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Phosphorus: A Resource in Decline

Resource scarcity is an increasing concern, and phosphorus is one of these declining resources. Phosphorus is present in all living species, is a key component in DNA and cell structures, and is also directly linked to modern agriculture in the form of commercial fertilizer derived from mined phosphate rock. Each year, to the detriment of our environment, more than 100 million tons of phosphate rock are mined and processed into fertilizer. Experts estimate that peak production may occur within the next 40 years.

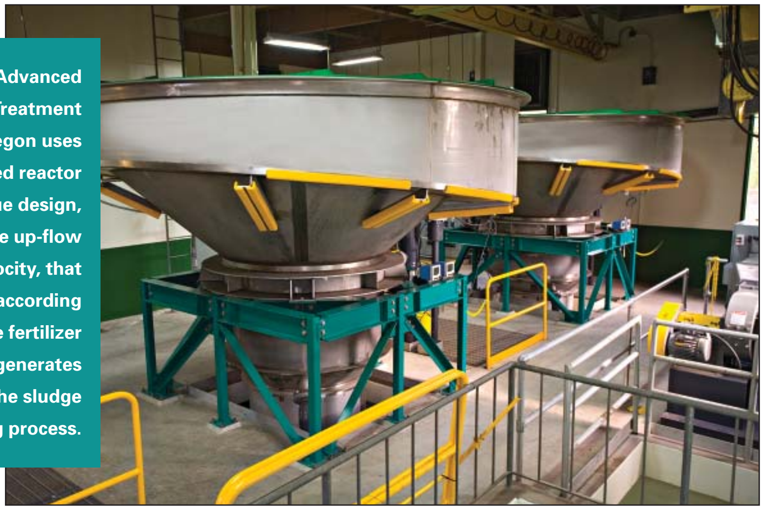
Paradoxically, although phosphorus is essential to sustaining life, it is also a pollutant. Over time, the majority of mined phosphorus enters the ecosystem as waste, leading to excessive nutrient levels in waterways. This overstimulates algae growth, causing eutrophication, killing off natural aquatic species by consuming too much oxygen in the water, and damaging waters for consumption and recreation. The increasing accumulation of nutrients discharged into the environment was cited by the Millennium Ecosystem Assessment in a 2005 report as one of the most significant environmental challenges facing the planet.

PROGRESSIVE PARTNERSHIP YIELDS MULTIPLE BENEFITS

In June 2009, Clean Water Services (CWS), a water resource management utility in Oregon, opened the first commercial facility in the United States to incorporate Pearl® nutrient recovery process technology by Ostara, a Vancouver, B.C., company. CWS serves more than 527,000 residents of urban Washington County west of Portland and treats 64 mgd of wastewater on average. CWS used this new technology at its Durham Advanced Wastewater Treatment Facility (DAWTF) to help meet tight phosphorus discharge regulations (an effluent phosphorus concentration limit of 0.1 mg/L applies during summer months). DAWTF provides wastewater treatment for the cities of Beaverton, Tigard, Sherwood, Tualatin, Durham, King City, and portions of Clackamas and Multnomah counties—all in Oregon—treating a total average flow of 20 mgd. The wastewater treatment plants discharge into the sensitive Tualatin River Watershed, so effective treatment is crucial to ensure its protection and to safeguard the area's economic and environmental vitality.

As is common with biological phosphorus removal facilities, phosphorus and ammonia become heavily concentrated in the sludge handling process, where they can cause the formation of struvite (magnesium ammonium phosphate). Struvite has a consistency similar to concrete and coats pipes and valves, causing blockages. The result is plant inefficiencies, risk of process failure, and costly maintenance. Further, the return of the phosphorus and ammonia to the main treatment plant raises the nutrient load, increasing both capital and operational treatment costs.

Alum dosing is a significant expense at treatment facilities. Before the CWS/Ostara partnership, biological phosphorus removal and aluminum sulfate dosing were chemically combined with phosphorus to remove it from the water discharged to the river. With the Ostara process removing 20% of the phosphorus load to the plant, the biological phosphorus removal process became more stable and efficient, resulting in a 23% reduction in alum use. Although it is not required, the Durham facility maintains the biological phosphorus removal process even during the winter months. Previously, all but a fraction of the phosphorus at the DAWTF facility was trucked out of the plant in the form of biosolids, which are land-applied.



The Durham Advanced Wastewater Treatment Facility in Oregon uses a fluidized bed reactor with a unique design, to create up-flow velocity, that segregates according to size the fertilizer pellets it generates during the sludge dewatering process.

has reduced centrate (concentrated nutrient recycle stream) phosphorus concentration by an average of 85% and ammonia by 15%. However, the ongoing optimization of the process has resulted in recent performance that surpasses the average; for example, in December 2009, the removal levels were 89% and 20%, respectively. Reducing these nutrient loads has eased the pressure on treatment processes in the main plant, making the whole plant more robust and providing increased flexibility in plant operations. This has consequently reduced the costs associated with alum dosing and reduced the amount of chemical sludge generated, decreasing dewatering and disposal costs.

Through the course of one year of operations, 300 tons of struvite have been generated, representing 76,000 pounds of phosphorus and 34,000 pounds of ammonia recovered from the system. The amount of dry tons of biosolids trucked out of the plant was also reduced by approximately 12%.

As a result of the cost savings derived from reduced chemical alum dosing, reduced maintenance costs, improved plant efficiency, and the income generated from Crystal Green, CWS is on course to make the projected five-year payback period. Currently, CWS is in the planning and design phase for a system at the 50% larger Rock Creek Advanced Wastewater Treatment plant.

NUTRIENT RECOVERY PROCESS USES SPECIALIZED REACTORS

The Pearl nutrient recovery process is based on a proprietary fluidized bed reactor in which magnesium is added to sludge dewatering liquor to precipitate struvite under a controlled chemical reaction. The reactor uses both its unique geometry and up-flow velocity to segregate prill (fertilizer pellets) sizes for several application needs. These specialized reactors use a tapered design in which the diameter increases in stages. The larger prills accumulate in the bottom section where up-flow velocity is the greatest because of the smaller diameter of the reactor. The magnesium, ammonia, and phosphorus concentrations are the highest in this zone, resulting in the precipitation of struvite on suspended prills. In the next stage, the velocity is reduced, and medium-sized prills accumulate. These prills have more surface area and longer contact time with the reactor liquids, so they scavenge unreacted magnesium, ammonia, and phosphorus.

In the top section, which is the largest, the velocity is further reduced and fine prills collect. These prills have even greater surface area and detention time to capture residual reactants. The process design is focused on precipitating struvite on existing prills rather than on new particle creation, although some new seed nuclei are created. The process is similar to an oyster making a pearl, adding layer after layer of material on an existing nucleus, resulting in prills, which are extremely pure, monolithic struvite crystals. The prills are retained in the process until they have grown to the desired size and are then removed, dried, classified, bagged, and sold as Crystal Green® fertilizer.

Ostara continuously monitors and evaluates the performance at each of the facilities where its reactors are installed, supported by real-time data and extensive automation, which enables teams to make adjustments directly to the plants' operating parameters, facilitating the optimization of both the treatment process and product manufacturing.

JOINT VENTURE IMPROVES PLANT EFFICIENCY

After completing a successful pilot project for CWS in 2007, Ostara was contracted by the utility to deliver a full-scale commercial facility. The system, which uses three Pearl reactors and can produce 500 tons of Crystal Green per year, was delivered under an "engineer, procure, and construct" contract, in which it provided a full turn-key system and also reengineered an existing building to house it.

Since the facility became operational a year ago, the Pearl process

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