MOVING TOWARDS SMART WWTP'S THROUGH ADVANCED AERATION CONTROL

C Herman, Allwater, Adelaide, South Australia
C Roche, Suez,Paris, France
S Lamble, Allwater, Adelaide, South Australia
I Dayman, Allwater, Adelaide, South Australia
J Dreyfus, Allwater, Adelaide, South Australia
N Dinesh, SA Water, Adelaide, South Australia
N Swain, SA Water, Adelaide, South Australia

ABSTRACT

Christies Beach Wastewater Treatment Plant (CBWWTP) in Adelaide (South Australia) consumes a large amount of energy to produce water suitable for reuse applications, as well as ensuring that any discharge to Gulf St Vincent meets the quality requirements for the sensitive receiving environment. Operator-driven optimisation of the treatment process and energy usage over the past five years has resulted in substantial improvements. However, to achieve the next step change in enhancements and take CBWWTP towards a 'Smart Plant', a new approach was needed. The Advanced Aeration Control (AAC) approach was selected to be trialled (using the innovative Suez algorithm Greenbass™ Plug Flow and HACH AMTAX Ammonia Analysers) as it aims to automatically and accurately match aeration needs in the activated sludge process with real-time ammonia load measurements. The automatic predictive control avoids over-aeration during low flows and under-aeration during peak flows and high Ammonia load events leading to improved energy efficiency and nutrient removal. The 18-month trial has demonstrated that 16% (143 kWh/day) energy savings can be achieved in addition to carbon dosing (ethanol) savings of 20 to 40% (25 to 45 L pure ethanol/day). The AAC trial proved to be successful through the robustness of the instrumentation selected, the reliability of Greenbass™ Plug Flow algorithm, the thoroughness of on-site integration within existing control systems, and the gradual commissioning and adjustments of the algorithm's set-points and coefficients. The outcomes of the trial are being used to help inform implementation at other WWTPs. This paper provides details of all aspects of the AAC trial at CBWWTP.

KEYWORDS

Advanced aeration control, energy savings, Smart Wastewater Treatment Plants

PRESENTER PROFILE

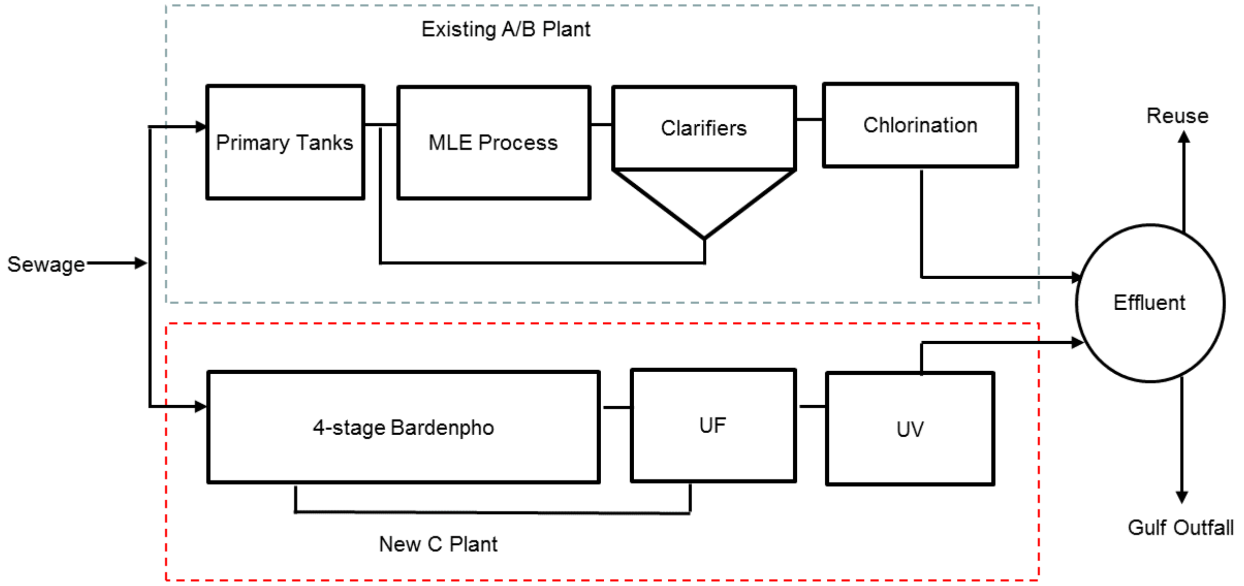
Jennifer Dreyfus is an engineer with a broad range of experience in wastewater treatment from being a site engineer at Glenelg WWTP, plant supervisor at Bolivar WWTP and process optimisation engineer across all plants. Her focus has been to optimise plant operations to improve nutrient removal and onsite energy production.

1 INTRODUCTION

Christies Beach Wastewater Treatment Plant (CBWWTP), owned by SA Water and operated by Allwater, has a design capacity of 225,000 person equivalents (PE), or 45 ML/d. Discharging treated effluent into Gulf St Vincent, CBWWTP is subject to stringent targets in term of nutrients released to the environment. Allwater's alliance partner, SA Water, has long term strategic goals to reduce the discharge of nitrogen to the ocean for environmental protection purposes.

CBWWTP has under-gone substantial upgrade works and subsequent operational optimisation in recent years to improve effluent quality. The plant currently includes a Modified Ludzack-Ettinger (MLE) plant which operates in parallel with a 4-stage Bardenpho equipped with membrane bio-reactors (MBR) (Figure 1).

Figure 1: Christies Beach WWTP Schematic



A/B plant is an MLE process composed of 2 reactors, and it receives an influent sewage flow of approximately 15 ML/d, which represents about 50% of CBWWTP's current total daily flow. Water quality targets for effluent ammonia (N-NH_4) and total nitrogen (TN) concentrations are 1mg/L and 15mg/L respectively for A/B Plant. In addition, CBWWTP has a target of discharging less than 100 tonnes of TN into Gulf St Vincent per year.

Power supply instability and increasing power prices in South Australia have led to a shift in operational focus towards reducing consumption of major power-intensive equipment, of which the most intensive in a WWTP are aeration blowers. Allwater has a duty to meet its corporate responsibilities through reducing electricity consumption and maximising nutrient removal from treated sewage.

With the help of Suez, aeration control improvements at WWTPs was identified as a key way to transition towards smarter plants with automatic process control leading to reduced overall energy demand without compromising effluent quality. To test this approach, a trial was established at CBWWTP using Advanced Aeration Control (AAC) to accurately match aeration needs with real-time ammonia concentration measurements. This paper provides an overview of the trial and the results achieved.

2 METHODOLOGY

2.1 ADVANCED AERATION CONTROL

Advanced Aeration Control (AAC) refers to the new generation of wastewater process controllers - using innovative analysers, algorithms, monitoring logic and architectures - that allow for real-time adjustments of the aeration system according to the actual needs within a biological reactor. AAC takes into account all the solutions that lead – through innovation – toward a SMART WWTP. A review of automatic control of continuous aeration systems in municipal wastewater treatment plants is contained in Amand *et al* (2003).

2.2 GREENBASS™ PLUG FLOW ALGORITHM

2.2.1 WHAT IS IT?

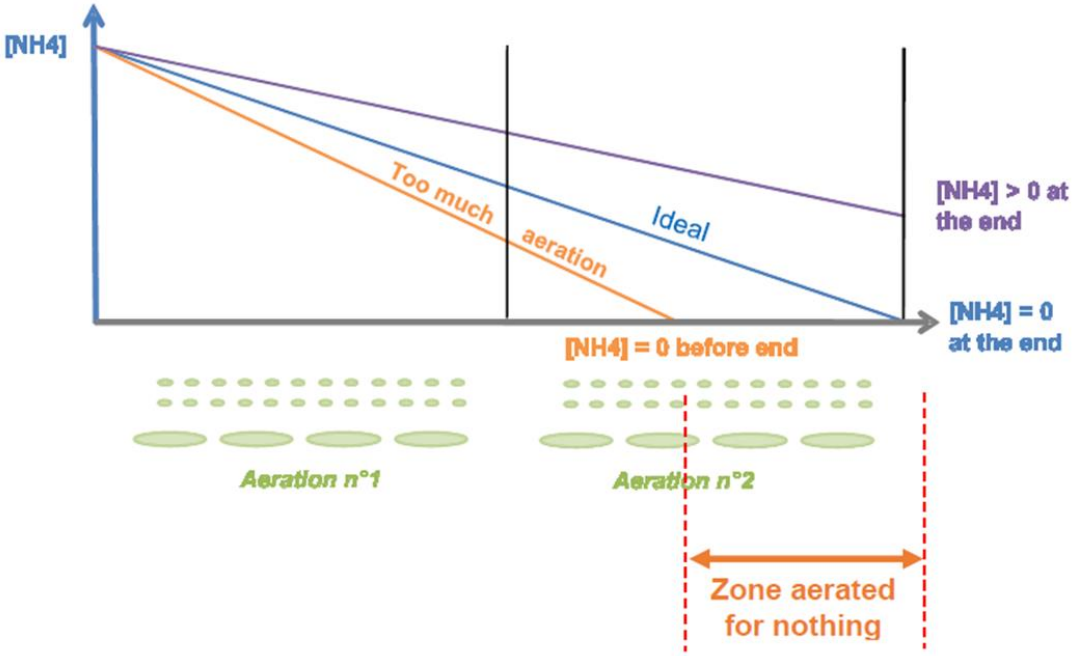
Greenbass™ Plug Flow algorithm is a new AAC system developed by Suez which is applicable to nitrifying activated sludge processes using a plug flow hydraulic configuration. The algorithm is based on real-time ammonia measurements in the biological tanks and can only be adapted to a variable air supply system (VFD-controlled blower associated with a specific tank or centralised air production with individual air regulation valves) in biological tank(s) with a plug flow hydraulic configuration.

Greenbass™ Plug Flow has recently gone through patent application process with the following patent reference: WO 2016001823 A1.

2.2.2 HOW DOES IT WORK?

The aim of Greenbass™ Plug Flow is to adapt the oxygen supply, and thus the ammonia removal, in order to achieve a gradually decreasing N-NH_4 profile along the aeration tank length that reaches zero at the very end of the tank (Figure 2). This reduces the energy wastage linked to over-aeration of an already treated water volume at the end of the biological reactor.

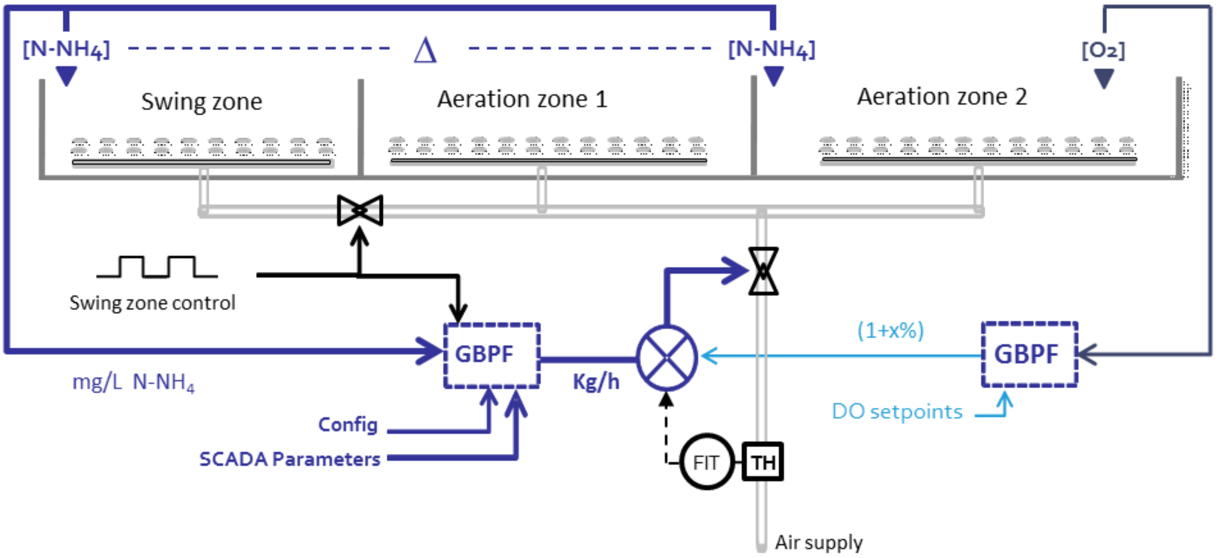
Figure 2: Aeration scenarios and effluent ammonia along a bioreactor



Greenbass™ Plug Flow is a mixed regulation system with three distinctive and complementary components (Figure 3):

- Predictive "feed-forward" control, based on inlet N-NH_4 measurement - ensuring an anticipated correction of the air supply in order to meet the changing needs of the incoming pollution load
- Feedback corrective action, based on the achieved N-NH_4 removal approximately half-way through the treatment line
- Closed-loop feedback corrective action, based on the Dissolved Oxygen (DO) at the end of the tank that fine-tunes the air supply to maintain a given DO range

Figure 3: AAC Greenbass™ Plug Flow Control Schematic



Initially, the air supply flowrate is adjusted according to the observed load variation and the theoretical amount of air needed to nitrify such a load in a given amount of time. If the nitrification efficiency at the second measurement point decreases, the algorithm adjusts the air supply flowrate upwards in order to compensate and increase the nitrification capacity. Finally, the DO probe located at the end of the treatment enables control of the DO residual levels, to ensure that oxygen remains within a predefined range. Outside of this range, Greenbass™ Plug Flow will refine the supplied air flowrate in order to avoid excessive or insufficient aeration.

Note that all these actions are fully configurable in terms of reactiveness, intensity of response and refreshing speed.

The control algorithm is capable of either computing ammonia concentration solely to determine the air demand or taking into account the flow and using the resulting Ammonia load to do so. These approaches are referred to as "Concentration mode" and "Load mode" respectively.

Two modes of operation exist within the algorithm, with different levels of predictive calculations:

- AUTO 1 mode: uses a continuous calculation of air setpoint according to the instantaneous measured values. This mode is mainly used at initialisation of the algorithm and aims at computing a preliminary airflow setpoint while collecting enough data to perform a moving average used in auto 2 mode
- AUTO 2 mode: uses iterative calculations, in which the air flow setpoint is re-calculated from its last value at a given adjustable time pace (every 15 to 30 minutes approximately), using moving averages of online analysers and based on:
  - the influent NH_4 load or concentration variation slope
  - the actual nitrification efficiency observed at the mid-point sensor
  - an additional DO post-correction based on tank outlet DO concentration which further corrects the air flow if the DO stays outside defined limits

2.3 IMPLEMENTING AAC AT CBWWTP

2.3.1 FEASIBILITY STUDY AND BENCHMARKING

In 2015, a feasibility assessment of implementing AAC at Allwater operated WWTP sites was undertaken. A theoretical assessment was undertaken by Suez, based on return of experience at other sites, which estimated that a saving potential of between 14% and 20% could be achieved at Christies Beach WWTP if AAC was implemented.

Review and benchmarking of existing technological solutions of online ammonia analysis instruments was also carried out by Suez. This allowed for informed selection of suitable and reliable instrumentation for implementation of AAC.

2.3.2 TRIAL OBJECTIVES

A decision was made to undertake an AAC trial at CBWWTP and the objectives of the trial were to develop a greater understanding of AAC systems and their costs, benefits and confidence levels to inform any decision making regarding further implementation of this technology.

2.3.3 ON-SITE IMPLEMENTATION

In order to implement the AAC trial at CBWWTP the following steps were undertaken:

- Review of plant layout, assets and operational data to determine the best location for analyser installation. "A Plant" was identified as the test location with a good balance in sewage flow distribution between the two treatment lines, A1 and A2. The diffusers in both treatment lines are also of similar condition, leading to similar aeration demand. A2 was selected as the trial basin.

- Purchase and installation of two HACH AMTAX ammonia analysers (Gaseous Ion Selective Electrode) and two HACH FILTRAX automatic sampling units. One unit was installed at the end of the trial basin's anoxic zone, representing the influent Ammonia from which the aeration demand is predicted. The other unit was installed halfway into the aerobic zone, accounting for Ammonia removal performance. Figures 4 – 6 show the location of the instrumentation and the instrumentation installed on site.

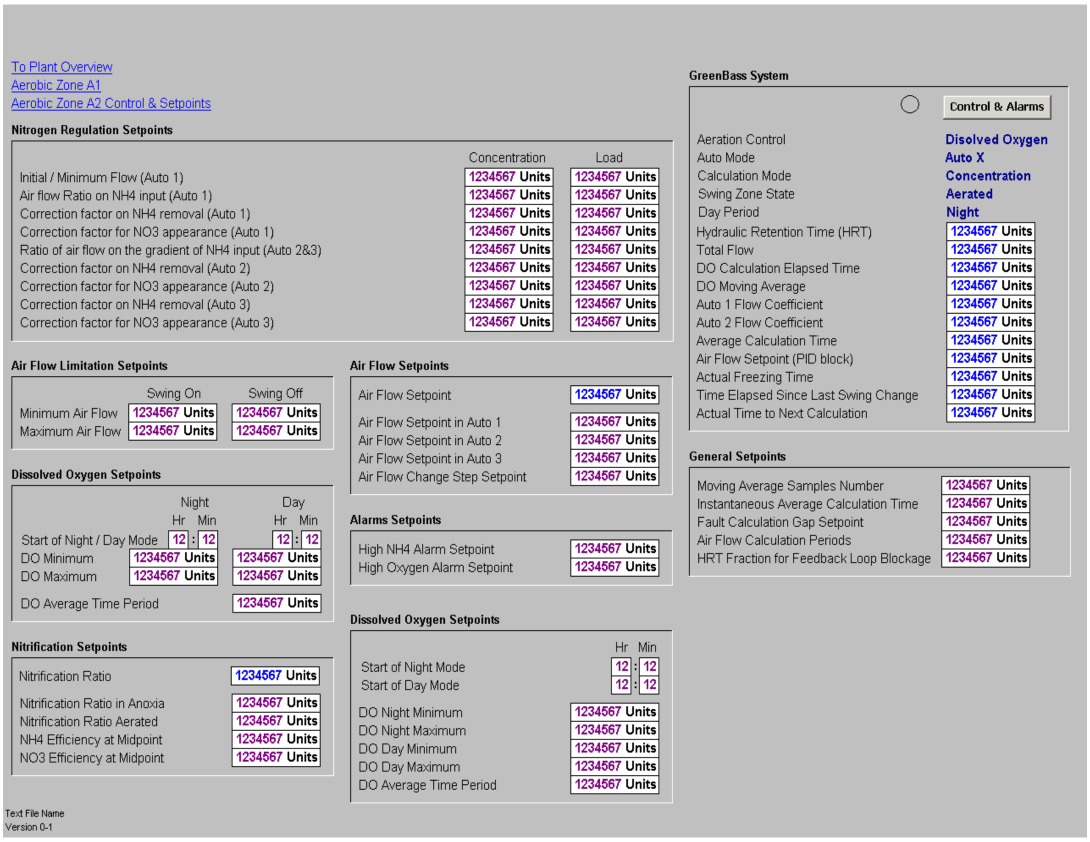
Figure 4: CBWWTP A/B Plant and ammonia analyser location

Figure 5: AMTAX and FILTRAX units

Figure 6: AMTAX unit internals

- Data collection for development of the plant's baseline plant performance was undertaken with the baseline defined as starting on the 1st of January 2017 until the date when Greenbass™ Plug Flow algorithm was put into operation (24th of May 2017).
- Integration of Greenbass™ Plug Flow algorithm into the PLC and development of a new SCADA interface for enhanced control (Figure 7).

Figure 7: Greenbass™ Plug Flow SCADA Control Screen at CBWWTP



Nitrogen Regulation Setpoints

	Concentration	Load
Initial / Minimum Flow (Auto 1)	1234567 Units	1234567 Units
Air flow Ratio on NH4 input (Auto 1)	1234567 Units	1234567 Units
Correction factor on NH4 removal (Auto 1)	1234567 Units	1234567 Units
Correction factor for NO3 appearance (Auto 1)	1234567 Units	1234567 Units
Ratio of air flow on the gradient of NH4 input (Auto 2&3)	1234567 Units	1234567 Units
Correction factor on NH4 removal (Auto 2)	1234567 Units	1234567 Units
Correction factor for NO3 appearance (Auto 2)	1234567 Units	1234567 Units
Correction factor on NH4 removal (Auto 3)	1234567 Units	1234567 Units
Correction factor for NO3 appearance (Auto 3)	1234567 Units	1234567 Units

Air Flow Limitation Setpoints

	Swing On	Swing Off
Minimum Air Flow	1234567 Units	1234567 Units
Maximum Air Flow	1234567 Units	1234567 Units

Dissolved Oxygen Setpoints

	Night Hr Min	Day Hr Min
Start of Night / Day Mode	12 : 12	12 : 12
DO Minimum	1234567 Units	1234567 Units
DO Maximum	1234567 Units	1234567 Units
DO Average Time Period		1234567 Units

Nitrification Setpoints

Nitrification Ratio	1234567 Units
Nitrification Ratio in Anoxia	1234567 Units
Nitrification Ratio Aerated	1234567 Units
NH4 Efficiency at Midpoint	1234567 Units
NO3 Efficiency at Midpoint	1234567 Units

Air Flow Setpoints

Air Flow Setpoint	1234567 Units
Air Flow Setpoint in Auto 1	1234567 Units
Air Flow Setpoint in Auto 2	1234567 Units
Air Flow Setpoint in Auto 3	1234567 Units
Air Flow Change Step Setpoint	1234567 Units

Alarms Setpoints

High NH4 Alarm Setpoint	1234567 Units
High Oxygen Alarm Setpoint	1234567 Units

Dissolved Oxygen Setpoints

	Hr Min
Start of Night Mode	12 : 12
Start of Day Mode	12 : 12
DO Night Minimum	1234567 Units
DO Night Maximum	1234567 Units
DO Day Minimum	1234567 Units
DO Day Maximum	1234567 Units
DO Average Time Period	1234567 Units

GreenBass System

Aeration Control	Disolved Oxygen
Auto Mode	Auto X
Calculation Mode	Concentration
Swing Zone State	Aerated
Day Period	Night
Hydraulic Retention Time (HRT)	1234567 Units
Total Flow	1234567 Units
DO Calculation Elapsed Time	1234567 Units
DO Moving Average	1234567 Units
Auto 1 Flow Coefficient	1234567 Units
Auto 2 Flow Coefficient	1234567 Units
Average Calculation Time	1234567 Units
Air Flow Setpoint (PID block)	1234567 Units
Actual Freezing Time	1234567 Units
Time Elapsed Since Last Swing Change	1234567 Units
Actual Time to Next Calculation	1234567 Units

General Setpoints

Moving Average Samples Number	1234567 Units
Instantaneous Average Calculation Time	1234567 Units
Fault Calculation Gap Setpoint	1234567 Units
Air Flow Calculation Periods	1234567 Units
HRT Fraction for Feedback Loop Blockage	1234567 Units

Text File Name
Version 0-1

- Commissioning of AAC system and adjustment of operational parameters and correction coefficients.

- On-going daily review of operational performance including airflow, DO levels as well as ethanol consumption leading to further optimisation of Greenbass™ Plug Flow algorithm parameters.
- On-going regular laboratory analysis to monitor the trial treatment line's performance against the reference treatment line in terms of ammonia removal.

3 RESULTS AND DISCUSSION

3.1 RELIABLE INSTRUMENTATION: THE BASIS FOR EFFECTIVE SMART CONTROL

Since their installation in early 2017, the HACH ammonia analysers have been providing accurate and reliable real-time data. AAC was therefore confidently implemented in May 2017 using the installed analysers. The maintenance on the instrumentation has been manageable with replacement of reagents every 3 months and 6-monthly check-ups carried out by the supplier. Overall, the operation and maintenance teams are very satisfied with the quality of on-line analysis as well as the maintenance linked to the analysers.

3.2 OPERATIONAL SAVINGS THROUGH IMPROVED AERATION

After a period of commissioning, during which the Greenbass™ control algorithm's parameters were set with safety margins to ensure stable operation and maintain required treatment performance, the algorithm's different capabilities were tested more thoroughly.

3.2.1 REDUCED AERATION

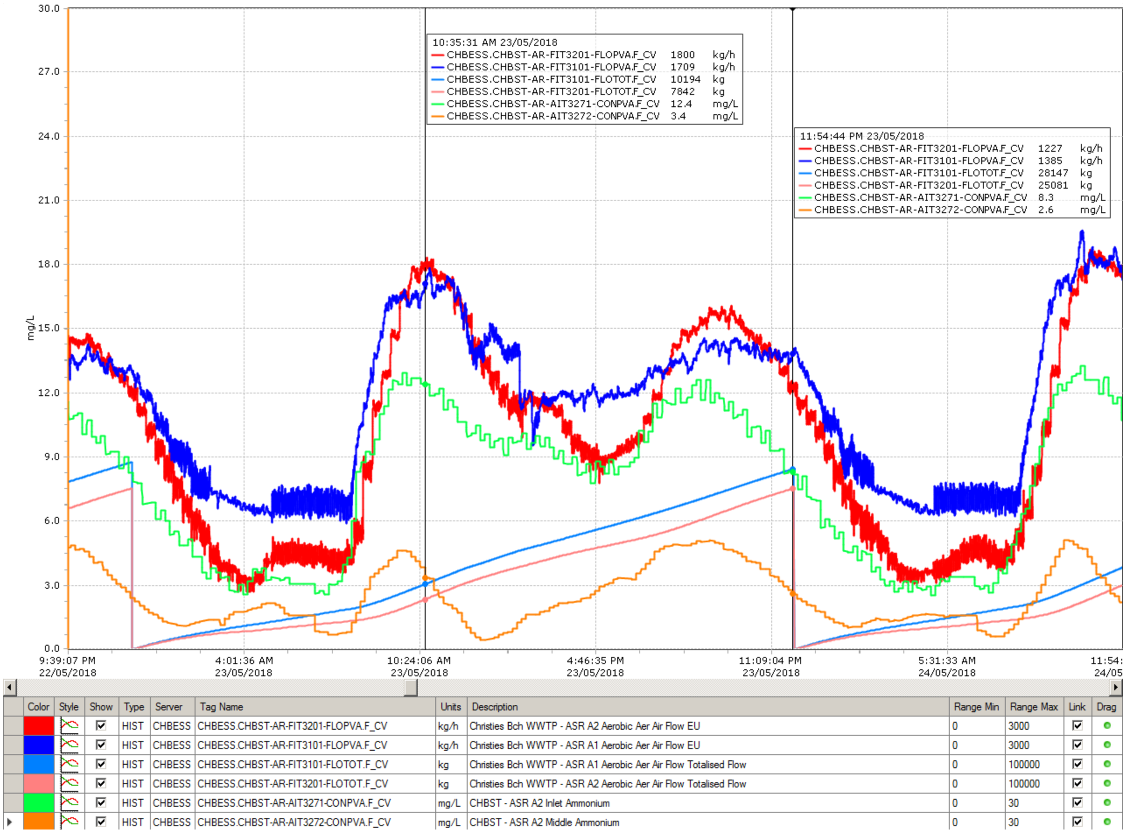
Over the trial period, the daily air consumption observed was globally lower in the trial basin than in the reference basin (Figure 8). Typically, it was noticed that the control algorithm actually distributes the airflow differently to the conventional DO system i.e. more airflow during the peak flows and less during the night when it is not required, thus the air supply better matches the oxygen needs to obtain the desired effluent quality. The Greenbass™ control algorithm inherently allows the WWTP to better deal with Ammonia peaks, especially over the weekend during which ammonia breakthrough was usually experienced at CBWWTP.

To account for variability, savings have been estimated using probability distribution fitting and by normalising results according to baseline data.

During the initial commissioning and testing period, from the 24th May to the 20th September 2017, the system's performance in terms of aeration, under both AUTO 1 and AUTO 2 mode, was very similar. The preliminary results showed savings ranging from 1500kg to 1700kg of air per day - which equates to approximately 5% of savings compared to the nominal daily total airflow.

Following "A Plant's" influent flowmeter failure in September 2017 and subsequent putting on hold of the trial, the control system was put back into operation on the 6th November 2017 in 'Concentration' mode. Since then, Greenbass™ has been in continuous operation with stable performance.

Figure 8: Greenbass™ Plug Flow SCADA Control Screen at CBWWTP



10:35:31 AM 23/05/2018

CHBESS.CHBST-AR-FIT3201-FLOPVA.F_CV	1800	kg/h
CHBESS.CHBST-AR-FIT3101-FLOPVA.F_CV	1709	kg/h
CHBESS.CHBST-AR-FIT3101-FLOTOT.F_CV	10194	kg
CHBESS.CHBST-AR-FIT3201-FLOTOT.F_CV	7842	kg
CHBESS.CHBST-AR-AIT3271-CONPVA.F_CV	12.4	mg/L
CHBESS.CHBST-AR-AIT3272-CONPVA.F_CV	3.4	mg/L

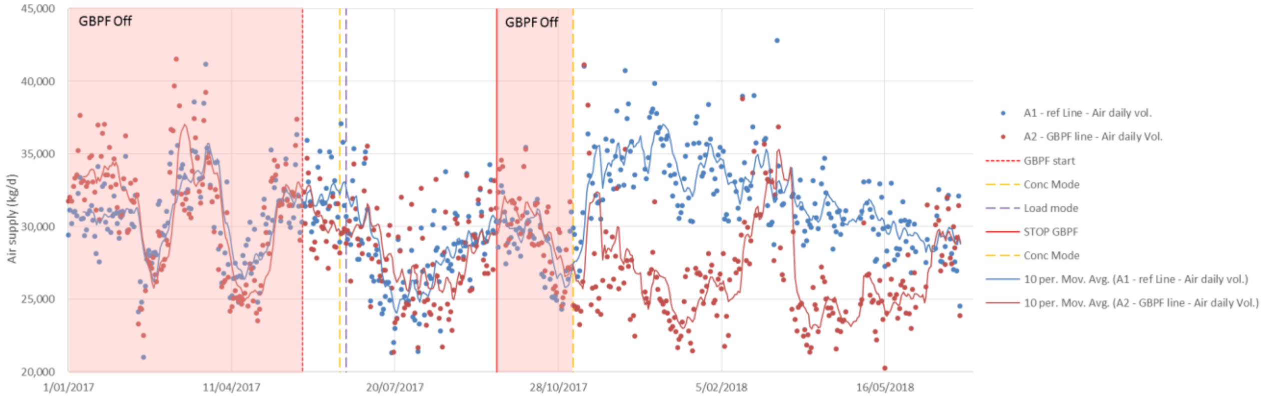
11:54:44 PM 23/05/2018

CHBESS.CHBST-AR-FIT3201-FLOPVA.F_CV	1227	kg/h
CHBESS.CHBST-AR-FIT3101-FLOPVA.F_CV	1385	kg/h
CHBESS.CHBST-AR-FIT3101-FLOTOT.F_CV	28147	kg
CHBESS.CHBST-AR-FIT3201-FLOTOT.F_CV	25081	kg
CHBESS.CHBST-AR-AIT3271-CONPVA.F_CV	8.3	mg/L
CHBESS.CHBST-AR-AIT3272-CONPVA.F_CV	2.6	mg/L

Color	Style	Show	Type	Server	Tag Name	Units	Description	Range Min	Range Max	Link	Drag
🟥		☑	HIST	CHBESS	CHBESS.CHBST-AR-FIT3201-FLOPVA.F_CV	kg/h	Christies Bch WWTP - ASR A2 Aerobic Aer Air Flow EU	0	3000	☑	●
🟦		☑	HIST	CHBESS	CHBESS.CHBST-AR-FIT3101-FLOPVA.F_CV	kg/h	Christies Bch WWTP - ASR A1 Aerobic Aer Air Flow EU	0	3000	☑	●
🟦		☑	HIST	CHBESS	CHBESS.CHBST-AR-FIT3101-FLOTOT.F_CV	kg	Christies Bch WWTP - ASR A1 Aerobic Aer Air Flow Totalised Flow	0	100000	☑	●
🟥		☑	HIST	CHBESS	CHBESS.CHBST-AR-FIT3201-FLOTOT.F_CV	kg	Christies Bch WWTP - ASR A2 Aerobic Aer Air Flow Totalised Flow	0	100000	☑	●
🟩		☑	HIST	CHBESS	CHBESS.CHBST-AR-AIT3271-CONPVA.F_CV	mg/L	CHBST - ASR A2 Inlet Ammonium	0	30	☑	●
🟧		☑	HIST	CHBESS	CHBESS.CHBST-AR-AIT3272-CONPVA.F_CV	mg/L	CHBST - ASR A2 Middle Ammonium	0	30	☑	●

Variations in airflow during the baseline acquisition period and throughout the trial are shown in Figure 9.

Figure 9: Comparative Daily Air Supply – trial basin A2 vs reference basin A1



Since November 2017, the air supply to the trial reactor A2 has been predominantly below the supply to the reference reactor A1. Over this period, the median air supplied to A2 amounted to 27,226 kg/d, as calculated with the statistical model applied. By comparison, using the same model, the median air supplied to A1 amounted to 32,048 kg/d. Taking into account the baseline data, the savings were determined to be 16% over the November 2017 to June 2018 period. In terms of energy, using sub-meters present on-site, the aeration savings translate to approximately 140 kwh saved each day on A2 reactor.

3.2.2 REDUCED CARBON DOSING

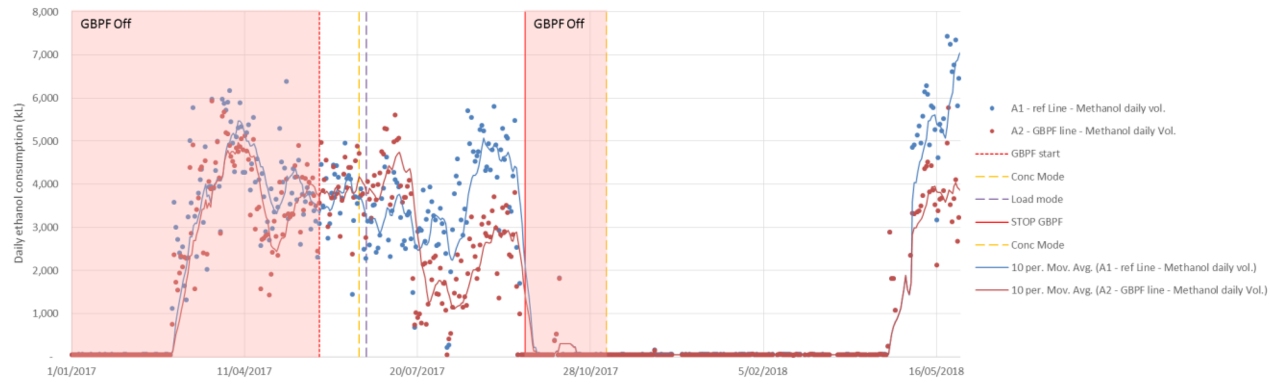
CBWWTP supplies reuse water to various clients in the region including irrigators, vineyards and councils. High reuse water demand is experienced seasonally and is referred to as the 'irrigation period'. During this period, that runs from the 1st November to the 31st March every year, CBWWTP effluent is primarily sent to reuse applications i.e. only a small proportion of effluent is discharged to the gulf. In recent years, negotiations have taken place with the Environment Protection Authority to relax the effluent water quality targets in terms of TN removal during this period as this nutrient is of value to irrigators. Since 2016, CBWWTP has less stringent targets for TN concentrations in its effluent during the 'irrigation period' which enables operations to cease dosing carbon, in the form of ethanol, usually used for advanced denitrification. In 2017-2018, ethanol dosing was ceased from mid-September 2017 to April 2018.

During the initial commissioning and testing period of AAC, from the 24th May to the 20th September 2017, we did not see any savings running the system under AUTO 1 mode. However, running the system under AUTO 2 mode, preliminary results showed savings amounting to a median of 45L of pure Ethanol per day, or 38% savings over the period of time AUTO 2 mode was active.

Since the resumption of the trial on the 6th November 2017 in 'Concentration' mode, limited data has been acquired due to the halt in ethanol dosing.

Variations in ethanol dosing during the baseline acquisition period and throughout the trial are shown below, in Figure 10.

Figure 10: Comparative daily ethanol dosing – trial basin A2 vs. reference basin A1



Since April 2018, the ethanol dosing in the trial reactor A2 has been predominantly below the dosing in the reference reactor A1. Over this period, the median ethanol solution dosed in A2 amounted to 3,349L/d, as calculated with the statistical model applied. By comparison, using the same model, the median ethanol solution dosed in A1 amounted to 5,118L/d. Taking into account the baseline data, the savings were determined to be 25% over the April 2017 to June 2018 period. In terms of pure ethanol, the savings translate to approximately 28L of pure product saved each day on A2 reactor.

The above results demonstrate enhanced denitrification in the anoxic tank upstream through minimised DO returned to the head of the basin via the internal recycle: the use of raw water carbon pollution for exogenous denitrification is therefore maximised, which has led to a reduction of external carbon consumption.

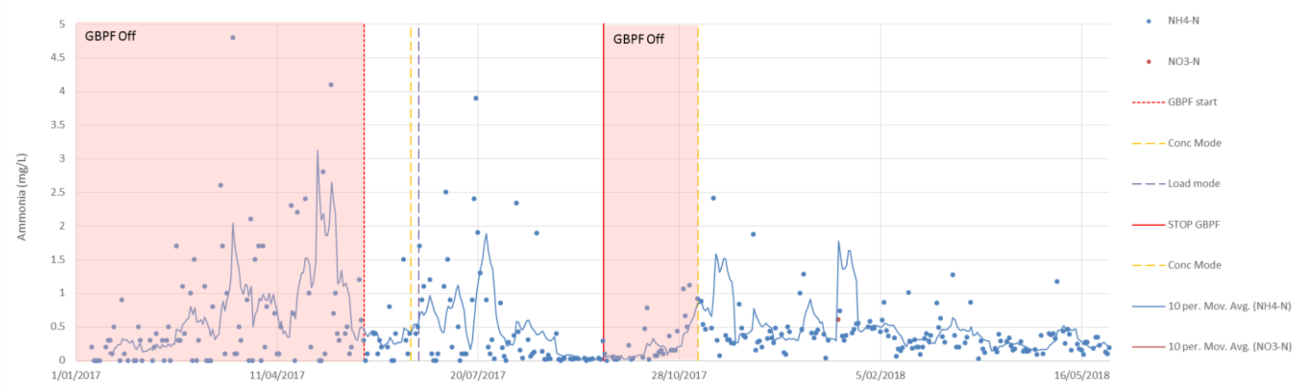
Average DO are globally lower with AAC, especially due to the lower DO at night while the peak period DO remains quite similar between the two lines.

3.3 IMPROVED STABILITY IN EFFLUENT WATER QUALITY

AAC provides the WWTP with a good adaptability to the pollution load. The air needs are evaluated based on the received pollution, which enables adjustment of air supply as close as possible to the real-time oxygen demand.

A composite sampler is located at the outlet of the "A Plant" clarifiers and is analysed daily for ammonia (Figure 11).

Figure 11: "A Plant" composite ammonia results



The trend in Figure 11 shows that with AAC applied to one of "A Plant's" two reactors, more stable effluent water quality is achieved. The data was analysed for standard deviation during the periods where the Greenbass™ control system was running and during the periods of conventional DO control. The results for ammonia and nitrates are summarised in Table 1.

Table 1: "A Plant" effluent water quality standard deviation comparison

A Plant WQ Standard Deviation	**Ammonia**	**Nitrate**
Conventional DO control	1.10	7.11
Greenbass™ Plug Flow control	0.71	6.14
% Reduction	*36%*	*14%*

Considerable gains have been achieved in terms of water quality stability when running with AAC.

3.4 CONSIDERATIONS FOR FURTHER IMPLEMENTATION

3.4.1 PROCESS CONSIDERATIONS

The actual savings achieved of 16% in terms of aeration are consistent with the expected savings determined during the feasibility assessment in 2015 (i.e. between 14% and 20%). However, potential savings directly depend on the process baseline i.e. if a plant has been subject to iterative optimisation, the configuration of its aeration system may already be close to optimal and savings achieved through AAC may be limited.

Consideration should be given to presence of external carbon source in determining whether AAC implementation is feasible. Savings in terms of carbon source addition could have a significant impact on operational expenditure.

At CBWWTP, ethanol dosing is controlled through online nitrate probes. Calibration of these probes can greatly impact ethanol dosing volumes and attention should be given to the accuracy of these sensors in estimating savings.

With lower aeration comes lower power consumption and lower Greenhouse Gas (GHG) emissions. Additionally, with AAC, the profile of GHG emissions linked with activated sludge processes could be changed and should be quantified.

AAC can also provide a regulatory benefit of reducing the risk of non compliance.

3.4.2 ASSET CONSIDERATIONS

Existing blower size should be carefully examined in determining savings linked to AAC implementation: to maximise savings, the minimum output of the asset should be low enough to enable the control system to ramp down aeration flowrate across a given plant for the whole low flow period.

Implementing AAC can lead to a more stable and smooth air flowrate profile throughout the day compared to the often observed oscillations with a conventional DO control system. Therefore, the air distribution equipment (blowers and regulation valves) is usually less frequently stimulated and asset wear is therefore reduced with Greenbass™ Plug Flow.

Limited infrastructure and manageable control system modifications were carried out in the implementation, making it feasible to retrofit any plant with AAC.

4 CONCLUSIONS

The implementation of AAC at CBWWTP led to the transition from a conventional control system to a ‘smart’ system, capable of fine tuning supply according to instantaneous demand, but also taking into account treatment performance. This transition concerned the plant’s most power-intensive process, aeration. Predictive aeration control was achieved according to the ammonia load coming into the plant as well as feedback correction on actual treatment performance.

This ‘smart’ control system has not only led to optimal use of air across the diurnal flow profile but also improved effluent quality stability. This directly translated to significant savings in terms of aeration with the trial basin using 16% less air than the reference basin. Significant savings followed in terms of Ethanol consumption with 20 to 40% of savings, due to the recirculation of lower oxygen quantities into the anoxic zones at lower flows, thus maximising the use of carbon sources for denitrification rather than its degradation through unnecessary aeration.

Having developed in-house knowledge about costs and necessary operational follow-up associated with AAC, the CBWWTP case-study can be used as a reference and as a decision-making tool for further implementation across WWTPs across Adelaide and the broader water industry.

ACKNOWLEDGEMENTS

The authors would like to thank the project partners and sponsors across SA Water, Suez and Allwater for their valuable technical and financial contributions. Thanks to Clement Roche, Marie Secondat and Steven Lamble for the development of the control algorithm and its local integration; to the maintenance personnel who installed the instrumentation and made sure it was reliable; to the operational staff at Christies Beach WWTP, including Ian Dayman and all process technicians and operators, who ensure daily monitoring of the control system and associated process performance.

REFERENCES

Amand, L., Olsson, G., Carlsson, B., (2013), Aeration Control – A Review, Water Science & Technology, volume 67.11, p 2374 - 2398