Winner of Ecolab Prize for Best Operator Paper
at the 76th Victorian Water Industry Operations Conference,
Bendigo, September 2013

HOW TO TRAIN YOUR CENTRIFUGE: AN EXERCISE IN PROCESS OPTIMISATION AND THE BENEFITS OF INTER-CORPORATION NETWORKING

Paper Presented by:

Jarrah Feather

Author:

Jarrah Feather, *Wastewater Treatment Team Leader,*

East Gippsland Water

39th Annual WIOA
Queensland Water Industry Operations Conference and Exhibition
Logan Metro Indoor Sports Centre, Logan
3 to 5 June, 2014

HOW TO TRAIN YOUR CENTRIFUGE: AN EXERCISE IN PROCESS OPTIMISATION AND THE BENEFITS OF INTER-CORPORATION NETWORKING

Jarrah Feather, *Wastewater Treatment Team Leader,* East Gippsland Water.

ABSTRACT

In 2009, East Gippsland Water (EGW) made the long term water security decision to build a 20ML per day dissolved air flotation and filtration water treatment plant (WTP) to supply its largest customer base within the Bairnsdale and Lakes Entrance region.

Like all major projects, the construction and commissioning of the new WTP was not without its issues. The one that would prove to be the most difficult to solve, extremely frustrating and time consuming for operators, was the operation of the WTP's washwater facilities, and in particular, the centrifuge. After many months and a great deal of expense in contractor call-outs, employee time and overtime attempting to maintain operation of the centrifuge, EGW contacted a neighbouring water corporation who had a very similar washwater system. They obligingly offered their time, experience and facilities which resulted in some significant findings and recommendations for potential improvements to assist with the operation of our centrifuge.

Following the visit, several of these findings and recommendations were trialled with greater than expected results. The current paper will describe our findings and experiences, so these learnings may assist other water corporations under similar circumstances.

1.0 INTRODUCTION

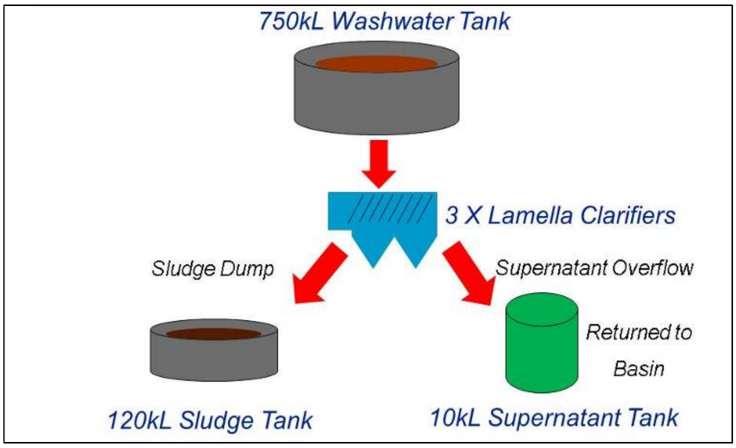
In 2009 the Woodglen WTP was built as part of EGW's water supply strategy. It was built with the demands of East Gippsland's growing population in mind and the ever changing and demanding environmental challenges that EGW has experienced, including floods, severe bush fires and extended periods of hotter than average temperatures and drought. It was also designed and built to meet any future water quality demands set out by regulators, and above all, to guarantee EGW's customers a safe, consistent and high quality product.

The waste treatment facility (or washwater system) is an integral component of a WTP that treats the materials removed during the water treatment process. This material generally consists of solids in the form of clays and soils, dissolved organic matter removed as part of the coagulation process and the chemicals used throughout the various stages of treatment. For a dissolved air flotation and filtration plant, such as Woodglen WTP, these materials are removed from the water treatment process into the washwater treatment system during backwash and during a float off. Washwater systems can often be quite difficult to operate and can be temperamental, depending on the consistency of the waste being treated and the equipment being used to treat it.

This paper will discuss the various issues experienced in managing the washwater system, with particular emphasis on the centrifuge and the measures taken in an attempt to rectify these issues. This discussion will also highlight how interaction and networking with skilled colleagues at Gippsland Water, our neighbouring water corporation, benefitted our efforts in managing the ongoing operational issues.

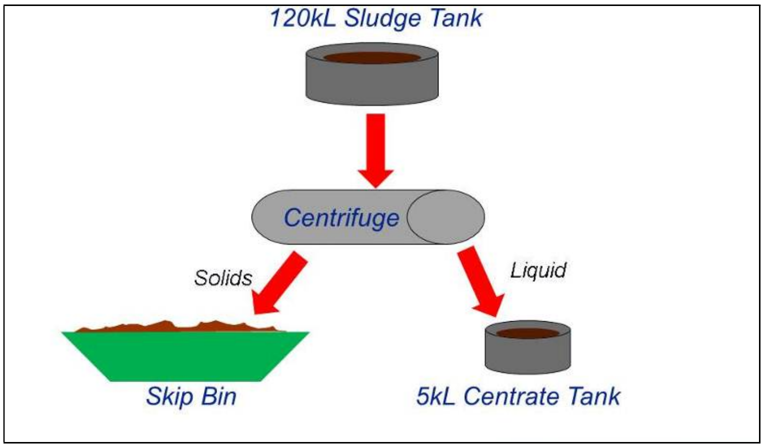
2.0 DISCUSSION

The washwater system at Woodglen WTP is comprised of a 750kL washwater tank, 3 lamella clarifiers, a supernatant return tank and sludge tank as detailed in Figure 1.



<u>Figure 1:</u> ***Woodglen water treatment plant washwater system***

The sludge from the sludge tank is pumped through a centrifuge where it is dewatered and the cake deposited into a skip bin. The centrate is returned back through the washwater system or to a raw water storage (depending on quality) via the centrate tank and pumps as detailed in Figure 2.



<u>Figure 2:</u> ***Woodglen water treatment plant sludge handling system***

As discussed previously, washwater systems can often be difficult to operate and temperamental and the washwater system at the Woodglen WTP was no exception. During commissioning and after handover, many issues were identified with the washwater system, and the centrifuge in particular. The unit was frequently experiencing blockages and inconsistent quality centrate making it difficult to manage and costly, particularly with respect to operator time.

2.1 Warning Signs During Commissioning and Proof of Performance (POP) Testing

During the early stages of commissioning there were some indications that the centrifuge was going to be difficult to operate. Initially there was thought that the main factor causing operational problems was colloidal clay coming from a recently constructed raw water storage.

This was confirmed as a contributing factor when raw water sources were changed and the centrifuge's operation became more stable. However there remained ongoing instances where the centrifuge was performing poorly, or partially blocking. After the completion of commissioning and POP testing came the operational handover from the contractor to EGW operations. It was at this point that it became apparent that the issues with the centrifuge were not going to go away.

It is worth noting that the POP plan for the new facility had a strong focus on the performance of the filters and less so on the washwater plant. The POP testing, as such, was unable to sufficiently capture the issues EGW staff were observing for rectification under the contract.

2.2 Post Commissioning Problems and Time Analysis

For several months following handover, maintaining reliable centrifuge run cycles was problematic, and the frequency of these issues was increasing. The issues ranged from poor centrate through to serious blockages that were costing significant down times for not only the centrifuge, but the entire water treatment plant. The water treatment plant was shutdown for short periods (no more than 8 hours) to allow for the backlog of washwater to cycle through the system. This created significant pressure on operations as maintaining water storage levels during summer peaks was difficult, even with these short breaks in treatment.

An excessive amount of staff time was being expended in an effort to keep up. The washwater system was designed with the centrifuge being able to operate at 3.5-4L/second for anywhere up to 8 hours per day. EGW's operators were struggling to maintain 2.0-2.5L/second through the centrifuge and it was rare that the centrifuge could run continuously for the required 8 hours without at least some intervention from an operator. In addition to this, the sludge cake from the centrifuge fell directly into a skip bin which had no means of distributing the cake out evenly, thus requiring an operator to physically enter the skip to spread out the cake. This created additional downtime with a requirement to isolate the centrifuge for safe access.

The average normal work time, overtime and estimated cost expended per week to keep the centrifuge operational the few months after handover are provided in Table 1.

Table 1: ***Staff time required to keep centrifuge operational (per week)***

Normal work time hours spent (includes routine and reactive operations)	Over-time	Sludge Cake Shovelling	Estimated Total Cost to EGW
12-14 hrs	3-9 hrs	3-4 hrs	$645

The amount of time being allocated to the centrifuge, only one small part of the whole WTP, was beginning to have repercussions on the overall operation. Other important areas of the water treatment process were becoming less of a focus and the constant battle to keep the system operational was taking its toll on the operational staff.

2.3 Post Commissioning Optimisation

EGW operations and engineering staff began an investigation into the issues being experienced with the centrifuge operation and the perceived causes.

The centrifuge manufacturer's recommendations stated that 2% solids concentration was required for best performance. The current system was only capable of delivering an average 0.2-0.3% solids concentration. There were several design constraints that were leading to poor solids concentration in the feed sludge to the centrifuge which were believed to be the major contributors to its lack of reliability. These included:

1. Lack of hydraulic capacity in the lamella clarifiers for sludge thickening
2. Incorrect polymer dosing – high concentration/lack of control
3. Ineffective desludging of lamella clarifiers due to a single desludge valve for double chambered lamella clarifiers

There was little that could be done about the lamella clarifiers themselves, apart from a complete replacement/augmentation which was not viable at the time. They are purpose built to produce high quality supernatant and were purchased for another treatment project and reused at the Woodglen WTP. The way they were operated was an area that could be improved and was the focus of some of the rectification works detailed below.

<u>Figure 3:</u> ***Lamella clarifiers used to process washwater at Woodglen WTP***

Modifications made to lamella clarifiers and washwater system were as follows:

1. Installed pneumatic desludge valves on both lamella clarifier chambers
2. Installed site tubes for visual confirmation of optimal desludging
3. Installed speed restriction devices on desludge valves to reduce hydraulic shock
4. Installed floating pump on sludge tank to remove excess water (i.e. converting the sludge mixing tank to a thickening process)
5. Removed every second plate from within the lamella clarifiers to prevent interplate clogging
6. Increased supernatant discharge pipe diameter
7. Optimised polymer LT27 dose – reduced concentration of polymer batch and reduced dosage significantly from 100mg/L to 13mg/L
8. Built new sludge cake holding skip with spreading auger.

These changes resulted in the feed sludge to the centrifuge being around 1% on average. As a result we saw greater efficiency throughout the washwater system and considerable savings in power, chemical and staff time. The load on the centrifuge was reduced by >25% due to the better quality feed sludge which took a great deal of pressure off operations staff. In addition to this, the new skip with a spreading auger removed the requirement for operations staff to manually spread the sludge cake and for shutdown periods for this work to occur. Table 2 below outlines the estimated annual cost savings as a result of these improvements.

Table 2: ***Estimated savings (per week)***

Chemical Savings	Normal Hours Saved	Over-time Hours Saved	Sludge Cake Shovelling	Power Saving (Reduced centrifuge runtime/Pumping etc.)	Estimated Total Cost Saving to EGW
>85%	8-10 hrs	3-9 hrs	3-4 hrs	>25%	$870

2.4 Emergency Pumping and Inter-Corporation Networking

The improvements had obvious and significant impacts on cost and time, yet operators were still being frustrated by repetitive blockages and having to spend considerable amounts of normal work time and overtime nursing the centrifuge through its cycles. Soon after the above rectification works were completed, a significant blockage occurred that was not able to be cleared (see Figure 4 below). This led to an extended period of centrifuge downtime.

Figure 4: ***Blocked centrifuge that led to significant period of down-time for the Woodglen WTP washwater system.***

Due to this long period of down-time, a tanker truck was contracted indefinitely to remove the non-dewatered sludge from the sludge tank. The tanker ran on demand for over 3 months and cost in excess of $25K. The centrifuge supplier's service agent was employed to completely dismantle the centrifuge, unblock it and run a staff training session on how to get better and more reliable performance out of it.

Once unblocked, the centrifuge was reassembled, tested, thoroughly flushed and switched off indefinitely. There was great hesitation and reluctance from all departments within EGW to restart the centrifuge until there was some certainty that it would not block again. It was at this point that operations came to the conclusion that external help from within the industry was needed. Accordingly, a call was made to colleagues at Gippsland Water.

A site visit was undertaken at a Gippsland Water plant that had a very similar washwater setup to Woodglen WTP. Lengthy discussion was held, focussing on their experiences and opinions on possible improvements for our site. The ideas we came away with were:

1. That our centrifuge flushing was inadequate
2. Our poly dose for the centrifuge was not close enough to the centrifuge inlet
3. The solids concentration was still not high enough
4. That our ability to monitor the centrifuge's performance was limited.

We already knew we were restricted with the solids concentration, as described earlier in the paper. The remaining three points were all very valid and became the focus of the next series of trials and investigations.

After several trials with alternative dosing points, the existing point appeared the most efficient, so no change was made regarding this point of advice. The flushing and performance monitoring, however, would prove to be the most valuable points of advice our colleagues had offered.

EGW invested in an analogue output device in the centrifuge's local control panel to allow the monitoring and trending of torque, differential speed and flow rate via the WTP's Citect control system. It also allowed remote adjustments of these parameters which enabled after hours monitoring and control. Being able to monitor these parameters is extremely important in managing instances where the centrifuge is running poorly and threatening to block. If the torque rises to a point where it appears a blockage is beginning to form, operators are able to intervene and run the centrifuge's flushing cycle and restart fresh, blockage free.

The second point of advice and the one that proved to be the most important was the flushing of the centrifuge. As simple as it might sound, the flushing turned out to be the main cause of the centrifuge blockages. Prior to the visit to Gippsland Water, our flushing ran at 2.5L per second and was thought to be ample for the system. Gippsland Water recommended that at least 3.5L per second or higher should be used for effective flushing. In addition, they advised that alterations should be made to the existing flushing regime, to allow flexibility in the duration and initiation time of flushing, facilitating complete cleaning of the internals of the centrifuge after each run.

3.0 CONCLUSION

Following the completion of the initial optimisation works undertaken by EGW and the follow-up work completed as a result of meeting with Gippsland Water operators, there has been a significant reduction in cost and time expended on running the Woodglen WTP's centrifuge. Operators are now able to focus their attentions on monitoring and optimisation of the water treatment component of the WTP and now have a much reduced stress load. Although the centrifuge may occasionally still run a little poorly, operators are now able to monitor its performance and intervene before the issue becomes one of catastrophic nature. The information gained from a simple one day visit to a colleague who had extensive knowledge of a system similar to EGW's turned out to be an invaluable exercise and should be the protocol for future issues that seem too difficult and costly to solve through trial and error.

4.0 ACKNOWLEDGEMENTS

Jaime Rachmaniw, Matt Whiteclaw, Ray Thomas, Rory McKeown and Lara Caplygin are gratefully acknowledged from East Gippsland Water.

Invaluable troubleshooting assistance and guidance was gratefully received from Len Ablett and Brendan Holt at Gippsland Water.