SECONDARY DISINFECTION "TRIM" UNITS

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ABSTRACT

For many years now, water quality management has been frustrated by the appearance of various species of coliforms being detected in locations downstream of Disinfection treatment. Their presence has been attributed to many things including regrowth, ingress of contaminants via Fireplugs or faulty bird proofing of a Reservoir Roof, or occasionally, Disinfection Plant equipment failure. In any event, the finding of such, has led to the sometimes urgent requirement to treat the location in some form, generally by means of "spot dosing" with Sodium Hypochlorite. This Paper will discuss the means now in use by several large Water Authorities, to address this problem, using continuously on-line dosing units, deployed at various locations.

1.0 DISINFECTION LOCATION DIFICIENCIES

The Disinfection process is typically located at, or near, the source of supply. These locations would therefore include such places as the Outlets of Basins, Reservoirs, Rivers or Lakes. They are chosen logically, as they offer a means to disinfect all water leaving the source, prior to being offered for public use that may include drinking. Disinfection, by means of the addition of Chlorine (CL_2), can still be regarded as the most common method of treatment at these locations, and are regarded as "Primary" Disinfection sites. They may take place by the use of Chlorine as a Liquid form, or Gas, and are designed with the intention to meet specific criteria regarding the concentration of disinfectant with time (Ct).

It is under these circumstances, that chlorine is introduced to the body of water being treated for the first time.

Where Chlorine alone is used, the term "Break Point" Chlorination is applied. In the case of Disinfection by the addition of Ammonia (NH_3) as well as Chlorine, known as "Chloramination", the Ct is changed considerably. Both of these methods and techniques have been well documented and are not addressed in detail here. However, a significant result arising from either process is the degradation of the disinfectant after treatment, as it travels in the water into what can often be a very long and complex reticulation system of conduits that carry it to the end user. This degradation, termed "rate of decay", can vary from rapid and steep, to slow and slight. In some cases, the decay can be clearly identified at the point of treatment, and can account for a Chlorine Residual recorded trace that emulates that of the rate of water flow, in "Flow Paced" dosing systems. It can also account for Dosage values that double, triple, or even more at lower flow rates, in order to maintain a "Target" residual leaving the treatment site. This comes about as a result of applying Residual "Triming" control to systems that are Flow Paced, and is more significant where "Primary" Disinfection is in place, and applied to water of poor water quality.

Having met the Ct criteria, and all other requirements, the rate of decay will continue as it travels into the system, and is "consumed" by such things as slimes, iron fittings etc as well as the longer-term chemical reactions competing within the water itself. In these situations, a depleted disinfectant may be incapable of eliminating Coliform Bacteria that may be encountered in areas remote from the treatment site.

To counter this, several major Victorian Water Authorities, have introduced “Secondary” Disinfection by the deployment of small chlorination systems known as “Chlorine Residual Trim Units” (C.R.T.U.), located strategically “within” the reticulated systems. This paper discusses the basic ***method*** applied, ***capacity and limitations*** and ***benefits*** of such a treatment process.

2.0 METHOD

The method applied by C.R.T.U’s are conventional, using Flow Pacing and Residual “trimming” control techniques commonly found at most “Primary” Disinfection Plants. This type of control is also referred to as “Compound Loop” control, where the Feed Rate of chemical is generally determined by;

The Flow Rate of water being treated + The Deviation Error from the Target Chlorine Residual

However, some locations were found to have no Flow Meter available, in which case Residual Control only has been deployed. Other restrictive conditions that have been overcome include, (Fig. 1)

- Mains Power unavailable
- Security / High profile location
- Minimal space available
- Dangerous Goods Regulations compatibility
- “Wash down” water availability
- Sample Water Waste
- Telecommunications for alarms / data / control

Figure 1: ***Optional Battery Pack***

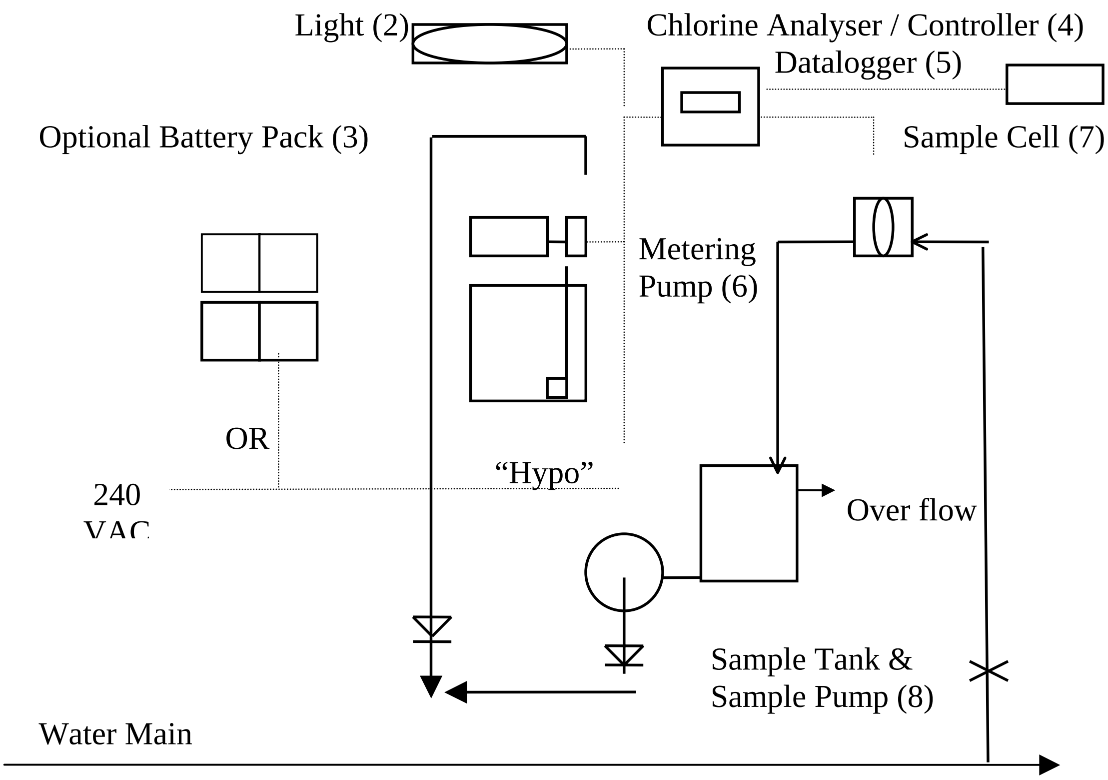
Optional Battery Power on “Roll-out” Draws, provides 7-8 days of continuous power.

Figure 2: ***Chemical Tank and Bund***

200 Ltr Chemical Tank & Bund.
Stainless Steel Sample Waste Return System

The procedures applied at most of the 30+ sites, now in operation in several major Victorian Water Authority Regions, follow a process developed by C-Tech Services Pty Ltd. The following schematic, (Fig.3), portrays the basic process, however, as one might anticipate, there are variations to suit local site conditions.

Figure 3: ***Schematic of Process***



3.0 OPERATION BRIEF

The Unit is strong but lightweight, which enables portability. In one instance, a Unit was "de-commissioned", re-located to another site approximately 40 Klms away, re-commissioned and placed back into operation within 6 Hours. The Cabinet style Units consist of two sealed compartments, each providing isolation from any corrosive or incompatible materials between chambers.

An "Optional" bank of 12VDC batteries (3) powers all instrumentation unless a 240 VAC source is available. A continuous power source is applied to a Chlorine residual Analyser / Controller (4), a small metering pump (6), a sample pump (8), and basic lighting. (2)

Water is supplied to a Sample Cell (7) via a pressure / flow limiter valve (not shown), and passes a chlorine sensor before draining into a sample tank. The sample tank is emptied approximately every 20 - 30 minutes, being returned to the main at a suitable location. (This location varies from site to site).

IMPORTANT: ***This design is suitable for flows in one direction only. Bi-Directional Flows will require an additional Analyser and associated interlock controls and power upgraded to suit.***

The chlorine residual is measured and controlled to a desired set-point by means of operating a metering pump (6) which injects low concentrate Sodium Hypochlorite into the main upstream.

The Controller (4) will stop the dosing when a level, slightly above the set-point is reached, and restart the dosing as the residual falls to a point just below the set-point. For this reason, the specially developed injection lance and sample off take points are located at a strategic point apart, to prevent large cyclic control. Also, if a Flow Meter Signal is available, this will provide additional proportional control to further enhance the Residual trimming control set up by the Chlorine Analyser.

During periods of zero “mains flow”, the upper cut off level will be reached and dosing will cease. This is achieved as the sample water continues to flow into the sample tank. If ***true*** zero flow conditions actually do exist, then the sample water loop will eventually reach a level that will cause the metering pump to remain off until water in the loop is changed, (mains flow increase).

Chlorine residual values being measured are continuously stored in an optional independently powered Data Logger (5) for later retrieval via phone and P.C. Modem. Alarms and control, by remote means are also available, (Optional).

Regular Chlorine Analyser calibration checks are necessary, and initially may need to be carried out frequently until confidence in optimum timing for this activity is assured.

A weekly visit to the Unit is therefore highly recommended, as chemical supply and general equipment inspection should be checked. If a Battery powered system is in use, then Batteries will also require weekly replacements to be made.

4.0 CAPACITY & LIMITATIONS

As an example of a system “capacity”, (Fig. 4), a unit could be sized to provide 200 Ltr. storage of low concentrate Sodium Hypochlorite chemical to last approx. 30 Days where the average consumption is 0.5 ML/Day, and a dosage of 0.8 mg/L. In this example, a Flow Rate could be estimated at between 0.2 & 20 L/Sec.

The limitation of this type of system is not only, “How big the Metering Pump is” or, “How high the Flow Rate is”. The limitation lies in “What the required Dosage will be, and how much Chemical storage is available?”

If for the same example, where the Dosage is say 2 mg/L, (Fig. 5), the Chemical storage will last only 12 days, and the Metering Pump will need to be capable of 2 ½ times the federate.

(*Note that 200 Ltrs of 5.9% “Hypo” should not require special HAZCHEM signage.*)

Figure 4: *System Capacity – 200 Litre Storage Dosing at 0.8mg/L*

L/Sec	L/Day	(ML/Day)	Dosage Req'd	HYPO Chem. Strength %	Chem Req'd (Litres/Day)	Pump Size L/Hr	Days of Storage Avail. using 200Ltr Tank
0.2	17,280	0.017	0.80	5.9	0.2	0.0	853.6
5	432,000	0.432			5.9	0.2	34.1
10	864,000	0.864			11.7	0.5	17.1
15	1,296,000	1.296			17.6	0.7	11.4
20	1,728,000	1.728			23.4	1.0	8.5

29.5 Days of "Hypo" Storage Capacity, where 24Hr. Consumption is approx. 0.5 ML

Figure 5: *System Capacity – 200 Litre Storage Dosing at 2.0mg/L*

L/Sec	L/Day	(ML/Day)	Dosage Req'd	HYPO Chem. Strength %	Chem Req'd (Liters/Day)	Pump Size L/Hr	Days of Storage Avail. using 200Ltr Tank
0.2	17,280	0.017	2.00	5.9	0.6	0.0	341.4
5	432,000	0.432			14.6	0.6	13.7
10	864,000	0.864			29.3	1.2	6.8
15	1,296,000	1.296			43.9	1.8	4.6
20	1,728,000	1.728			58.6	2.4	3.4

11.8 Days of "Hypo" Storage Capacity, where 24Hr. Consumption is approx. 0.5 ML

5.0 BENEFITS

Disinfection has traditionally been applied at the source of supply, and has become known as "Primary" Disinfection. Whilst this has been proven to be successful in treating the "bulk" water supply into a water supply system, it has limitations in maintaining an active disinfectant to remote parts of the system. This can often be in areas beyond secondary storages such as Standpipe Tanks and Storage Basins.

Intermittent Bacteriological "failures" occurring at these remote locations, for whatever reason, have become less tolerated in the quest to provide better quality water to the consumer. To this end, C.R.T.U. equipment enables the means to "top-up" the level of an active disinfectant, and reduce or remove these failures.

The Table shown in Fig 6 shows the Bacteriological results prior to, and following the installation of a C.R.T.U. in a Melbourne suburb, commencing operation in December, where an increased level of Free Chlorine was required to improve Water Quality Compliance. One can see that penetration of the active disinfectant into the area was progressive in improving the water quality. Fig. 7 shows a typical trend of data obtained for a similar site.

Figure 6: ***Bacteriological Results Pre and Post Installation of CRTU Equipment***

2002-03 Month	No: of samples	# Found with <20 coliforms		#Found with <10 coliforms		Found with <1 coliforms	
October	10	9	**90%**	9	**90%**	9	**90%**
November	8	7	**88%**	7	**88%**	5	**63%**
December (Start C.R.T.U.)	10	8	**80%**	8	**80%**	4	**40%**
January	9	9	**100%**	8	**89%**	7	**78%**
February	9	9	**100%**	9	**100%**	8	**89%**
March	9	9	**100%**	9	**100%**	8	**89%**
April	10	10	**100%**	10	**100%**	10	**100%**
May	9	9	**100%**	9	**100%**	8	**89%**
June	8	8	**100%**	8	**100%**	6	**75%**
July	10	10	**100%**	10	**100%**	9	**90%**
August	9	9	**100%**	9	**100%**	7	**78%**

Figure 7: ***Typical Trend for Data from a Similar Site***