source of revenue from the fertilizer.

Until recently, struvite has largely been understood as more of a threat than an opportunity. Independent of the UBC-designed reactor, phosphates and ammonia will crystallize in wastewater digestion and post-digestion processes, forming a struvite scale that can clog pipes and foul equipment, particularly heat exchange surfaces.

Sewage treatment plant operators view struvite as a costly operational nuisance. The City of Edmonton alone spends about $100,000 annually eliminating struvite build-up in their process equipment.

Struvite build-up is particularly challenging for municipalities like Edmonton that operate biological nutrient removal (BNR) processes in their wastewater treatment plants, according to Stantec vice-president Bob Dawson. In BNR plants, he noted, the average concentration of phosphorous in the activated sludge is two to three times greater than that found in normal sec-



ondary treatment sludge processes.

Stantec has identified more than 1,000 municipalities in North America and Europe with BNR systems that would be prime candidates for struvite reactors. The total world market is estimated at as much as $3 billion.

Stantec provides BNR expertise

Stantec has been an extremely important partner during the commercialization of the struvite reactor technology. They have extensive experience in nutrient recovery technology, having designed many of the BNR plants in North America. This has proven crucial in identifying and evaluating candidate facilities for this technology.

Although municipalities have been characteristically conservative when it comes to adopting new technology, the market is becoming more receptive to innovative ways of removing and recovering nutrients in the face of ever-tougher environmental guidelines governing nutrient concentrations in wastewater discharges.

In particular, communities in industrialized countries are seeking better ways of reducing discharges of phosphorous (phosphates) and nitrogen (ammonia) because they can over-enrich plant life in receiving waters. Ammonia discharges can also be toxic to organisms within the receiving waters.

With the Ostara reactor, up to 95% of the phosphorous can be removed from highly concentrated sludge that has already passed through BNR and digestion processes. Without the reactor, the sludge supernatant has to be continually re-cycled through the entire wastewater treatment process until the desired reductions in nutrients are achieved.

"We are not just removing nutrients, we're actually recovering them into a high-grade fertilizer," Mavinic emphasized. "It's a great deal for the municipalities because they also get a significant share of the proceeds from fertilizer sales – revenues that immediately offset the cost of installing and operating the struvite reactor."

Designing a better mousetrap

Mavinic's mission to design a struvite reactor began in 1999 when BC Hydro approached his group about investigating wastewater as a possible source of slow-release fertilizer for replenishing its nutrient-depleted reservoirs. The utility provided the UBC team with an initial research grant of $400,000.

UBC researchers studied struvite reactors that had already been developed in Europe and Japan over the previous decade. What they discovered was that those systems fell well short of producing both the quality and size of fertilizer pellets required for slow-release (environmentally friendly) applications.

Ostara's reactor overcomes those limitations through two key differences with competing offshore solutions.

The first involves patented hydraulic mixing regimes, powered by proprietary chemical and sewage injection ports at the bottom of the reactor. The mixing regimes are key to maintaining optimal control of struvite quality and growth.

Additionally, Ostara's solution is the only struvite reactor that self-seeds the growth of crystals. In this nucleation process, the struvite particles fall from the top of the reactor and become seeds for particles percolating up from the bottom.

Competing reactors use bedding materials like sand and dolomite clay as the particle nucleus for seeding struvite

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growth. But this results in undesirable impurities in the final fertilizer pellets.

By combining innovative mixing regimes and self-seeding, the Ostara reactor generates unmatched struvite crystal quality, with purity in excess of 97%. Moreover, the struvite crystals produced by Ostara's reactor are at least three times larger (up to 6 mm in diameter) than those generated by Japanese reactors.

"Others may have invented this mousetrap, but we believe ours is far superior," Mavinic declared. And Mavinic isn't stopping there. His UBC research team is intent on making their mousetrap even better, while exploring new applications for the struvite reactor.

The group recently received a three-year commitment from NSERC to continue reactor scale-up optimization, develop online instrumentation for greater process automation, and investigate ways of reducing production costs. Much of that R&D is being carried out at Vancouver's Lulu Island wastewater treatment facility where as many as nine post-graduate students are collaborating with staff from the Greater Vancouver Regional District and Stantec.

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Animal wastes a bigger prize

Although human waste represents the first target market for the UBC-designed reactor, Mavinic said there's a potentially much larger opportunity in recovering nutrients from animal wastes.

"Agricultural waste management actually dwarfs the municipal wastewater treatment market because animal wastes are much more concentrated in nutrients than human wastes. But it's a terribly under-serviced market in terms of waste management, never mind nutrient recovery."

To address this opportunity, Mavinic has teamed up with Dr Victor Lo of UBC's Department of Civil Engineering, along with Dayton & Knight (D&K), a mid-sized consulting engineering firm specializing in water and wastewater treatment. The partners are backed by an NSERC Strategic Grant, which supports longer-term research further distant from the market than the R&D funded by NSERC's collaborative R&D (CRD) program.

The first off-campus trials of struvite recovery from animal (dairy) wastes began earlier this year at the Agricultural Research Farm in Agassiz, BC. The farm is managed jointly by UBC and Agriculture and Agri-Food Canada.

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