ADVANCED PROCESS CONTROL AIDS OPERATIONAL DECISION MAKING

Paper Presented by:

Geoff Lukin

Authors:

Richard Brice, *Senior Process Engineer,*
AWT Water
Geoff Lukin, *Team Leader, Sunbury,*
Western Water

76th Annual WIOA Victorian Water Industry Operations Conference and Exhibition
Bendigo Exhibition Centre
3 to 5 September, 2013

ADVANCED PROCESS CONTROL AIDS OPERATIONAL DECISION MAKING

Richard Brice, *Senior Process Engineer,* AWT Water
Geoff Lukin, *Team Leader, Sunbury,* Western Water

ABSTRACT

At many plants design engineers provide operations and maintenance manuals, which specify an operating MLSS concentration. This concentration is mostly provided only for the design horizon, which in some cases can be between 20 and 30 years.

Significant growth can occur in a catchment over this period and as a result the operating MLSS at year 1 may need to be significantly lower than in year 20. Excess biomass can lead to a number of issues such as settleability problems, excess foaming and scum production and increased aeration demand (i.e. increased power costs).

At Sunbury operations staff have reverted to Solids Retention Time (SRT) as a means of managing MLSS (specifically the biomass inventory). This has been completed by adding an SRT calculator to the site SCADA output on the PLC.

Operations staff are undertaking a program of works to optimize the plant and have implemented a sampling plan in order to find the breakpoint SRT for ammonia breakthrough during different seasonal conditions.

This paper explains the background to SRT based control and advantages of this control mechanism and the specific sampling and advantages to the Sunbury Recycled Water Plant (RWP).

1.0 INTRODUCTION

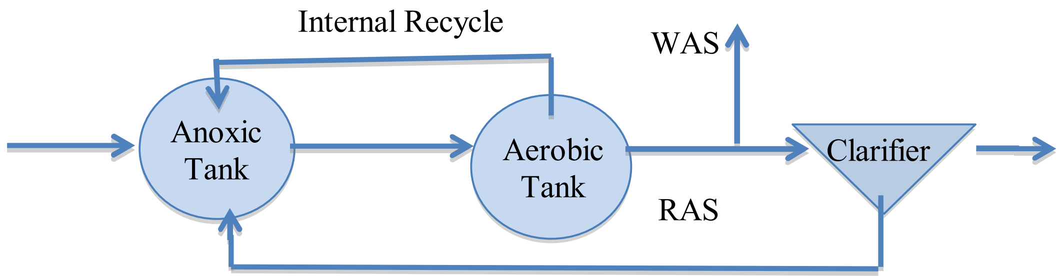
This paper outlines the advanced control techniques that are being adopted at the Sunbury Recycled Water Plant (RWP), the reasons for the use of the control techniques and the results (both culturally and in terms of treatment performance). Further to this is the way ahead – “what next”.

Sunbury RWP is owned and operated by Western Water (WW). The plant is a conventional two stage MLE process and has had a recent system upgrade. The plant currently treats around 5 - 6ML/d and is required to treat to low levels of nitrogen and phosphorus. The plant biologically removes nitrogen and has chemical addition for phosphorus removal.

The location of the Sunbury RWP is presented in Figure 1.

<u>Figure 1:</u> ***Sunbury WRP location (circled)***

Figure 2 presents the outline layout of the MLE process.



<u>Figure 2</u>: ***Modified Ludzack-Ettinger configuration***

The sludge wasting at the Sunbury RWP was controlled based on the plant MLSS and was altered by operations staff on a daily basis.

The Sunbury WRP appears to be limited to around 5 – 6MLD as the plant struggles to remove nitrogen at this flow.

Operations staff wish to review and optimize the process as much as possible. This requires a consistent approach to on - going operation. Part of this approach is to understand the mechanisms for the plant operation. The first stage of which is the calculation of solids retention time (SRT) and operation based on fixed SRT.

The benefits of controlling the plant based on SRT was thought to be a consistent approach to operation of the plant and in particular to highlight how much biomass was needed to be retained within the system for treatment. Minimising this biomass maximizes the hydraulic capacity of the plant.

2.0 DISCUSSION

As discussed the Sunbury RWP the plant operates as a MLE process with two separate trains. Solids wasting is direct from the reactors to a thickening tank; with thickened solids passing to two aerobic digesters prior to further settling and then thickening in a belt press. Chemical addition for phosphorus removal occurs after the secondary clarifiers. The process flow diagram is outlined in Figure 3.

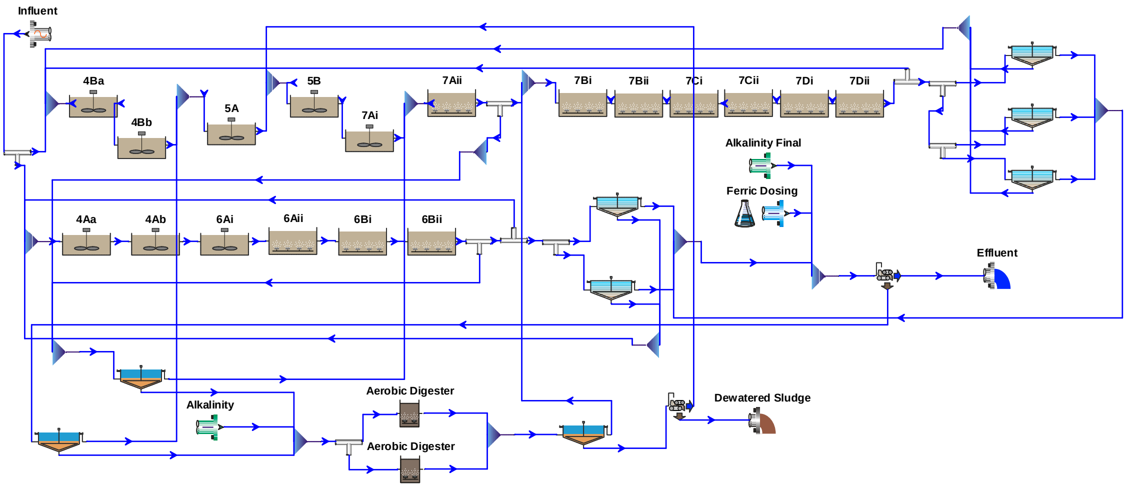


Figure 3: ***BioWin based Process Flow Diagram***

There are a few fundamentals to operation any activated sludge plant. Some of these are:

2.1 Sludge Age

The defining principle behind activated sludge is the separation of the solids retention time (SRT) from the hydraulic retention time (HRT). The right bacteria need to be kept in the system for long enough to do the necessary work of carbon (COD) removal, nitrogen (N) removal and phosphorous (P) removal. Nitrifiers are the slowest growing organism of note and as such we target the lowest sludge age whereby full nitrification still occurs.

In practice it is wasting that determines the sludge age. It is important to note that the wasting is defined as the final sludge mass removed from site, as in many plants the solids processing system returns a percentage of the solids back to the reactors reducing. At Sunbury the solids wasting occurs from both reactors and passes through a series of thickening steps. There is particular concern over the efficiency of the thickening units and this was thought to have a large effect on the overall SRT.

Operations Staff have identified a number of innovative ideas to improve the performance of their thickeners.

2.2 Separation

To ensure the clearest possible effluent (lowest possible solids) and to capture the solids to allow return of the active "bugs" to the reactor, it is necessary to separate the solids from the liquids. The most common way to do this is to stop the mixed liquor moving and to let the solids settle and then remove the clarified effluent from on top.

The capacity of settlers (i.e. clarifiers) is defined by:

- Flow through the settling unit (including RAS flows);
- Solids mass "pushed" onto the settling unit;
- The settling characteristics of the biomass;

In this case we are unable to alter the hydraulics through the plant (i.e. there is no upstream equalisation basin and no ability to bypass around the process units and/or clarifiers), so the only mechanisms for controlling the capacity of the clarifiers are by affecting the solids "pushed" onto the clarifiers.

Reducing the solids mass load to the clarifiers or improving the settleability of the solids increases the clarifier capacity. The mechanism to do this is to reduce the SRT to reduce the solids loading to the clarifier and attempt to assist with solids settlement.

2.3 Calculating the SRT

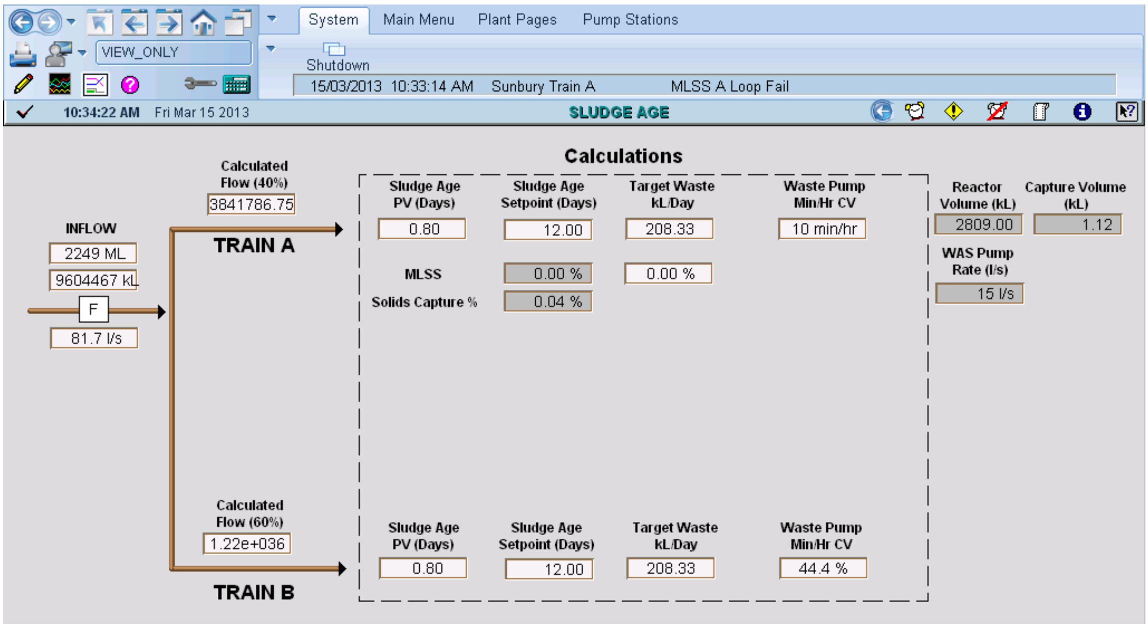
There are a number of ways of calculating the SRT of an activated sludge plant ranging from simple to relatively complex. At Sunbury this was discussed with operations staff and the plant monitoring plan was altered to allow a range of these methods to be used in the future.

In the short term there was insufficient information to undertake the SRT calculations on a mass balance basis. As such it was considered the most appropriate method would be to calculate the SRT on a volumetric basis where the wasting is based on the total activated sludge tank volume divided by the volume removed from the activated sludge tanks. A factor was added to this calculation based on the assumed efficiency of the thickening units as a whole (with this number being firmed up via the altered monitoring plan).

Initially it was thought that around 15 – 20% of the solids removed from the activated sludge tanks was returned from the thickening units. This can have a particular impact downstream of the aerobic digesters as a higher percentage of the solids returned to the reactors was inert (ie. does nothing in the treatment process but takes up valuable space!).

2.4 Display of SRT

The SRT is calculated in the site SCADA system. The inputs from plant operations staff are the solids process efficiency and the MLSS is plotted as a comparison to the calculated SRT. The display page (not as complete) is presented in Figure 4 below.



<u>Figure 4</u>: ***SRT Calculator Display Page***

The operator inputs the MLSS and the measured solids capture. The WAS rate and time are taken direct from the plant data and the sludge age is calculated. This is then compared to the sludge age set point and decisions are made as to whether to increase or decrease the solids wasting based on the effluent ammonia data.

2.5 Outcomes from the SRT Calculation

Operations staff are targeting reducing the SRT until a small ammonia breakthrough occurs. It is expected at all plants that there should be a diurnal pattern to the effluent ammonia and if the plant is operating effectively on DO control this could range from 0.4 – 1mgAmmonia/L.

The SRT (estimate) whereby this ammonia breakthrough occurs is then set as the operating SRT and the MLSS will increase or decrease around this value. If there is ammonia carry over in the effluent (seen building up over a number of days) the sludge age is increased. If no ammonia carry over is measured then the sludge age is reduced (by 1 day per 12 – 20 days) until some ammonia carry over is measured and then the SRT is raised by a day.

The monitoring plan includes effluent ammonia, alkalinity and the influent load and tracks the MLSS and solids thickening system. This ensures that there is sufficient alkalinity so as not to inhibit nitrification, there is not an anomalous load spike and the MLSS doesn't mysteriously drop (most likely due to changing efficiency of the thickening and digestion units).

It is understood by operations staff that there is likely to be a different (lower) operating SRT during the warmer summer months than in the cooler winter months.

2.6 What next?

The goals for operations staff is as follows:

- Install smart process monitoring through the clarifiers to review actual operating clarifier capacity;
- Review the performance of the digesters;
- Review the performance of the thickening units (in particular the belt press) to allow optimization of these units to save power, chemicals and in particular reduce costs of trucking sludge from site (as well as reduce solids returned to the process);
- Use the monitoring data capture to improve the accuracy of the SRT calculator.

3.0 CONCLUSION

The SRT calculator has been a great tool to get buy in from all operations staff in decision making around the performance of the dewatering system (and in particular the thickeners), gaining further understanding of the key operational parameters of the activated sludge plant (effluent ammonia and aeration input), and evaluating laboratory based samples and performance with the unit performance.

There is a great excitement on site and a number of ideas being bought up by operations staff as to methods of optimisation and a collaborative approach to working these through.

By keeping the calculations and display relatively simple and tracking performance against the calculations the system can be closely monitored and further improvements highlighted.

4.0 ACKNOWLEDGEMENTS

Site operations staff at the Sunbury RWP for buying into this optimization process and collaboratively identifying opportunities to improve the process.

- Paul Barry
- Scott Johnson
- Shane Robson
- Aaron Lane
- Sarah Marcato

Andrew Groves –WA Cromarty and Co – programming
Richard Brice – AWT Water Pty Ltd – process assistance