# USE OF A STREAMING CURRENT DETECTOR AT WARRAGUL WATER TREATMENT PLANT


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# USE OF A STREAMING CURRENT DETECTOR AT WARRAGUL WATER TREATMENT PLANT

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## ABSTRACT

Warragul Water Treatment Plant is located approximately 110 kilometers west of Melbourne. The raw water is supplied from Pederson Weir, with very high turbidity and colour entering the plant during dirty water events. Gippsland Water decided to build a new DAFF Plant, which replaced the old clarification plant. The design of the plant included provision for a Milton Roy SC 5200 Streaming Current Detector (SCD), this was the first SCD to be installed and trialed at any of Gippsland Water's treatment plants.

The operation of this SCD required several changes to the set-up at the Warragul site. These changes included changing the planned Alum and pre-lime dosing points, installing a new sample point for the SCD unit, installing a smaller Alum dosing pump, and altering the pre-lime dosing system to provide better coagulation pH control.

These changes allowed the SCD to provide close control of the coagulation at the Warragul site, including managing dirty water events with turbidities up to 300 NTU's and colour of up to 300 PtCo. During these events the SCD manages coagulation dosing to produce suitable output quality.

These changes have significantly reduced chemical consumption and operator input, particularly during these dirty water events. This time is utilized for routine maintenance and further performance testing around the water treatment plant to better manage water quality,

## KEYWORDS

Streaming Current Detector (SCD), water treatment, turbidity, colour, pH control.

## 1.0 INTRODUCTION

The Warragul Water Treatment Plant is situated 5km north of Warragul on the main Neerim road. It supplies water to the townships of Drouin, Buln Buln, Rokeby, Nilma, Darnum and Warragul. This equates to a population of approximately 20,000 people.

The raw water is supplied from Pederson weir on the Tarago River which is located 8 km up stream from the Tarago Reservoir. The raw water is supplied by gravity to the Water Treatment Plant via a 450mm mild steel concrete lined main, 32 km's in length with an 80 meter static head . The supply main is limited to only 12 ML/day to the water treatment plant due to the size of the main and volume available from the catchment area.

The incoming raw water turbidity varies from 5 NTU TO 400 NTU and the colour from 10 PtCo to 300 PtCo. The raw water quality changes very dramatically, during heavy rains and storms. Due to this variability the original water treatment plant had a lot of difficulty, ensuring the correct Alum feed dose and removing the colour. Under normal operation jar tests had to be carried out at least twice a day and more often during varying raw water events. The water treatment was able to handle low turbidity raw water, but did not automatically adjust the chemical dosing during varying or high turbidity raw water events. These changing conditions also caused problems controlling coagulation pH.
Typical treated water quality results from the original water treatment plant were around 0.7 NTU to 1.2 NTU, colour units were from 5 to 10 PtCo. During high rainfall or storm events, significantly worse results were regularly obtained.

Gippsland Water was going through a process of improving, designing and reconstruction of Water Treatment Plants. At several sites, including Warragul, the existing plants were very old and the technology out of date. At Warragul, a tendering process for a design and construction contract was commenced. From analysis of the submissions, it was decided to construct a Dissolved Air Floatation/Filtration water treatment plant. This was to be the first water treatment plant of this type in Gippsland Water.

A contract was awarded to Aqua-Clear Technology P/L from Geelong, at a cost of $3.2M. This plant was designed to produce 20 ML/day, and be fully automated to reduce the operators work load and hours. Much of the design was based on similar works undertaken by the contractor for other authorities. During commissioning many of the differences at Warragul were highlighted and these had to be remedied.

## 2.0 CHEMICAL DOSING

The new water treatment plant design provided for the alum dosing point to be located 50 meters up stream from the inlet chamber. Also the alum dose rate was manually determined by doing jar tests. During early operation it was determined that the pin-flocc was breaking up in the inlet pipe, before it reached the inlet chamber. After testing alternative alum dosing points, it was found that 8 meters from the inlet chamber was the best spot. This change improved the coagulation, but did not assist control the correct dose rate, particularly in different raw water quality. Jar tests still had to be performed at least twice a day.

After much consideration it was decided to develop a coagulant dosing table (alum dose [ppm] versus raw water turbidity [NTU]). This table worked quiet well, however because of the indifferent raw water quality, it was not always correct and still required many jar tests to determine the correct dose rate and adjustment of the table. The water treatment plant utilises a pre-lime dosing system to control coagulation pH. This pre-lime system also worked manually and would always under dose or over dose, causing poor coagulation pH control, which resulted in bad coagulation (NO PIN-FLOC).

The original design of the water treatment plant included provision of a Streaming Current Detector (SCD) to be tested for suitability for controlling alum dosing in a water treatment plant of this type. These units had never been previously used in Gippsland Water's water treatment plants for coagulant dosing control.

## 3.0 STREAMING CURRENT DETECTOR (SCD)

A Milton Roy SC 5200 Streaming Current Detector was installed (with no weather protection), just above the inlet chamber. It was originally set-up with the sample being drawn from the pressure inlet main two meters after the alum dosing point. This model SCD unit has its own PID Controller to control the output to a dosing pump. However it was decided to utilize the control capabilities of the water treatment plant PLC for this purpose.

During every PLC program cycle the PID Control Loop the required Alum Dose-rate Set-point [ppm] is calculated.

The SCD output value is compared to the SCD controller Set-point, as follows:
Every minute the PLC performs the following calculations –

- If the SCD output is greater than the SCD controller set-point high limit then decrease the Alum dose-rate set-point by one;

- If the SCD output value is less than the SCD controller set-point low limit then increase the Alum dose-rate set-point by one

Where the SCD controller set-point high limit and the SCD controller set-point low limit are 0.5 above and 0.5 below the SCD controller set-point which is set by the operator. Any values within these limits will not change the current Alum dose-rate set-point. One unit SCD change is equivalent to 0.1mg/L change in the Alum dose-rate set-point.

The required alum dose is then calculated by multiplying the Alum dose-rate set-point by the raw water inflow to obtain the dose-rate in litres/hour. If selected by the operator, the supernatant return flow is added to the raw water inflow for this calculation.

The SCD unit output works with the setting and adjustment of the gain and the zero setting. The more gain means the higher the rate of change in the Alum dose rate when compared to SCD value, the less gain would drop the rate of change in the Alum dose rate when compared to SCD value. The zero setting also adjusts the Alum dose rate, if the zero is set on 1.00, you would automatically lift the alum dose rate, if the zero was on –1.00 it would drop the alum dose rate.

To setup the SCD output adjust the Zero to "0.00", select an appropriate control set-point (relating to good coagulation performance) and adjust the gain(±) to achieve the required rate of change in the Alum dose rate corresponding to the variation in raw water quality. This process sounds very straight forward, but this step actually took 12 months for the SCD to be set correctly. There are not a lot of problems in setting up an SCD, however it takes time. Following a change to the gain, a week of different types of water quality and jar tests to cross check, was required to assess how satisfactory the change was.

This SCD unit also has its own wash cycle, with over 8 different time settings, to wash the sensor probe to prevent contamination of the output. The unit at Warragul is set at half hour intervals to wash for 30 seconds.

## 4.0 PROBLEMS ENCOUNTED

### 4.1 Pre-Lime Dosing

The next problem was the coagulation pH control and the pre lime system, was being dosed directly into the inlet chamber and did not get enough time to mix and react the lime particles properly. These particles passed though the SCD causing incorrect readings and output, Alum over dosing and poor coagulation.

This prompted a week of tests to find the correct point for the pre lime, to be dosed. The best result was found 50 m upstream from the inlet chamber (prior to Alum dosing). Another problem was that the lime concentration strength was far too thick and was not mixed properly.

When a dirty water event occurred it would cause a high concentration of lime in the slurry bin with poor mixing and a lot of lime particles would continue to pass though the SCD causing false readings and again over dosing with Alum, which resulted in more lime.

After a lot of thought it was decided to alter the calculations in the PLC regarding control of the Lime feeders, and fit VSD's to the lime dosing mono pumps as part of a coagulation pH control. By adjusting the speed of the dosing pump to achieve the required coagulation pH, better control was achieved.

In addition, the PLC the lime feeder control was altered to provide lime solution strength of 1% up to 50 NTU, 2% from 50 NTU to 100 NTU and 3% from 100 NTU to150 NTU. This enabled the VSD on the mono pumps to ramp up to their maximum speeds before changing the lime solution strength, and drop to their minimum speeds when required to dilute the lime strength.

Now that the dosing points for the Alum and the pre-lime were working correctly, it enabled a trial of the SCD control with the indifferent types of dirty water that entered the Warragul Water Treatment plant, to commence.

### 4.2 Suitable SCD Sample and Installation

As previously discussed, the alum dosing point was moved to 8 meters from the inlet chamber, on the inlet manifold. A submersible sample pump was installed in the middle of the inlet chamber to provide a reliable well mixed sample water to the coagulation pH control probe and the SCD for more accurate response. Another reason for choosing this location is that it was after the addition of supernatant return water and the control system could adjust automatically for any changes in this quality.

A flow meter was installed on this sample pipe, so if the pump faults, and stops pumping water to the pH probe or the SCD unit, the water treatment plant will shut down, and alarm out and let the operator know there is a fault. This assists to stop any dirty (incorrectly dosed) water entering the plant. A weather proof stainless steel cabinet was fitted over the SCD to protect it and ensure reliable long-term operation.

### 4.3 Alum Pumping System

Another problem was the limited range the two Alum pumps had to ramp up and down. The pumps, as provided were ranged for 35 to140 litres/hour, to allow for the high turbidity water that enters the water treatment plant. The two pumps are on a duty/standy arrangement, which will automatically swap over if one fails. With this equipment, it was impossible to set the stroke and pulse rate for both high and low turbidity waters. It was decided to alter one of the pumps, and fit a 12 -35 litres/hour pump. Then by altering the PLC program, so the low pump controlled the low turbidity waters, then swap over to the larger pump when required by either high turbidity or high colour.

### 4.4 Highly Coloured Raw Water

At Warragul, the raw water has high colour that enters the water treatment plant after a dirty water event has started to subside. The old water treatment plant could not control this increased coloured water. The new water treatment plant, when running on the manual system also failed to control the colour.
The SCD certainly proved it could control the coagulation dosing to remove the colour from the water. The SCD picks up the colour in the water, and ramps up the Alum dosage by up to 20 ppm to assist remove the colour.

## 5.0 PERFORMANCE RESULTS

### 5.1 Dirty Water Events

Three years a go when the decision was made to use the SCD, many individuals were very skeptical about leaving a water treatment plant with the coagulation being controlled by an instrument and particularly since this instrument had not been used, not only in Gippsland Water, but at many other Water Authorities previously. It took a while to become familiar with the unit,

just to get the zero set and determine an appropriate set-point that was wanted. Altering the gain up and down certainly made big differences in the coagulation of the water.

At first, The SCD unit could control at very low Alum dosages at low turbidity, but it would fall behind when higher turbidity entered the water treatment plant. By turning the gain up a tweak certainly helped the SCD control dirty water events. It increased our Alum dose rate marginally, and controlled the coagulation really well. The SCD now controls the coagulation reliably under very varying raw water conditions without any jar tests being performed for over three years. The SCD unit has never failed, some dirty water events, with varied turbidity from 5 NTU to100 NTU in less than 10 minutes, with colour of up to 300 Pt Co. These high turbidity and high colour events occur regularly at the Warragul Water Treatment Plant, particularly in autumn.

## 5.2 Colour

The Warragul Water Treatment Plant had never been able to reliably remove colour from the incoming raw water. The old water treatment plant had a clarifier with no filters, jar tests had to be performed at least twice a day, as the PLC could not control the proper Alum dose rate for colour removal. The new water treatment plant, a Dissolved Air Floatation/Filtration system, was expected to remove approximately 80% of the colour.

With the SCD detector now working well with the turbidity variation, the next step was to trial the SCD to see if it could assist with the removal of colour from the raw water entering the plant. The SCD was now controlling the huge changes in the raw water turbidity very well, but continued to only removed about 75% of the colour. Although this was a big improvement, it was felt that with more tuning of the SCD it could remove nearly all the colour.

By altering the SCD gain over a period of six months, the SCD successfully managed to control the Alum dose rate to remove the colour . Now when the high coloured water enters the plant, the SCD automatically adjust the alum dose-rate set-point (up to 20 ppm higher) to remove the colour, even when the raw water turbidity is dropping off. The colour of treated water leaving is less than one PtCo, even during dirty water events.

## 5.3 Reduced Chemical Use

At the start of the commissioning at the Warragul Water Treatment Plant chemical consumption was very high. Because of the manual control, more alum was dosed than was needed because of inconsistent raw water turbidity entering the plant.
Even doing jar tests prompted the selection of dose rate that produced the best heaviest flocc. This flocc was much heavier than needed. This overdosing was to be improved by controlling coagulation with a dosing table (Alum dose rate verses raw water turbidity).

The raw water from Pederson Weir is very inconsistent and the control did not work all the time, often over dosing the alum, causing the pre lime to also over dose. With the SCD working correctly it lowered the dosage of alum and lime dramatically which adjusted the coagulation and flocc formation and definitely helped the Dissolved Air Floatation plant. With the coagulation of any water, you need the correct amount of Aluminium Ions to balance the negative charges on the dirt particles. It is then necessary to get the right flocculant dosing (polymer) to form the size the flocc required. DAFF flocc needs to by light and fluffy to lift easier. The SCD reduced the alum dosage by up to 50%. Typically the lower alum dose rate meant that the pre lime dose rate was also dropped by 50 %. A cationic polymer (1190) was installed at the water treatment plant to assist in removing the colour, since the SCD detector was working to its specification, this has not been used, even during dirty water events.

## 6.0 CONCLUSION

The SCD unit controlling coagulation has made the Warragul Water Treatment Plant a very reliable water treatment plant, even with each dirty water event. The high turbidity and colour prove to be no problem for the SCD. Chemical usage of Alum and Lime has dropped by approximately 50% and the 1190 polymer is not needed at all. This is a huge saving compared to the old plant, and the new plant before the SCD was put on line. The operators testing load to keep the water treatment plant performing well has decreased by up to 60 %,(as we have not done a jar test for over 3 years). This gives the operator time do other water parameter tests and routines. The maintenance of the SCD unit involves cleaning only every three months, and takes a half an hour.

## 7.0 ACKNOWLEGEMENT

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