Case study

Do more with less: OSCAR System with NURO controller improves treatment capacity at reduced cost

Results from Hammarby Sjöstadsverk, Sweden

Wastewater treatment plants (WWTP) face many challenges. To protect surface waters from eutrophication, the permits on nitrogen and phosphorus in the effluent water are progressively becoming stricter. At the same time, plants are required to reduce the consumption of energy and chemicals and are often challenged with limited time and staff. In total, they are required to do more with less.

To meet these challenges, an advanced process control system was implemeneted in a Sequencing Batch Reactor (SBR) pilot plant in Hammarby Sjöstadsverk, Sweden. By controlling the process in a smarter way, the solution resulted in improved total nitrogen and phosphorus removal while reducing energy and chemical consumption and wear on the blower.

Plant data

The study was conducted at a pilot plant with a continuous feed ICEAS advanced SBR situated at Hammarby Sjöstadsverk (Nacka, Sweden). The plant was operated for ammonia (NH_4) and phosphorus (TP) removal with a treatment cycle consisting of anaerobic followed by aerobic conditions. No designed anoxic treatment cycles were included.

During the study, the influent and effluent streams to the SBR were monitored with 24 hour composite samples analyzed for organic material, nutrients and suspended solids. Online sensors of NH_4, nitrate (NO_3), total suspended solids (TSS), orthophosphate (PO_4) and dissolved oxygen (DO) concentration was placed in the SBR basin. In addition, the solids retention time (SRT) and mixed liquor suspended solids (MLSS) of the process as well as the energy consumed by the blowers was monitored.

The plant was designed for a minimum temperature of 10°C while the operating temperature during the study was 22°C. To compensate for this the SBR was fed a load three times

TEST PLANT: Hammarby Sjöstadsverk, Sweden
PROCESS: Sanitaire ICEAS (continuous feed SBR)
DESIGN FLOW: 4500 GPD / 17 m^3/day
TEST: September - October 2016

INFLUENT LOAD

		Design	Actual
Flow	Gpd	4500	7700
	m^3/day	*17*	*29*
BOD	kg/day	3.3	9.4
TN	kg/day	0.8	1.7
Temp	C	10	22

DESIGN EFFLUENT PERMITS

NH4	mg/l	1
BOD	mg/l	10
TP	mg/l	1

greater the original design, resulting in the proess operating at close to maximum capacity.

Nutrient removal control system

The ICEAS system was upgraded with an OSCAR process performance optimizer control system with NURO controller. With a combination of online sensor measurements and process knowledge, this nutrient removal controller continuously adapts the process conditions in the basin to current requirement to meet an operator selected desired effluent ammonia concentration while optimizing total nitrogen and phosphorus treatment.

Result: Improved treatment capacity

The NURO controller adjusted aeration of the process to the current requirement. By automatically detecting lower loaded cycles and avoiding over-aeration, the controller allowed time for anoxic treatment, which provided significant denitrification while still ensuring that the effluent ammonia concentration was maintained stably below the desired setpoint. With the NURO controller, effluent NO_3 of 3.9 mg/L and TN of 6.3 mg/l was achieved, despite the treatment cycle not being designed for total nitrogen removal .

The improved denitrification combined with the continuous carbon source enabled anaerobic treatment and biological phosphorus removal. By using the whole treatment cycle and enabling anaerobic phosphorus release during both react and settling phase, the nutrient controller reduced the influent TP of 7.4 mg/L to an effluent consistently below 1 mg/L without any chemicals required. Before NURO was implemented, effluent TP from the SBR was on average 2.0 mg/L.

Result: Operational cost savings

Continued aeration during underloaded cycles wastes energy and also causes unstable control and wear on the blowers. By automatically detecting these low loaded conditions, the NURO controller reduced energy consumption by 12% and the number of blower starts by 45%, despite operating at close to maximum load capacity. The improved biological phosphorus removal, reaching effluent TP stably below 1 mg/l, offered additional savings by eliminating chemical consumption and reduced sludge production from chemical addition.

Conclusions

By upgrading the ICEAS system with an OSCAR system with NURO controller, operation was optimized to improve treatment capacity while reducing operational cost. Despite being designed without anoxic treatment, the ICEAS system reached effluent TN of 6.3 mg/l and effluent TP of 0.7 mg/l while at the same time reducing energy consumption and blower wear.

EFFLUENT CONCENTRATIONS WITH NURO CONTROLLER

BOD	mg/L	7.4
NH_4	mg/L	0.2
NO_3	mg/L	3.9
TN	mg/L	6.3
TP	mg/L	0.7
PO_4	mg/L	0.3

ICEAS SYSTEM OPERATION: EXAMPLE LOW LOADED TREATMENT CYCLE