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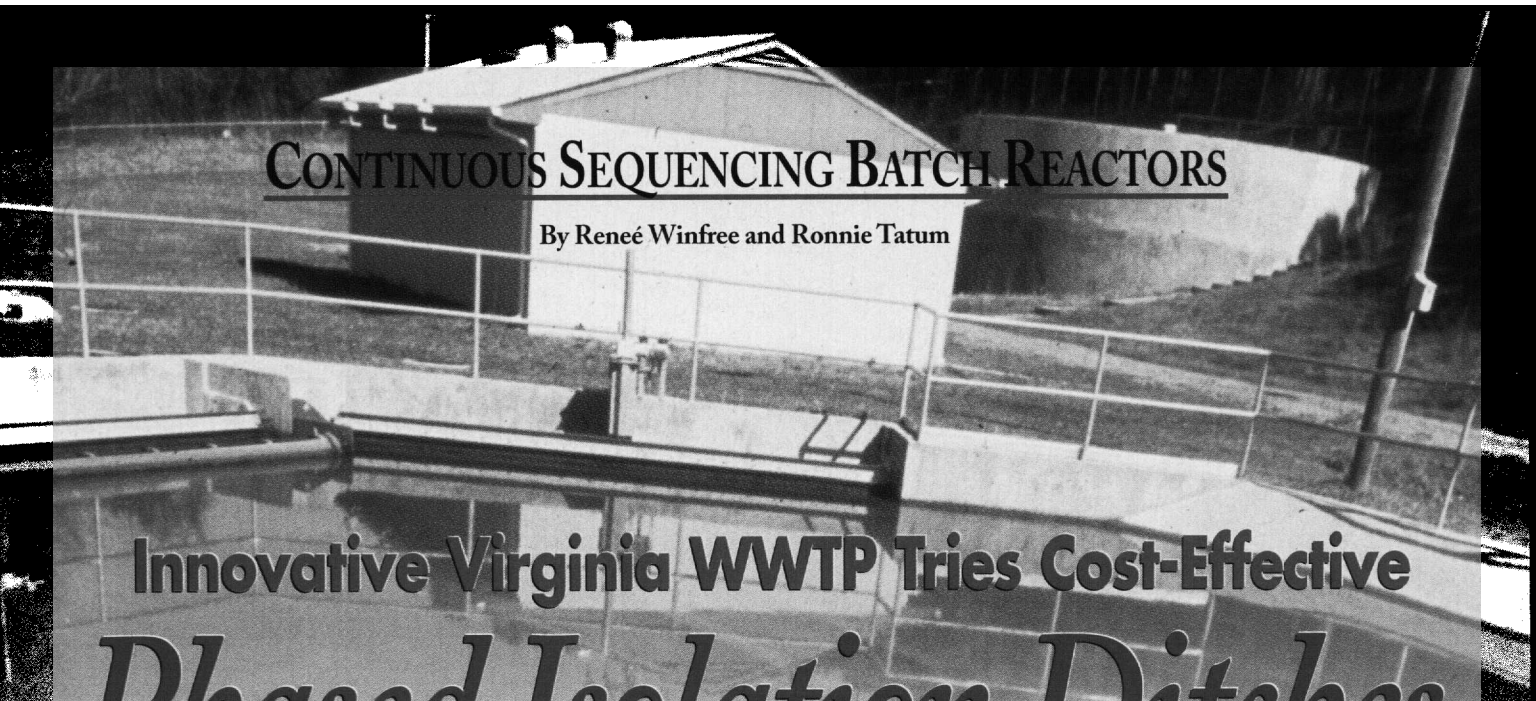


CONTINUOUS SEQUENCING BATCH REACTORS

By Reneé Winfree and Ronnie Tatum

Innovative Virginia WWTP Tries Cost-Effective *Phased Isolation Ditches*

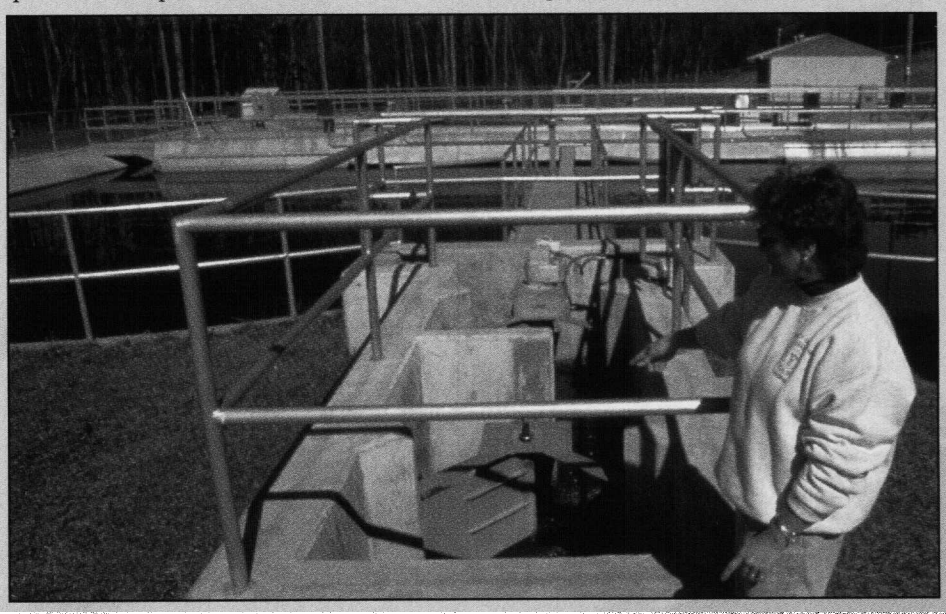
Taking an innovative step forward in wastewater treatment, the Amelia Courthouse Wastewater Treatment Plant (WWTP) in Amelia County, Va., became the first plant in the United States to adopt the continuous sequencing batch reactor (CSBR) process in 1994. This treatment system already had been well established in Europe. After Amelia WWTP replaced its pond and lagoon system with the CSBR process, it consistently has met regulatory limits while significantly increasing plant efficiency. In 1998, the Amelia Sanitary District received the Wastewater System of the Year award for outstanding performance from the Virginia Rural Water Association.

When the State of Virginia began phasing out pond and lagoon systems in 1990, the Amelia Sanitary District planned to build a new plant on the Appomattox River by the year 2010. However, the State worked with Amelia to locate funds for construction, and the plan-to-build project went forward ahead of schedule in 1991. In conjunction with B & B Consultants, Inc., the engineering firm in charge of plant design, the District supervisory board evaluated a number of systems. They selected CSBR technology due to its simplicity and its suitability for the site.

The process is self-contained and produces a fully nitrified effluent low in BOD and suspended solids. The process utilizes phased isolation ditches to alternate between aeration and settling phases, eliminating the need for an external clarifier. Automated dissolved oxygen (DO) control allows the aeration equipment to meet current oxygen demand without excessive run times or over-aeration. The water level remains constant and effluent discharge is continuous from the settling phases of the operation.

Initially, the decision to install phased isolation ditches created controversy. Some residents advocated a totally natural system centered on duckweed or reeds, but these processes were in the experimental stage and the District felt they might be inadequate to handle future growth. Other treatment systems under consideration required valves, pumps and constant manipulation, creating the potential for high maintenance demands.

Following District approval and construction, the Amelia CSBR system went on-line in 1994. The District, located 35 miles west of Richmond, was able to build the new plant on the existing site while



A splitter box diverts influent into the ditch that is aerating, while effluent is discharged from the ditch that is settling.

Background: Settling occurs rapidly in the quiescent phase. Each ditch is equipped with submersible pumps used to waste mixed liquor each day.

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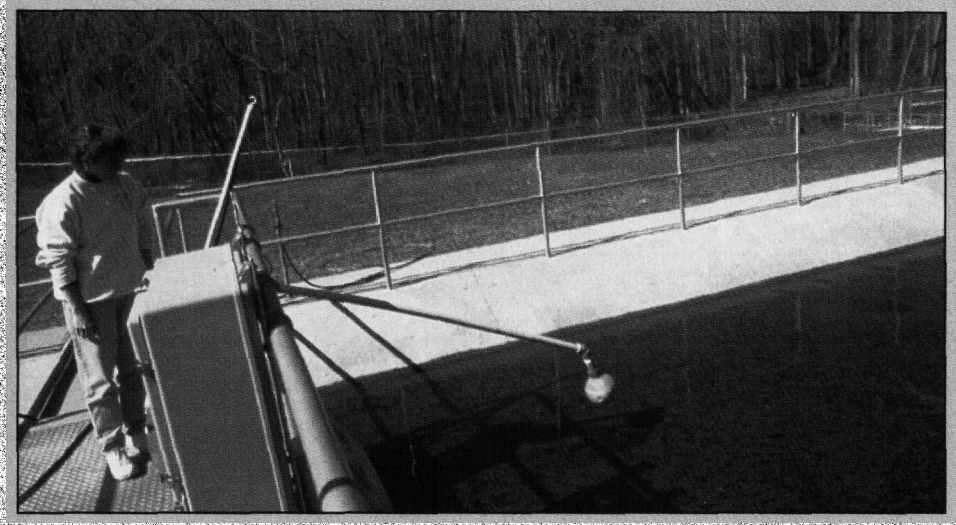

DO probes in each ditch signal the PLC, which automatically adjusts rotor operations to meet DO demand.

still leaving space for a third oxidation ditch to be added.

Phased Operations

The ditches alternate between aeration and settling modes throughout four main phases. After the influent flows through a bar screen and undergoes grit and grease removal, an automatic splitter box diverts influent into the ditch that is aerating, while effluent is discharged from the ditch that is settling.

Intermittent surging discharge and fluctuating water levels do not occur in the Amelia phased isolation ditch system. Continuous flow and a constant water level eliminate the need for flow equalization or oversized downstream processing units such as the disinfection system.

A small port is located in the common wall between ditches at the end opposite of the weirs. The port allows a small stream of mixed liquor to continuously feed into the settling ditch. As the fluid circulates around the ditch, the large surface area allows for rapid settling of solids and eliminates the need for an external clarifier or sludge return pump.

Phases A and C, where one ditch is in aeration mode and the other is settling, mirror each other. Phases B and D are short intervals during which both ditches are quiescent. They also mirror each other. Effluent discharge is continuous through all four phases.

Phase lengths and operating conditions are adjusted easily to accommodate variations in influent flow and character.

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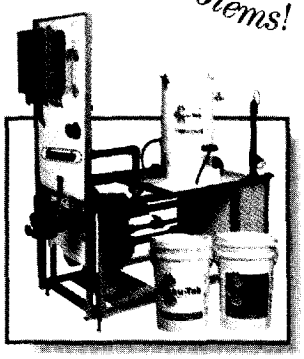

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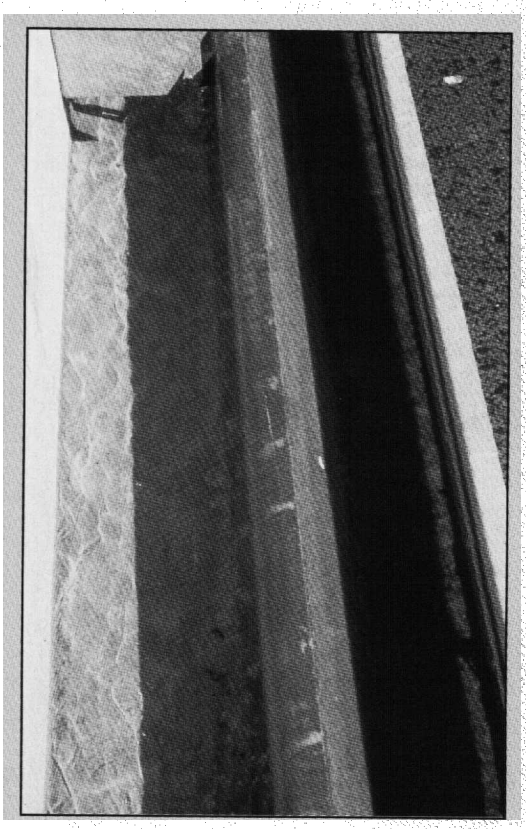


Ditch phases, aeration and weir operations are controlled automatically with a programmable logic controller (PLC), allowing the plant to meet strict effluent quality requirements with minimal energy consumption under all conditions.

Bacteria break down the pollutants during the aeration phase, where the desired DO level is maintained by the PLC. The PLC receives signals from DO probes in each ditch. If the level falls to 1.0 mg/L or below, the PLC automatically turns on the second of two rotors or increases the speed of the rotors if they are both already in operation. This type of DO control system provides energy savings.

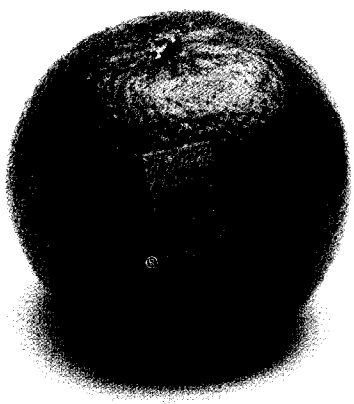
No external clarifiers are required to produce consistently high quality effluent. All settling is accomplished in the ditch itself. The effluent is disinfected with chlorine, then dechlorinated and aerated immediately prior to discharge into Nibbs Creek, which feeds into the Appomattox River. The plant pumps 5,000 gallons of mixed liquor out of each ditch daily, sending it to the aerobic sludge digester.

◀ No external clarifiers or chemicals are required to produce consistantly high effluent quality. All settling is accomplished in the ditch, eliminating the cost of a separate clarifier and sludge return pump.

The system components include a splitter box below the headworks, covered brush aerators for both mixing and aerating and automatically controlled weirs. Once the raw sewage is pumped to the headworks, all flow is directed by gravity through the remainder of the process. Noise, aerosols and winter ice damage are eliminated because the rotors are enclosed beneath a covered walkway. Rotor covers easily are lifted from the walkway for maintenance purposes.

Proven Track Record

After four years of operation, the Amelia Sanitary District is very satisfied with the performance of the phased isolation ditch process. The 0.3 mgd plant operates under differing summer and winter



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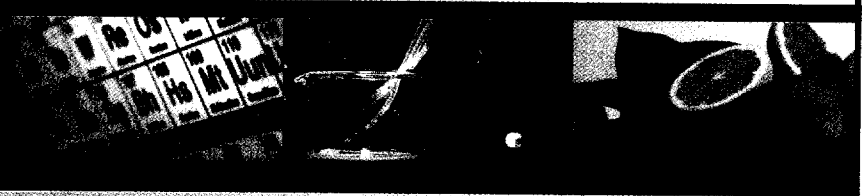

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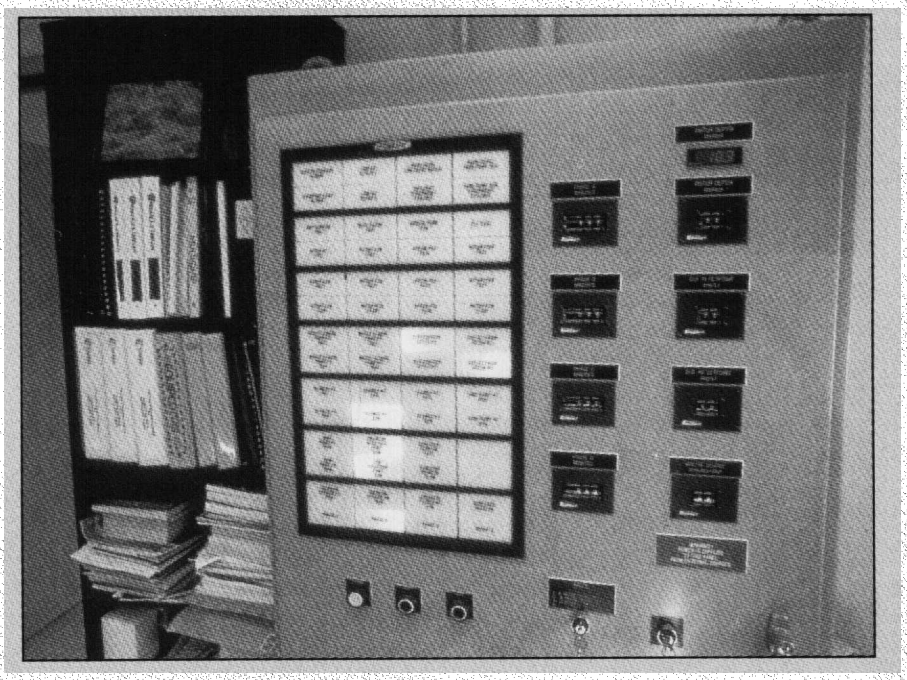

A programmable logic controller (PLC) automatically controls plant operations, including switching phases between ditches, maintaining DO levels and adjusting the weirs. ▶

limits and has had no problem meeting regulatory standards for both. For example, the winter limit for TSS is 45.0 mg/L, and the plant effluent consistently averages less than 5.0 mg/L. The limit for CBOD is 37.5 mg/L, and the plant achieves 4.7 mg/L. From May through November, the ammonia removal limit is 2.3 mg/L. The typical monthly average for the plant is 0.4 mg/L.

No polymer or chemical additions have been necessary at the Amelia facility. At the outset, the plant purchased approximately 10,000 gallons of two percent activated sludge to establish a healthy growth of bacteria necessary for the process. Since then, the plant has had no problem maintaining the appropriate bacterial growth with raw sewage.

In a letter nominating the plant for recognition by the Virginia Rural Water Association, the Department of Environmental Quality project engineer pointed out the facility's achievements. "Since the [Amelia] wastewater treatment facility was issued a Certification to Operate in September 1994, the facility has not once violated the advanced, secondary effluent limitations of its VPDES permit. Additionally, [it] has provided a long term benefit to the rural receiving stream and has reduced the discharge of toxic NH_3-N by approximately 1,131 kg/year."

Energy and Labor Savings

Automated PLC control has proven to be an energy saver. The rotors run for exactly the length of time necessary to maintain the targeted DO level. Careful tracking of runtimes on the aeration equipment shows that the Amelia plant is saving between 40 to 45 percent on energy costs compared to plants where rotors must operate continuously.

The operation does not depend on valves or pumps to distribute wastewater to varying locations for treatment, so there are very few moving parts. Each component and each function is programmed to do exactly what is needed and no more, maximizing the efficiency of the plant. If unusual conditions arise such as heavy storm flows operators can easily switch to specialized preprogrammed operational modes or to manual control.

The efficiency and reliability of the process helps the District optimize plant operations. The amount of time typically devoted to maintenance and repairs is reduced, freeing operators to solve other wastewater treatment problems such as eliminating sources of inflow and infiltration.

By taking the lead in applying new, cost effective technology, the Amelia Sanitary District has become a model for other double ditch wastewater treatment systems in Virginia and the United States. Consistently high effluent quality and low operating costs led to Amelia Sanitary District's commendation by the Virginia Rural Water Association.

About the Authors:
Reneé Winfree has served the Amelia Sanitary District since 1987 and was named Senior Operator in 1994.

Ronnie Tatum, who was part of the construction team that built the phased isolation ditch plant, has been an operator for the District since 1995.

For more information on this subject, circle 861 on the reader service card.

The new plant was constructed on the existing site with enough space remaining to install a third oxidation ditch in the future. ▼

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