WTP OPTIMISER – A SIMPLE AND HANDY TOOL TO OPTIMISE WATER TREATMENT PROCESSES

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ABSTRACT

In water industry, the value of process optimisation is well understood. However, there is a lack of suitable tools for operators and process specialists to conduct optimisation. Providing treatment professionals with such tools can be profoundly beneficial.

WTP Optimiser is a simple and handy tool that performs complex calculations relating to process optimisation. As these complex calculations are performed in the background, the user only sees the simple and user-friendly interface. A large number of complex and regular calculations can be performed by treatment professionals using WTP Optimiser in a fraction of time it would take to manually do these calculations. This tool also enables a rapid assessment of how changes to certain parameters can affect a treatment process. With WTP Optimiser, process related calculations are uniform, accurate, robust and reliable.

Using accurate and reliable data assists in making good operational and capital expenditure decisions that are reinforced by scientific principles. Further, WTP Optimiser improves record keeping for auditing purposes as calculations that provide the scientific basis for operational changes can be easily printed out or electronically stored. However, one of the biggest benefits of WTP Optimiser is the cost saving aspect as optimum process operations can cut down waste and make processes quite efficient.

KEYWORDS

WTP Optimiser, treatment, process, optimisation, calculation, tool

1.0 INTRODUCTION

'Optimise' is 'to make the best of or most effective use of a situation or resource' (Oxford Dictionaries, 2015). Making the most effective use of existing resources is highly cost effective and productive. Optimisation can significantly improve a treatment plant performance, reliability, process knowledge and reduce waste.

To optimise a treatment plant, one requires a good knowledge and understanding of the process stages and how these processes change under various conditions. A water treatment plant operator may have an excellent wealth of knowledge and understanding of the processes of a treatment plant he/she is quite familiar with. With this knowledge and understanding, he/she can attempt to optimise a treatment process. However, an operator trying to optimise a process may face serious limitations when it comes to making use of the underlying scientific principles and chemistry that explain and predict the process behaviour under various conditions. This is when a process scientist/engineer can assist.

However, the availability of a process scientist/engineer on a regular and frequent basis may pose a challenge. Further, from a process scientist/engineer's (who may need to provide technical assistance to a number of treatment plants) view point, this may mean a regular and frequent tedious and repetitive calculations. This may be further complicated by inconsistent and unreliable technical data generated at treatment plants. This leads to frustration to both process scientist/engineers and operators.

This was somewhat a familiar scenario at Wannon Water a few years ago. Water treatment processes were not optimal. Without an appropriate tool, a 'gut feel' was often used by operators to change operational parameters instead of performing scientific evaluations. While some operators performed scientific calculations, there was no uniformity across the service area and the data generated were inconsistent and quite confusing. There was also an over reliance on the process specialists.

Some of the consequences of these unoptimised operations were a significant amount of waste, frequent water quality issues and customer complaints. There was also a risk of potentially significant capital expenditure based on inaccurate and unreliable operational data.

The introduction of a calculation tool - WTP Optimiser has made optimisation much easier. Over the last five and a half years, WTP Optimiser has evolved into a powerful tool. Feedback from operators and treatment specialists alike have helped to capture useful calculations needed for treatment plant optimisation.

WTP Optimiser was crucial in optimising many chemical dosing processes. It has also provided the scientific basis for major operational changes including changeover of 4 different systems from chloramination to chlorination which resulted in significant benefits including significant cost savings. Process optimisation across Wannon Water treatment plants also resulted in better process control, better water quality and improved organisational reputation.

2.0 DISCUSSION

2.1 History

One of the biggest issues faced by Wannon Water was the unreliability and inconsistencies of operational data. Ten years ago, three different water authorities merged to form Wannon Water. Predecessor organisations had different ways of doing things. Different operators had different ways of doing the same thing. For example, it was very confusing and frustrating to see different chemical dose figures by different personnel while the actual dose of that chemical was in fact unchanged. For example, if you consider ammonia dose, some operators used the dose from SCADA set point while others calculated the dose from total weekly ammonia and total treated volume for that week. Yet some other operators conducted a pump draw down to calculate instantaneous dose. Most of the time, each of this method would produce a different result while the actual ammonia dose remained the same. This was further complicated by inaccurate pump delivery rates, SCADA dose set points vastly varying from real doses, discrepancies between duty and standby pumps etc. This has caused a lot of confusion and understandably, optimisation was nearly impossible.

In late 2009, Wannon Water treatment division needed to optimise chloramination. This was primarily due to ongoing chlorine residual loss in the clear water. This triggered alarms and raised concerns over the safety of drinking water. Often chlorine dose was increased or ammonia dose rate was decreased to compensate for the drop in chlorine residual. This often had the negative effect as the systems were pushed into chloramination by-product zone due to high chlorine/ammonia ratios. Further, ammonia exceedances in the distribution network were also quite common. At this time, free ammonia was used as the critical control point (CCP) to control chloramination.

This had a serious flaw as the inaccuracies in ammonia measurements significantly affected the chloramination process.

In many cases, the laboratory test results were over 50% different to the in-house test results. Our approach was to change the CCP from free ammonia to chlorine/ammonia ratio and use test results (of free ammonia, mono chloramine, total chlorine and free chlorine) as a guide to locate the operating point in the chloramination curve. This meant all operators had to calculate chlorine/ammonia ratio 1-3 times a week. To assist the operators with this ratio calculation and provide a consistent method of performing these calculations, we set up an Excel spreadsheet and made it available on the intranet. This greatly assisted the chloramination process as the method used for calculation was more accurate and consistent. This inspired other calculations to be added to this spreadsheet.

Over time, the Excel spreadsheet became very tedious and non-user-friendly. At this point, the limitations of Excel spreadsheet was realised and the need for a new program arose. Fortunately, we had in-house expertise in programing. So, the Excel spreadsheet was converted into a software program which resulted in the development of the current version of WTP Optimiser.

2.2 Features

Current version of WTP Optimiser has calculations categorised into the following process sequence:

1. General
2. Raw water
3. Pre-treatment
4. Clarification
5. Filtration
6. Disinfection
7. Distribution network

The general calculations include dimensional calculations (e.g. area, volume), water hardness, general chemical dose rates (e.g. average chemical dose rate over a week) etc.

Raw water calculations include the number of days of storage available, detention time in the storage, chemical dosing (e.g. copper sulphate dosing) and pollutant concentration calculation (e.g. phosphate).

Pre-treatment includes chemical dosing (e.g. chlorine)

Clarification calculations include contact time, mixing and jar testing related calculations. Figure 1 shows an example of a jar testing calculation.

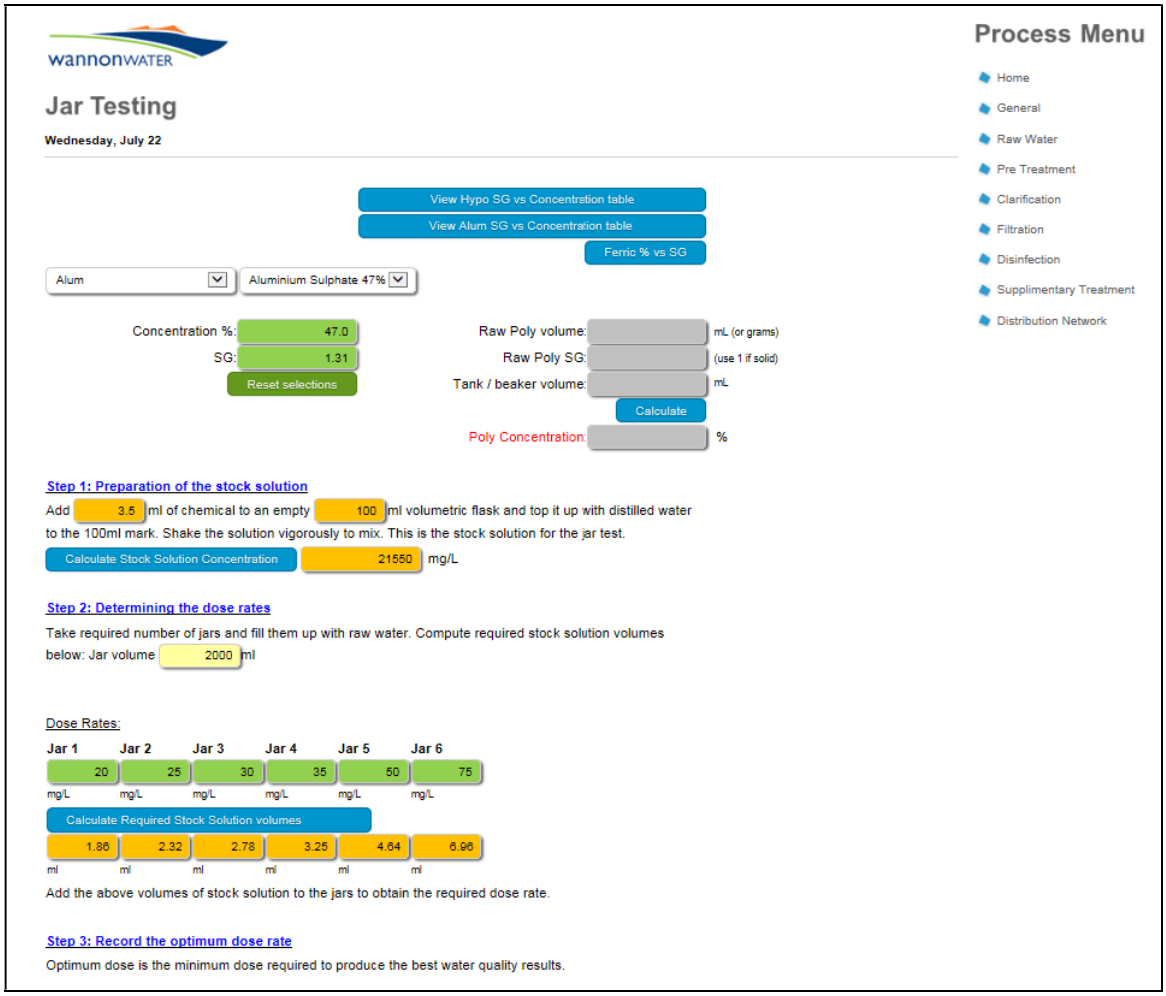

Figure 1: ***Jar Testing Calculation using WTP Optimiser***

Filtration stage includes calculations regarding filter and filter bed volumes, filter loading rates and backwash profile assessments.

Disinfection stage includes calculations on risk assessments, disinfectant dose rates, slug dosing, CT calculations etc.

Distribution network stage contains calculations regarding CT review during low chlorine residual situations or biological contamination in an intermediate storage or in water mains.

2.3 Case Studies

There are a number of benefits in using a tool such as WTP Optimiser. Over the years, WTP Optimiser has assisted with more accurate chemical dosing which has resulted in better control of treatment processes. It has also assisted with more accurate risk assessments and provided with scientific justifications for significant operational changes.

Figure 2 below shows chlorine/ammonia ration of a 18ML/day treatment plant over the last 5yrs. As can be seen, initially chlorine to ammonia ratio was read off SCADA screen of the treatment plant. These data had no real use as these data were unchanging and unrepresentative. However, later on chlorine/ammonia ratio was calculated using WTP Optimiser and the data became real and consistent with calculations at other Wannon Water treatment plants.

This has enabled much better control of chloramination, more stable chorine residuals and less ammonia exceedances in the distribution network.

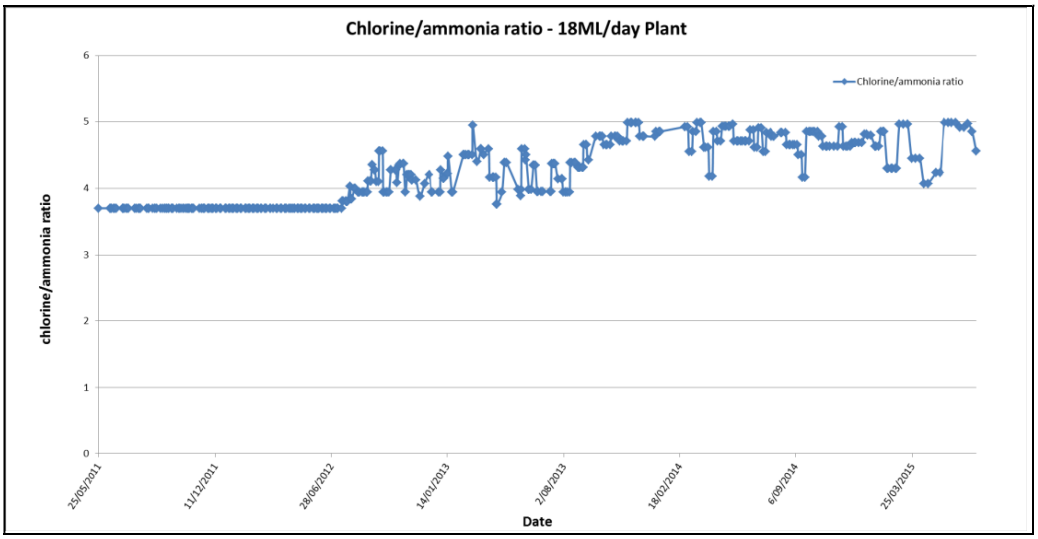

Figure 2: ***Chlorine/ammonia Ratio Trend of an 18ML/day Plant***

Figure 3 below shows an example of how WTP Optimiser was used to better control chlorine dose rates at a 15 ML/day treatment plant. Chlorine dosing has not only become more controlled over the years but has also dropped considerably. In January 2014, the disinfection at this treatment plant was changed over from chloramination to chlorination. This has resulted in significant savings by the cessation of ammonia dosing and considerably reduced chlorine dosing. There was also additional savings resulted from the removal of tests (both internal and external) associated with chloramination.

Interestingly, there was also a much better persistence of chlorine residuals in the outskirts of the city possibly due to less nitrification. In fact chlorine residual persisted so well that the two boost chlorine and chlorine/ammonia dosing stations linked to this system were able to be turned off.

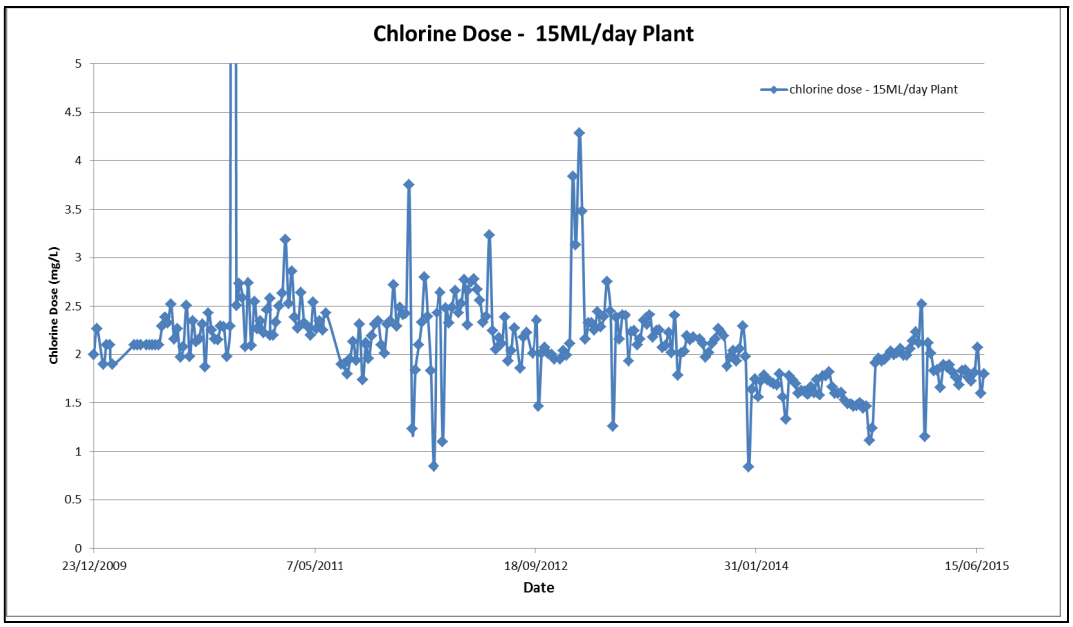

Figure 3: ***Chlorine Dose Over 6 Years at a 15ML/day Treatment Plant***

3.0 CONCLUSION

WTP Optimiser was developed as a basic Excel spreadsheet to assist operators perform accurate and uniform calculations across Wannon Water treatment plants. Over the years, this spreadsheet has developed into a more sophisticated optimisation tool called WTP Optimiser. WTP Optimiser can be used by both treatment plant operators and process specialists to perform powerful calculations to optimise water treatment plant processes.

At Wannon Water, WTP Optimiser is continuing to provide excellent scientific basis for major operational changes and improved record keeping at water treatment plants across our service area.

WTP Optimiser over the years has significantly assisted in optimising various treatment plants across Wannon Water. The following benefits have been achieved using this tool:

1. Significantly improved plant performance, improved water quality, and improved organisational reputation.
2. Improved understanding of the strengths and limitations of a treatment plant including critical process stages.
3. More reliable operational data to assist with capital expenditure decisions.
4. Uniformity and consistency in calculating operational parameters.
5. Reduced wastage and significant cost savings.

4.0 ACKNOWLEDGEMENTS

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