APPENDIX C.1
SANITAIRE ICEAS SBR

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Let's Solve Water

Sanitaire ICEAS SBR

THE FULLY AUTOMATED, ADVANCED SBR TECHNOLOGY FOR MUNICIPAL AND INDUSTRIAL WASTEWATER TREATMENT

The proven wastewater treatment process solution that allows continuous inflow of wastewater into all basins

It's time you get to know Sanitaire ICEAS: the enhancement of the conventional SBR. ICEAS is the only proven wastewater treatment solution that allows continuous inflow of wastewater into all basins. The influent flow to the ICEAS basin is not interrupted at all during the settle and decant phases or at any time during the operating cycle.

What does this mean for you?
Simplicity, efficiency and robustness.

Sanitaire ICEAS is a proven process that enhances the standard SBR system performance and delivers substantial costs, operational and maintenance advantages. The ICEAS does not need primary and secondary settlement tanks, like a conventional activated sludge plant, hence significantly reducing the complexity of mechanical equipment, piping and control. The continuous inflow provides equal loading and flow to all basins, thereby simplifying operation and process control while reducing costs. The process enables single basin operation that is particularly useful for maintenance and for taking basins out of operation in low flow conditions.

The continuous flow SBR system
Designed as an ICEAS continuous flow process, the system will deliver reduced capital costs. To begin with, as opposed to conventional SBR, the ICEAS process necessitates only one set of tanks. This means that up to 30% less basin volume is actually required to achieve the same operating performance as a conventional SBR with the same design conditions. Typically the ICEAS requires up to 30% less volume to achieve the same performance than a conventional SBR. This results in savings due to less concrete, reduced excavation and smaller required land area.

The ICEAS process design allows simplified expansion because each basin forms a modular treatment unit. This makes the ICEAS process ideal for growing communities requiring wastewater treatment.

The ICEAS process technology is applicable for both pre-treatment and complete secondary treatment. ICEAS has been applied in the treatment of several types of industrial effluent including: pulp and paper, meat packaging, pharmaceutical, food processing, dairy industry, textile, bottling plants and chemical and agricultural products.

The advantages of the robust, continuous flow ICEAS process
- Minimizes the decant volume requirements
- All peak and diurnal loadings are distributed equally in all tanks simplifying plant operation
- Organic load is available for nutrient removal through the react phase
- Load during settle and decant provides 'substrate gradient' through react phase to select away from filaments
- Improved maintenance operation since you can run a two-tank system with one tank out of operation
- Peak loads evenly spread out over all basins
- Peak influent flows attenuated across all basins, thereby reducing peak effluent flows

They liked the ICEAS so much they bought another one

Doha Wastewater Treatment Works, Qatar. Phase 4

The ICEAS basin

The ICEAS basin is divided into two zones, the pre-react zone and the main react zone. A non-hydrostatic baffle wall with openings at the bottom is constructed to divide the ICEAS basin into the two zones. These openings at the bottom help distribute flows evenly into the main zone. The influent flows continuously into the pre-react zone and is directed down through engineered orifice openings at the bottom of the baffle wall into the main react zone. The pre-react baffle evenly disperses the incoming flow through the sludge and prevents short-circuiting. The volume of the pre-react zone is typically
10 to 15 percent of the total basin volume.

The ICEAS hydraulics

Time based cycles are used in sizing the ICEAS process. A normal cycle is designed to handle the Average Dry Weather Flow (ADWF) and Peak Dry Weather Flow (PDWF) to the plant. A storm cycle is used to handle the storm flows. The storm cycle operates with a shorter duration compared to the normal cycle so that higher flows can be processed by the system. Typically, the ICEAS process can be designed to handle 3 to 6 times the average flow conditions, while maintaining the same hours of aeration per day in all cycles.

Basin layers

Three stratified layers are formed in each basin at the end of the settle phase and beginning of the decant phase. The sludge blanket forms on the bottom of the basin
as the mixed liquor suspended solids (MLSS) settle. A buffer zone of one meter acts to buffer the sludge blanket from the volume that will be removed during the decant phase. The top layer of clear treated liquid is drawdown after the MLSS settles.

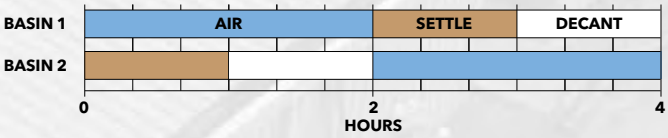
The advantage of the buffer zone is that it provides improved final effluent solids performance even in high flow operation, and at the end of the decant cycle.

Control features that enable more flow processing

ICEAS incorporates two or more hydraulic cycle control features that allow you to operate the system in two basic process modes: Nitrification (NIT) and Denitrification (NDNP).

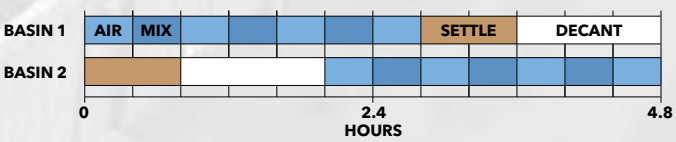
NIT Cycle

The simple cycle provides half the cycle for aeration and treatment of the sewage and a total of 2 hours for settle and decant. The cycles are staggered so one blower can provide air to a pair of basins while ensuring that only one basin is aerated at any time.



NDNP Cycle

If nutrient removal is required the cycle time is extended to provide time for anoxic periods to allow denitrification and Bio P removal. The continual feed provides BOD at all times to provide good denitrification rates at all points in the cycles and optimize nitrogen removal.



Today there are over 900 ICEAS installed all over the world

A time based control system for simple operation
Influent is received continuously during all phases of the cycle, including settle and decant. This allows the ICEAS process to be controlled on a time, rather than flow basis and ensures equal loading and flow to all basins at all timers. Use of a time-based control system in the ICEAS process facilitates simple changes to the process control program, and makes it easier to control the process.

In a flow-based conventional SBR, cycle times and individual segments of each cycle may be different among basins due to diurnal flow variations. Thus, it may not be possible to simply affect a change to the entire system. In essence, separate control must be maintained over each basin in the SBR system.

Robust driven decanter design
High quality workmanship and advanced engineering provide a long-lasting decanter. The decanter itself is built to be highly resilient and features a rugged stainless steel construction.
- A proprietary scum exclusion float prevents the carryover of floating material with the treated effluent
- Flow over the decanter weir is visible providing a check of effluent quality
- VFD actuator provide a constant effluent discharge rate to downstream facilities

Reduced operating cost
- No return sludge (RAS) pumping requirements
- Proven control system for optimizing energy usage
- Highly efficient Sanitaire Fine Bubble Aeration minimizes energy used for aeration
- No supplemental mechanical mixing required for aeration system

Reduced maintenance cost
- No influent or effluent control valves
- Continuous flow enables shut down of one basin to facilitate maintenance of equipment when required
- Retrievable aeration facilities not required
- Decanter actuator is easy to service from walkway

Continuous flow delivers Biological Nutrient Removal (BNR)
- The ICEAS process can be designed for enhanced nitrogen and phosphorus removal
- Alternating periods of 'air on' and 'air off' during the react phase can produce aerobic/anoxic/anaerobic conditions to promote nitrification / de-nitrification and enhanced biological phosphorus removal
- New and existing plants can be designed to accommodate future BNR effluent requirements

The ICEAS process is a fully automated and simple to operate biological treatment system that has multiple advantages over conventional activated sludge and SBRs

- Designed to handle flows from 100 m^3/day to 300,000 m^3/day
- High quality effluent (10/10/5/1 mg/l of BOD/TSS/TN/TP average)
- Smaller basin size and less equipment needed than conventional SBRs
- Eliminates primary and secondary clarifiers and return sludge pumps
- Reduced operating costs, since no mixers or pumps necessary for oxygen transfer or sludge recirculation

Simple civil construction
- The ICEAS does not require primary tanks or settlement tanks. All treatment is done ina single basin
- Construction is simple with a single set up structures and common wall construction, reducing construction cost and time
- Flexible basin configuration means rectangular or circular tanks can be used
- Significantly reduced foot print over conventional activated sludge

Pre-react zone process

The pre-react zone acts as a selector with high F:M to promote proper settling. It effectively disperses flow across the width of the tank with no disturbance of blanket during settle and decant. Short circuiting does not occur throughout the process.
- PRZ has usually a 3-hour retention time for a 2-hour settle and decant period
- Flow from the PRZ hydraulically displaces treated effluent in the main aeration zone

Continuous inflow design
- Operates as a time-based control system for continuous inflow of wastewater
- Provides equal loading and flow to all basins, simplifying operation and process control
- Can be designed to accommodate up to six times average daily flow
- PLC based control and SCADA software can provide remote monitoring capabilities
- Capable of single basin operations

Energy efficient aeration systems
- Sanitaire diffusers provide high oxygen transfer efficiency
- Sanitaire Fine Bubble Membrane aeration systems are engineered for durability in domestic and industrial applications and require minimal maintenance
- Patented design of piping system accommodates thermal expansion and contraction
- Sanitaire aeration systems are one of the most energy efficient methods
- Aeration efficiencies of 4-6 kg O2/ kWh possible including guarantees

Rugged decanter design
- Rugged, corrosion resistant stainless steel construction
- Decants from the top down visibly withdrawing only the uppermost clear water from the basin
- Variable frequency driven actuator provides control flexibility to change decant times and accommodate high flows
- Actuator drive mounted outside of the basin at walkway level for easy maintenance and access
- Parked above top water level during react and settle phases serving as an emergency overflow device in cases of extreme storm conditions or power failure

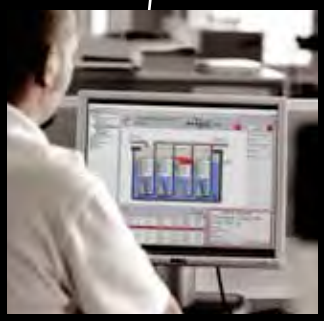
Blowers
Years of experience allow us to provide the correct blower type like centrifugal, rotary lobe, screw rotor etc. to match your operational aeration requirements

Aeration
Sanitaire Silver Series II is the most widely used fine bubble diffused aeration system available today, with millions installed worldwide

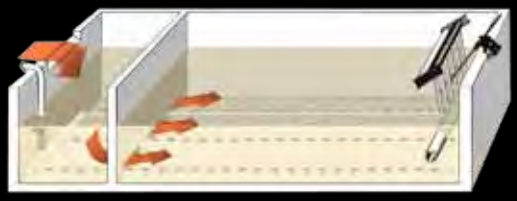
Mixers
Flygt compact mixers provide clog free, efficient hydraulics and reliable operation

Pumps
The Flygt proven submersible N-Pumps have been engineered to give highly efficient, reliable and trouble-free pumping over long duty periods

Decanters
The easy access to Sanitaire decanters makes maintenance straightforward. The resilient construction provides lifelong reliable operation



Control systems
The ICEAS control system makes it easy for the operator to understand and make cycle changes to optimise the plant performance

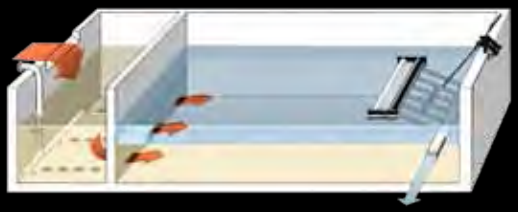


React

During the react phase, raw wastewater flows into the pre-react zone continuously to react with the mixed liquor suspended solids. The basin contents are aerated to remove pollutants, but depending on the process scheme, may also be anoxically mixed, allowed to react anaerobically, or a combination thereof. As the basin continues to fill, biological oxidation/reduction reactions take place simultaneously to treat the wastewater

Settle

During the settle phase, basin agitation from the react phase (i.e. aeration or mixing) is stopped to allow the solids to settle to the bottom of the basin. Raw wastewater continues to flow into the pre-react zone as the main-react zone settles. As the solids settle, a clear layer of water will remain on top of the basin



Decant

During the decant phase, the decanter rotates downward to draw off the clarified supernatant and discharge it to the effluent line. The decanter removes the top water and always reaches bottom water level at the end of the decant phase allowing maximum settlement time for optimal performance. Raw wastewater continues to flow into the pre-react zone displacing the treated effluent in the main-react zone over the decanter. Sludge is typically wasted from the basin during this phase in the cycle

Sterling Wastewater Treatment Works, UK

Scottish Water were required to upgrade the Sterling Wastewater Treatment Plant to improve the quality of the effluent in line with the European Urban Wastewater Treatment Directive (UWwTD). The upgrade included the removal of ammonia from the effluent that the existing treatment works was not able to achieve. The land owned by Scottish Water was not large enough to accommodate a traditional treatment plant and would mean the purchase of additional land and associated additional costs and potential delays to the project.

Sanitaire recommended to Scottish Water the ICEAS SBR. The ICEAS is a continuous flow SBR that treats the sewage to the required effluent in a single tank and therefore does not require separate settlement tanks. This feature significantly reduces the footprint of the plant, to such an extent that the ICEAS would fit on the existing site.

In working together with the main contractor, Sanitaire were able to construct the works on time, while still ensuring the continued operations of the existing works. The new ICEAS treated the same flow as the existing plant while occupying a significantly reduced area.

Jefferson City Regional Water Reclamation Facility, USA

"The plant has operated at a high level since it was built with very little labor needed to operate and maintain the plant. The service we receive from Xylem is second to no one. I have been in the wastewater business for 32 years and have never worked with a group of people that care more about their customers. You never get put off or "forgotten" when you call and ask for help. The answers they give are quick and accurate. I would highly recommend this type of plant and this company to anyone."

David F. Erwin, Plant Manager

By 1998 the existing facilities at Jefferson City Wastewater Treatment Plant were no longer effective in treating the increased flows from system growth, and City officials decided to upgrade the facility to meet current and future discharge standards and wet weather flows. In addition the city wanted to eliminate unpleasant odors that had become a concern over the years. The new treatment plant would serve 18,200 active customers and a daytime population exceeding 50,000. After evaluating several treatment options, SBR was chosen as the most effective system for treating wastewater to meet the City's objectives. The flexibility involved with process control of the ICEAS would allow increased reduction in BOD and total suspended solids (TSS), nutrient removal (nitrogen & phosphorus) and controlling high flow problems.

A conventional activated sludge plant would not fit within the existing centralized site's space constraints, and would increase project costs. The ICEAS technology saved about 30 percent in project costs and also offers an ongoing reduction in operations and maintenance expenses.

Xylem [ˈzīləm]

1) The tissue in plants that brings water upward from the roots
2) A leading global water technology company

We're 12,000 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to xyleminc.com.

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