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By **Henry Alamzad, Kason Corporation**

Green solution to waste woes

City of Saskatoon tackles phosphorus problem through Canadian-first nutrient recovery process

Saskatchewan's largest city has turned a problem of excess phosphorus accumulating in its wastewater treatment system into a slow-release, environmentally friendly fertilizer.

Saskatoon's wastewater treatment plant, built in 1971, has expanded several times to serve the city's growing population of more than 300,000, and comply with environmental regulations. In 1991, an enhanced biological phosphorus removal (EBPR) process was installed to reduce phosphorus to meet discharge permit limits for the South Saskatchewan River.

In the EBPR process, microbes known as phosphorus accumulating organisms (PAOs) remove phosphorus from the incoming waste water stream of 85 million litres per day. The resulting biomass is piped 12 kilometres to settling lagoons where it is aerobically digested and dewatered. The resulting biosolids from the lagoons are applied to farmland, and the supernatant liquid is pumped back through a second 12-kilometre pipeline to the wastewater plant inflow.

Although EBPR has many advantages over chemical phosphorus removal, the accumulating sludge was releasing phosphorus back into solution, resulting in greater loads of phosphorus and other nutrients (i.e., ammonia and magnesium) circling back to the main treatment process.

The nutrient overload promoted formation of a precipitate called struvite (magnesium ammonium phosphate hexahydrate) that was coating pipes, valves and other equipment, reducing plant flow capacities and increasing maintenance requirements.

The dewatering screener and classifier dewater separate and classify pure prills from a nutrient recovery process that transforms phosphorus and nitrogen from municipal wastewater into fertilizer.

"Struvite formation was challenging operational reliability and reducing process efficiency in the sludge treatment stream, impacting digesters, dewatering, and associated biosolids infrastructure," says Derek Lycke, director of Ostara Nutrient Recovery Technologies Inc., which was commissioned by the City of Saskatoon to install Canada's first commercial facility that could recover phosphorus and nitrogen, transforming them into more than 725 tonnes per year of a slow-release, environmentally responsible, enhanced efficiency Crystal Green fertilizer.

Like an oyster forms a pearl

The heart of the nutrient recovery process is a fluidized bed reactor into which the nitrogen (i.e. ammonia) and phosphorus-rich sludge water is fed. Magnesium chloride is separately added.

Additional phosphorus and magnesium are fed to the reactor by a waste-activated sludge stripping process that strips both nutrients from the sludge. The stripping produces as much as 40 per cent more phosphorus for recovery, and further controls struvite scale formation throughout the sludge treatment stream.

The reactor removes 90 per cent of phosphorus and 40 per cent of nitrogen from its feed water, and converts them into the high-value fertilizer. Microscopic crystals of struvite (each crystal containing both nitrogen and phosphorus) begin to form in the reactor, like a pearl, and grow until they reach desired particle size of one to 3.5 millimeters in diameter for the fertilizer product. >>

Left: Following the reactor, a single-deck dewatering screener reduces moisture content from the slurry containing phosphorus and nitrogen pellets. The prills are next dried in a horizontal fluid bed dryer. Centre: From the horizontal fluid bed dryer, the classifier separates the phosphorus-nitrogen prills into four fractions, yielding the final Crystal Green® fertilizer product. ***Photos (above and previous page) courtesy Ostara Nutrient Recovery Technologies Inc.***

<< "The result is struvite in the form of extremely pure, crystalline pellets (prills)," says Lycke. "They are batch harvested from the reactor in a slurry consisting of approximately 10 per cent solids by weight at a rate of one to 1.5 kilograms per minute.

Circular screener dewaters pellets

"Following harvest, fertilizer finishing occurs automatically in batch mode. First, the 762-milimetre diameter single-deck dewatering screener. dewaters (separates solids from liquid) the prills to a moisture content of 18 to 20 per cent. The screener also helps spread out and equalize the flow to the horizontal fluid bed dryer.

In operation, an imbalanced-weight gyratory motor imparts multi-plane inertial vibration to the screen deck, causing solid particles to migrate across the 35 mesh (445-milimetre) screen and exit through the upper discharge spout. The liquid flows through the screen apertures, exiting through the lower discharge spout, and returning to the head end of the treatment process. The particles smaller than 35 mesh are captured.

Because the solids tend to agglomerate, a Kleen Screen ring anti-blinding device is fitted atop the screen. The device consists of plastic rings that move continuously by the screener's vibration, across a perforated stainless steel plate having apertures slightly larger than those of the screen beneath.

The motion of the rings across the steel plate shears and scrapes the clumping particles so they can pass through the screen. Because the rings are hollow, they promote product flow over the entire screen surface, maximizing screening efficiency.

The screened and dewatered particles pass to the horizontal fluid bed dryer, which further reduces their moisture content to 0.5 per cent. Using heat, air flow and vibration, the unit separates and fluidizes individual particles to maximize drying.

Separating fertilizer pellets into commercial sizes

Following the fluid bed dryer, the five-deck 813-milimetre diameter classifier separates the prills into four fractions ranging from 3.5 to one milimetre. The top deck has a six mesh (3.5-milimetre aperture) screen. Each deck below has a screen with smaller apertures than the one above it: eight mesh (2.4-milimetre), 14 mesh (1.5-milimetre) and 18 mesh (one-milimetre). Particles smaller than 18 mesh exit the bottom deck's discharge spout.

Each screening deck is fitted with the same anti-blinding rings as the dewatering screener. The classifier separates the pellets based on the same multi-plane inertial vibration principle as the single-deck screener.

Enhanced efficiency fertilizer

Ostara claims Crystal Green fertilizer is the first to provide slow-release of plant-available phosphorus, nitrogen and magnesium in one citrate-soluble product. Releasing these nutrients slowly over 160 to 200 days promotes plant health while reducing the risk of leaching and runoff.

"The result is struvite in the form of extremely pure, crystalline pellets (prills)."

The product is distributed by fertilizer-blending firms and distributors to farmers, superintendents and growers in the agriculture, turf and horticulture markets throughout North America. In general, the small size grades are blended for turf applications such as golf courses, while the larger size grades are blended for specialty and commercial agriculture.

The City of Saskatoon receives a share of the revenue generated from fertilizer sales, which helps offset the costs of the system.

"The process not only helps us to dispose of an otherwise troublesome byproduct, but also creates a new revenue stream for the city," said Saskatoon Mayor Don Atchison.

"It really is a win-win situation."

About the author: Henry Alamzad is president of Kason Corporation and head of global sales and marketing. Previously, he served as Kason's vice-president of sales and marketing, USA. Alamzad holds an MBA degree in marketing from New York Institute of Technology, an MS degree in chemical engineering from City University of New York, and a BS degree in chemical engineering from University of Rhode Island.