GUARANTEED DISINFECTION RESIDUALS AT NETWORK EXTREMITIES BY SECONDARY CHLORINATION

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ABSTRACT

To reflect the fact that water flows from the Rosewood Reservoir Pumping Station in Orange NSW are highly variable, a new hypochlorite dosing system was installed.

Previously, a "fixed rate" injection of hypochlorite into the outlet of the 20 ML Reservoir, meant that residuals at the reticulation extents were also variable. The Orange City Council operating staff know the usual flow patterns, so this "fixed rate" can be altered for week days, holidays, weekends etc.

Orange City Council were also very aware of the need to protect their staff against accidental exposure to hypochlorite, therefore any new system must be designed with clear OH&S advantages.

1.0 INTRODUCTION

Orange is a growing town of approximately 40,000 people in the Central West of NSW. It has an advanced water treatment plant, from which seven pump station reservoirs are fed. The advanced water treatment plant in Icely Road Orange, has several treatment steps including sedimentation, ozonation (dual stage), activated carbon and final disinfection by chlorine gas. After that barrage, it is no wonder that pathogen counts are low.

The bulk chlorine gas injection works well, with a residual target of 1.0 mg/L normally achieved. From Icely Road the disinfected water has to travel around 4 km to the Rosewood reservoir. Depending on seasonal conditions, the water takes about 3 days to traverse the 20 ML reservoir. Water leaving the reservoir has a chlorine residual of 0.1-0.2 mg/L and requires secondary chlorination, to ensure a residual at the reticulation extremities.

Orange City Council has applied Stage 4 Water Restrictions to its residents (at the time of compiling this Paper), which means hand held hosing of gardens only twice a week. The times allotted to hosing are also quite tight. Because the large majority of consumers from the Rosewood Pumping Station are suburban households, very high demand is experienced at these times.

If Figure 1 is examined next page, an 11 hour period on a Sunday is shown from 0930 hrs to 2030 hrs. Sunday morning and lunchtime are popular times for consuming water, plus a large peak at around 1930 hrs, which corresponds to garden hosing time. When natural variations in weather are superimposed on top of this graph, it is evident that an automatic control system is required, to guarantee accurate chlorine residuals are maintained.

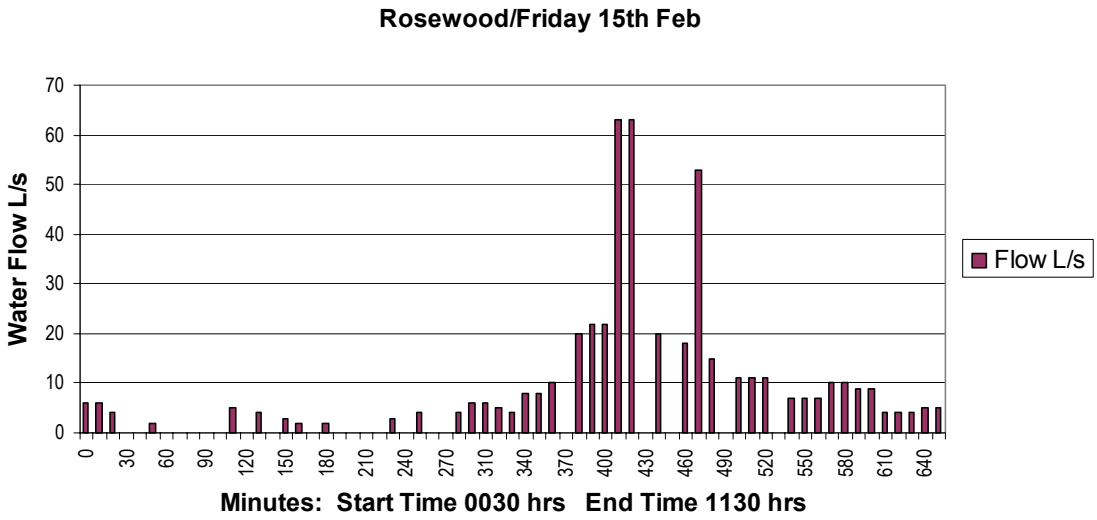

Figure 1: *Water Flow from Rosewood Reservoir 15th February 2008*

There are three delivery pumps in the Pump Station, with two larger units interlocked with one much smaller "jockey pump". As the demand varies, the pumps cut in and out regularly, therefore the demands on a hypo dosing system are quite onerous. Figure 1 reveals, that there are periods in the midnight to dawn period, that flows drop off to <1L/sec.

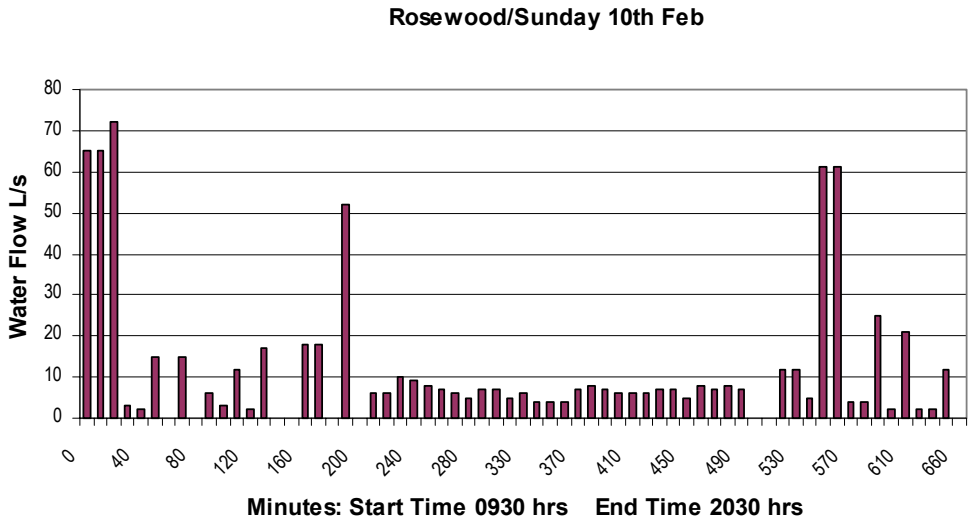

Figure 2: *Water Flow from Rosewood Reservoir 10th February 2008*

Figure 2 above shows the flow graph over a Sunday daytime, which is decidedly different to a Weekday, however once again the variance in flows is dramatic. Data taken from the Orange SCADA system shows minimum flow 0.00, maximum flow 73.0 and average flow 11.0 L/sec.

1.1 Former Installation for Hypochlorite Dosing

A simple fixed rate hypo dosing system, pumped from a 100 Litre drum of diluted hypo. Commercial grade hypo (approximately 12%) undergoes self degradation, whereby oxygen bubbles are released. If certain precautions are not taken, these oxygen bubbles can stall the pump, preventing delivery of the hypo. An operator would then be required to "burp" the pump, so normal operation can be resumed. If the commercial grade hypo is diluted to (say) 1:5, this degradation effect is not so pronounced.

Even though both stroke length and frequency of the dosing pump could be manually adjusted, there was no feed-forward signal from a flowmeter to enable automatic control. It was also not possible to obtain a feedback signal from a chlorine residual analyser to use as a control variable.

Regular measurements of chlorine residuals at households being fed from Rosewood Reservoir, showed a significant variation depending on flow rates, weather conditions, etc.

1.2 Desirable Features of a new Hypochlorite Dosing System

After discussions with the Treatment Plant Supervisor, the following features were called for:

- Ability to maintain constant chlorine residuals at variable water flows.
- No requirement to dilute the commercial hypo
- No maintenance problems with gassing off
- System designed to avoid operator contact with hypo
- Relatively small footprint/integrated system
- Communication options

Obviously, the ability to comply with the ADWG for all consumers is of prime importance to Orange City Council. The thing that strikes me about the Guidelines is the statement "disinfection is the single process, that has had the greatest impact on drinking water safety".

1.3 Description of Delivered Dosing System

Figure 3: ***Portachlor Hypochlorite dosing system***

The unit shown in Figure 3 is designed and manufactured by the AQ2 Company in WA, with the technology known as Smartaflow. In the Orange application, dosing is done on the outlet of the Reservoir using flow pacing with chlorine residual trim. Signals from the on site flow meter and a chlorine residual analyser are accepted by the Smartaflow unit and the pump controlled accordingly. It is also possible to have a dual pump assembly, whereby hypo is dosed at a tank inlet, and also dosed on the tank outlet to the consumer. Tank inlet dosing would be flow paced and tank outlet would be chlorine residual trimmed. At Orange, the size of the Rosewood Reservoir made it more practical to dose only on the outlet. Dosing occurs approx 5 meters up stream of the take-off point for the chlorine residual analyser, therefore the dead time in the feedback control loop is minimised.

1.4 Unique Features of the Installed Smartaflow System

Ability to Maintain Chlorine Residuals

A dosing system with a turndown ratio of >> 20 times and micro dosing (< 1.0 L/sec) capabilities, is required to maintain chlorine residuals at Rosewood. Using the flow and residual inputs, the Smartaflow controller utilises a standard control program for normal operation. Superimposed upon this, is a proprietary software algorithm developed for micro-dosing applications. This algorithm regulates the auto by-pass of the dosing pump, which means the exact volume of chemical per pulse is known. Only by utilising full stroke length and varying the pulse rate, can maximum accuracy be achieved. Indeed, similar installations in country WA and Victoria have proved beyond doubt, that the Smartaflow system can accurately dose at flows <0.2 L/sec. The final element in this system is the injection spear, which has an integral pressure-sustaining device, anti siphon/check valve and bypass valve. Backpressure on the Smartaflow pump can be regulated to counter any pressure changes in the water pipeline.

Figure 4: ***"Spearsafe" removeable injection spear***

The Spearsafe unit as shown in Figure 4 is the actual unit at Rosewood Reservoir. It can be automatically withdrawn from a pressurised pipeline to facilitate cleaning.

All materials used in the Spearsafe are completely compatible with hypo, which enhances the operator's safety.

Vapour Lock Problems Overcome

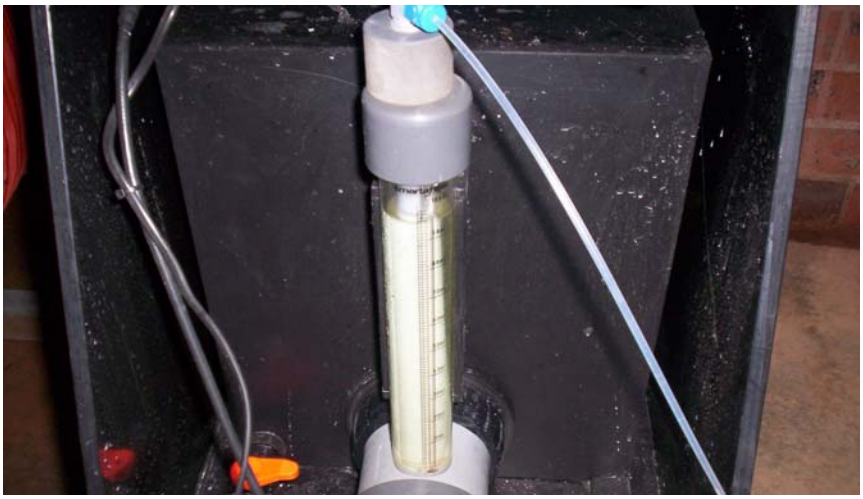

Figure 5: ***Smartaflow injection pump***

Figure 5 shows the Smartaflow dosing pump mounted at the bottom of the hypo storage tank in the Portachlor. Naturally, the semi-submersible design ensures a flooded suction, to all but eliminate pump stalling due to loss of prime. Coupled with this, is the automatic venting of gas built up during the degradation of hypo. This has been a real disadvantage of hypo dosing in the past. As well as the dosing being inaccurate, maintenance of the system caused lack of operator confidence and cost money. This problem has caused operators to look at alternative technologies such as hypo generating systems, which produce low strength hypo from salt. Low concentrations of hypo do not exhibit the same automatic degradation problems, as seen with commercial 12% hypo.

Large Advances in OH&S

In 2004, Smartaflow received a Worksafe Award for its development of safer working practices, in connection with the handling of sodium hypochlorite.

The ability to use easily available 15 or 20 litre containers of hypo is seen as a distinct advantage. No decanting of hypo from one container to another, with the commensurate risks of spillage. A specially developed "cap tap" replaces the normal lid on a hypo drum, which is then loaded into the Portachlor. When the operation storage vessel at the bottom of the Portachlor is depleted, an automatic replenishment occurs from the top hypo drum. The decanting can also be manually driven from the controller in the Portachlor.

The auto decanting system is also used with the larger dosing units such as Chlorisafe 60 and Chlorisafe 600.

The installation at Orange is conventional mains powered, however the Smartaflow units can be battery/solar powered. For installations in remote locations and/or emergency systems, the ability to operate without mains power is a huge plus.

Obviously the hypo container shown in Figure 3 looks familiar to operators of backyard swimming pools. By design, once the hypo container decants completely into the bottom operation vessel, there is only a "teaspoon" of hypo left in the upper container. This is also seen as an OH&S advantage, as no drums are left sitting around with significant quantities of hypo in them.

Because the operation storage vessel has an integral sight glass, it is easy to see the amount of chemical remaining.

Communication Options

This feature was seen as highly desirable for use in country and especially remote areas. As well as conventional hard wired analogue/digital connections to SCADA systems, a large range of other options are available.

The intelligent controller in the Smartaflow dosing systems has on-board capacity to store and transfer data using various modes of communication. The most simplified being cell phone networks, namely GSM, 3G and satellite. For operators in our industry, the ability to track system operation on a mobile phone, potentially avoids visits to site. A further step forward is configuration of the dosing system from an off-site computer. An example could be the remote change of the residual setpoint, when process conditions change quickly. Naturally, acquisition of on-site historical data can also be achieved.

Alternatively the Smartaflow controller uses an onboard MODBUS protocol, which allows it to interface with suitably configured RTU units operated by the Utility.

Space Requirements

The Portachlor does not take much space at all within the Rosewood Pumping Station. All the various elements of the dosing system are compacted into one unit, plus it is easy to expand the capabilities of the Portachlor. If extra dosing capacity is required, a simple modification to add a further pump can be made.

When you compare the space requirements of the Portachlor with a hypo generation system, the difference is clear.

2.0 CONCLUSION

Orange County Council has been operating the Portachlor in automatic control for over 3 months, with a set point of 0.7 mg/L as CL_2. Unfortunately the chlorine analyser output has not been logged by the SCADA system however random checks of residuals at consumer's premises have all been within specification. There have been no major maintenance problems, with one 20 Litre hypo container lasting about 5 days.

The Smartaflow system has shown that precise dosing of hypo into very low and often variable flows can be economically and safely achieved.

Many thanks to Geoff Warren and his operation staff for their enthusiasm to try new technology, in a bid counter well known problems.