OVERCOMING CHLORAMINATION OPERATIONAL PROBLEMS AT WILLOW GROVE WATER TREATMENT PLANT

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ABSTRACT

Maintaining microbiological compliance in the township of Willow Grove has been a challenge that has recently been overcome by Gippsland Water. This paper details the transition from simple hypochlorite dosing to the use of chloramination. Operational difficulties that were experienced with chloramination dosing equipment and chemical solution strengths, and the steps taken to overcome these problems are described. The use of chloramination at Willow Grove Water Treatment Plant is now relatively trouble free, and is producing consistent disinfectant residuals that ensure microbiological compliance is achieved.

KEY WORDS

Chloramination, Ammonia, Sodium Hypochlorite, Monochloramine, Dichloramine, Trichloramine.

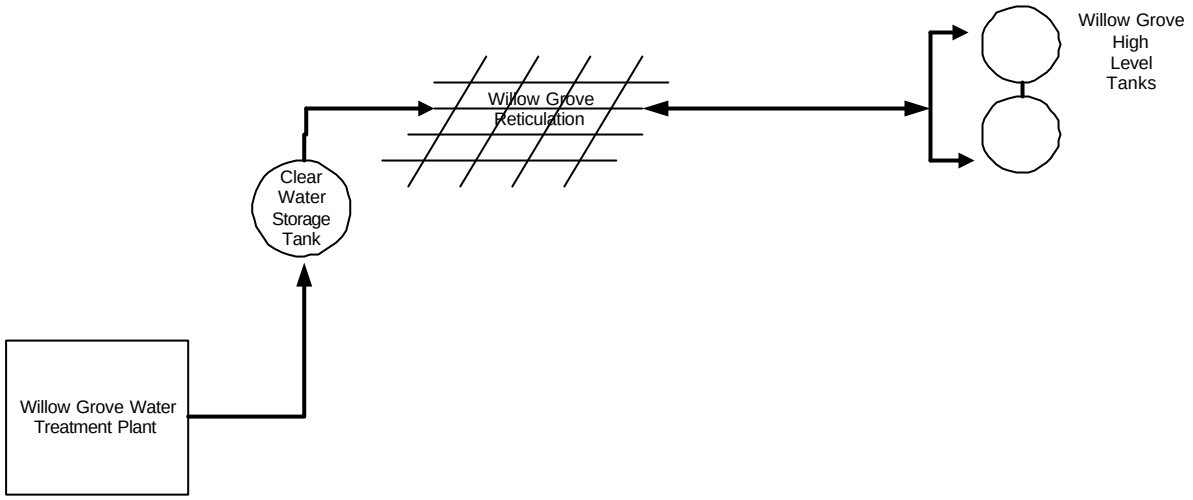
1.0 INTRODUCTION

The Willow Grove Water Treatment Plant was built and erected towards the end of 1999 by Water Treatment Solutions, a consortium of Latrobe Valley Engineering, Aluminates Pty Ltd and Works Filter Systems. Commissioning of the new plant began around mid November of 1999. The Willow Grove WTP draws raw water from Blue Rock reservoir and is situated approx 180km E of Melbourne.

Figure 1 : ***Location of Willow Grove***

The raw water is pumped to the WTP by one of two raw water pumps, then treated and stored in a 0.5 ML Clearwater tank on site. The WTP is a direct filtration plant with a flocculation tank, used for slow mixing, prior to the filter. Alum is used as the coagulant and the Betz 1115 polymer is used as a filtration aid with liquid soda ash used for pH control. On demand this water is then pumped through the town and up to the 2 High Level Tanks. These High Level tanks are situated about 3 kilometers out of town. The two High Level tanks have a total capacity of 180kL. Refer to Figure 2 for a schematic of the Willow Grove water supply.

Figure 2: ***Willow Grove reticulation schematic.***



The method of disinfection at Willow Grove is chloramination, which is achieved by adding chlorine and ammonia. The advantage of chloramination over chlorination is a much more persistent residual, which was required due to the low water consumption of the Willow Grove township. When chlorine and ammonia are added to water they react to form products called "chloramines". The species of chloramine that is desirable to form is monochloramine. Monochloramines are tested for when performing residuals.

The reason for forming monochloramine and not the other chloramines (dichloramine and trichloramine (nitrogen trichloride)) is because the dichloramine and trichloramine create taste and odour problems. Chloramines are known as the combined chlorine residual whereas in chlorination the formation of hypochlorous acid is known as the free chlorine residual (Water Training Centre 1999). Chloramine is not as reactive as chlorine with organic material in water, thereby producing substantially lower concentrations of disinfection by-products in the distribution system. Some disinfection by-products, such as the trihalomethanes (THMs) and haloacetic acids (HAAs), may have adverse health effects at high levels (East Bay Municipal Utility District Report 1998).

Because the chloramine residual is more stable and longer lasting than free chlorine, it provides better protection against bacterial regrowth in systems with large storage tanks, dead-end water mains and lower flow demands.

Chloramines are also effective in controlling biofilms, a coating of slime on the inside of the pipe caused by bacteria and other micro-organisms. Controlling biofilms also tends to reduce coliform concentrations. Because chloramines do not tend to react with organic compounds, the Willow Grove system has experienced fewer taste and odour complaints since converting from the use of sodium hypochlorite as a disinfectant.

2.0 DISCUSSION

2.1 Problem 1. - Unable to maintain Cl_2 residual when using Sodium Hypochlorite as a disinfectant.

Originally the Willow Grove system was disinfected using only sodium hypochlorite. Before the WTP was built sodium hypochlorite was dosed directly into the raw water line. Due to the long detention times associated with the system the High Level tanks had to be additionally dosed using calcium hypochlorite tablets several times per week. This system proved difficult to achieve satisfactory chlorine residual levels thus resulting in microbiological non-compliances. The concrete High Level tanks also caused the disinfected water to reach pH levels in excess of 9.00, another non-compliance with the Australian Drinking Water Guidelines (ADWG).

Solution 1.

To overcome the high pH's (caused by concrete leaching), both High Level tanks were lined with welded PVC sheeting and no pH problems have been evident since. In an attempt to improve the chorine residual a trial use of chloramination as the disinfectant was used for a short time before the new WTP was built. When the specification for the proposed WTP was written, an important part of the specification was the inclusion of a chloramination dosing system. Disinfection results from the trial on the untreated water using chloramination were encouraging.

2.2 Problem 2. - Difficulty in maintaining residuals when using Chloramines as a disinfectant

During the summer months when the demand was approximately double that of winter, the chloramination was working perfectly. The monochloramine residual leaving the plant was 1.2 ppm. The residual was similar or marginally lower in town and the High Level tanks had an average monochloramine residual of around 0.3 ppm. At this stage the operating level of the High Level tanks was 1.0m (90 kL) and 1.9m (175 kL). It should be noted that the volume of water in the pipe between the town and the High Level tanks is about 50kL and because of the single inlet / outlet line of the High Level tanks, when the pump starts the tanks are never fully replenished with freshly chloraminated water, as the water in the pipeline is shunted back and forth. (Refer to Figure 2.)

In March and April 2000 it was noticed that the residual in the High Level tanks was diminishing. This was attributed to lower water demand and got to a point when there was no residual whatsoever. For approximately 2 weeks chlorine tablets were added to the High Level tanks to give some form of disinfection but this was not desirable in the long term as it affects the chloramination process, and leads to undesirable taste and odours in the water. Excess amounts of chlorine added to chloraminated water will convert monochloramine into dichloramine and trichloramine.

Solution 2.

It was decided to change the operating level of the tanks to 0.3m (30 kL) and 1.9m (175 kL) to get more turnover of the water in the High Level Tanks. To achieve success with this strategy, the High Level tanks were first filled with freshly chloraminated water by opening the scour valves and draining the High Level tanks.

With the High Lift Pump running the water was scoured from the High Level tanks until a total chlorine residual of 1ppm was reached, then the scours were turned off and the High Level tanks were allowed to fill. Chloramination residuals were taken at the tanks every day for 2 weeks so Gippsland Water could get data on chloramine decay.

Chloramine residuals are still taken weekly with the tanks now maintaining a healthy monochloramine residual of about 0.4 $\rightarrow$ 0.5 ppm and a total chlorine residual of about 0.5 $\rightarrow$ 0.6 ppm.

2.3 Problem 3. Ammonia Decay And Lack Of Dosing Control.

Ammonia system history.

The ammonia storage at the water treatment plant was a 500L black poly tank situated at the edge of the chemical bund area. When the plant was commissioned it was using 9% ammonia. The reason this strength was used was:

- It is not classed as a Dangerous Good.
- The dosing pumps were sized to deliver the right ratio of ammonia at 9%.
- Gippsland Water gets good value for money (we are not paying to cart water around).
- Gippsland Water uses 9% ammonia at other sites.

After ordering a batch of 9% ammonia it was noticed that within a week the strength was about 4-5%. It was also noticed that during the hotter days the ammonia would decay more quickly due to it being released as ammonia gas that vented to the atmosphere. The ammonia tank is situated at the side of the chemical bund where it is exposed to the full rays of the sun for the majority of the day. The relatively small dosages of ammonia being used also proved a problem as at 9%, only 2-3mls/min was being delivered. This made it quite difficult to get an accurate feed rate. These small feed rates also caused another problem.

The ammonia in storage was lasting a couple of months between deliveries, and the longer it was sitting in the tank the more it would decay. It was getting to a stage where the strength had to be tested every couple of days. The result of this was the need to constantly change the dose rate therefore disrupting the chloramination process. It was a challenge to get consistent residual figures. The release of ammonia gas also caused the problem of air-locking of 2 Prominent gamma/4 1.02l/hr (1 duty / 1 standby) dosing pumps.

Solution 3.

After reviewing the problems listed above, it was decided that some alterations needed to be made to the ammonia tank/storage system. Visits were made to the Tyers and Neerim South WTP's (where chloramination has also been set up) to view their installations. It was decided that four areas of concern had to be addressed and overcome.

- The turnover time of the chemical in storage.
- The ammonia gas venting out of the tank.
- The sunlight being inflicted on the tank.
- Air – locking of the metering pumps.

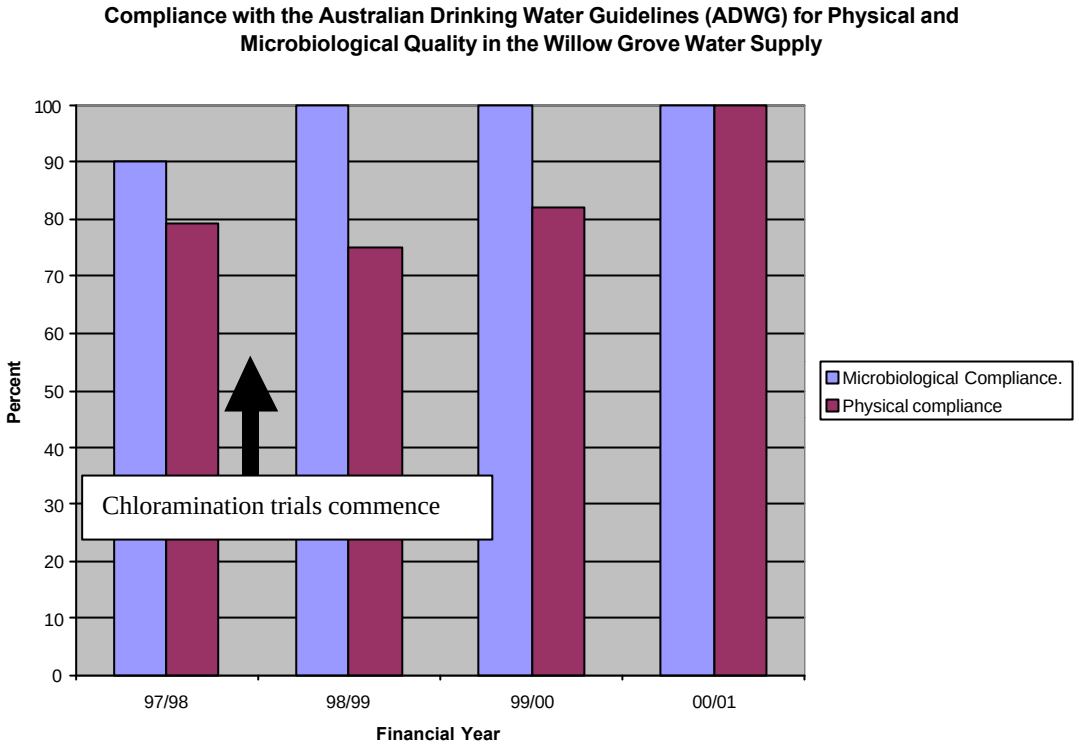
The following alterations were made to best alleviate these problems at minimal cost and minimal interruption.

- The 500L storage tank was replaced with a 200L tank.
- A water trap was installed on the top of the new tank to prevent vapour loss.
- A "Sun block" frame was installed with 2 layers of 70% UV resistant mesh.
- Auto de-gas heads were installed on metering pumps.

Since these alterations there have been minimal problems as a result of ammonia decay. There is now no need for continuous testing of the ammonia strength. There has been no need for "extra" ammonia deliveries as one is always made in conjunction with another chemical delivery. An ammonia delivery is now made once a month as opposed to about once every 3-4 months. The ammonia is always fresh and stable therefore making it easier to achieve correct dose rates. These improvements have saved a lot of time wasting (and frustration), and it is now easier and less of a worry for the stand-by or on-call operator to run the plant.

The system has been running for 9 months now and has been producing very consistent residual results with little need for dosing adjustments. Microbiological results are now 100% compliant with the Australian Drinking Water Guidelines. Refer to Figure 3 for an indication of the improvement to the Willow Grove reticulation system over the past few years as a result of the introduction of chloramination.

Figure 3 : ***Improvement in microbiological and physical compliance of Willow Grove water supply***



3.0 CONCLUSION

The disinfection conversion from sodium hypochlorite to chloramination in the Willow Grove system has proved a success. With its persistent residuals and minimization of taste and odours in the water, it has been welcomed by the Willow Grove community. With greater dosing control now possible than with sodium hypochlorite it is much easier to maintain disinfection residual levels that are adequate to ensure microbiological compliance.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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