THE EFFICIENCY OF CLARIFICATION/SEDIMENTATION AND DAF IN REDUCING PHYTOPLANKTON AT WARRNAMBOOL WTP

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ABSTRACT

The raw water sourced at the Warrnambool Water Treatment Plant (WTP) is a combination of approximately 10% ground water and 90% surface water from the Gellibrand River and two of its tributaries in the Otway forest, a pristine closed catchment (Johnstone & Johnstone, 1993). The water, generally low in turbidity (average 5.86) with an average color of 87 TCU, is piped approximately 81 kilometers to Warrnambool either directly or through a series of storages. Whilst the physical characteristics of the water are excellent, periodically, large abundances of phytoplankton and in particular filter clogging algae are present in the water. In March of 2006, a Dissolved Air Floatation (DAF) cell was commissioned at the Warrnambool WTP; this paper will compare and contrast the ability of both the existing clarifier and the DAF cell in removing the phytoplankton before it reaches the filters.

1.0 INTRODUCTION

1.1 Study Site

The Warrnambool WTP services a population of 32,500 people living in Warrnambool, Alansford and Koroit. Prior to January of 2006, it consisted of a clarifier with a 25ML capacity and 3 filters, which were backwashed under manual control with no PLC input. To ensure that the Warrnambool WTP was capable of keeping up with forecasted increasing demand, in 2003, the Warrnambool WTP was identified as requiring a capacity upgrade. Works commenced on building a 19ML DAF cell and extra filter in 2005 and hand over took place in January of 2006.

Currently, the Warrnambool WTP consists of a clarifier and DAF cell feeding settled/floated water into a common series of four filters (Figure 1). The raw surface water is dosed with aluminium sulphate, clearflox 549 as coagulants and polyflox 4593 as a flocculant. The treated water is fed into a flow splitter where the water is divided between the clarifier and DAF cell according to a programmed flow rate. The water then undergoes its respective treatment; untreated ground water is fed into the launders of the clarifier as a pH buffer. The clarifier and DAF cell both feed settled/floated water (at different input sites), through four dual media filters. The water treatment process is completed by dosing the filtered water with chlorine and ammonia for disinfection and lime to correct the pH. This water is stored in a 20ML storage where it is fed to the consumers on demand.

The raw water sourced for the Warrnambool WTP is primarily from the Otway catchment. The physical characteristics of the water are excellent with an average turbidity of 5.86 and true color of 87TCU. However the low turbidity of the water means that it periodically has a high abundance of phytoplankton particularly filter clogging algae to be processed through the Warrnambool WTP.

Historically, to combat filter clogging algae operators have dosed storages with copper sulphate and completed intensive backwashing of the filters.

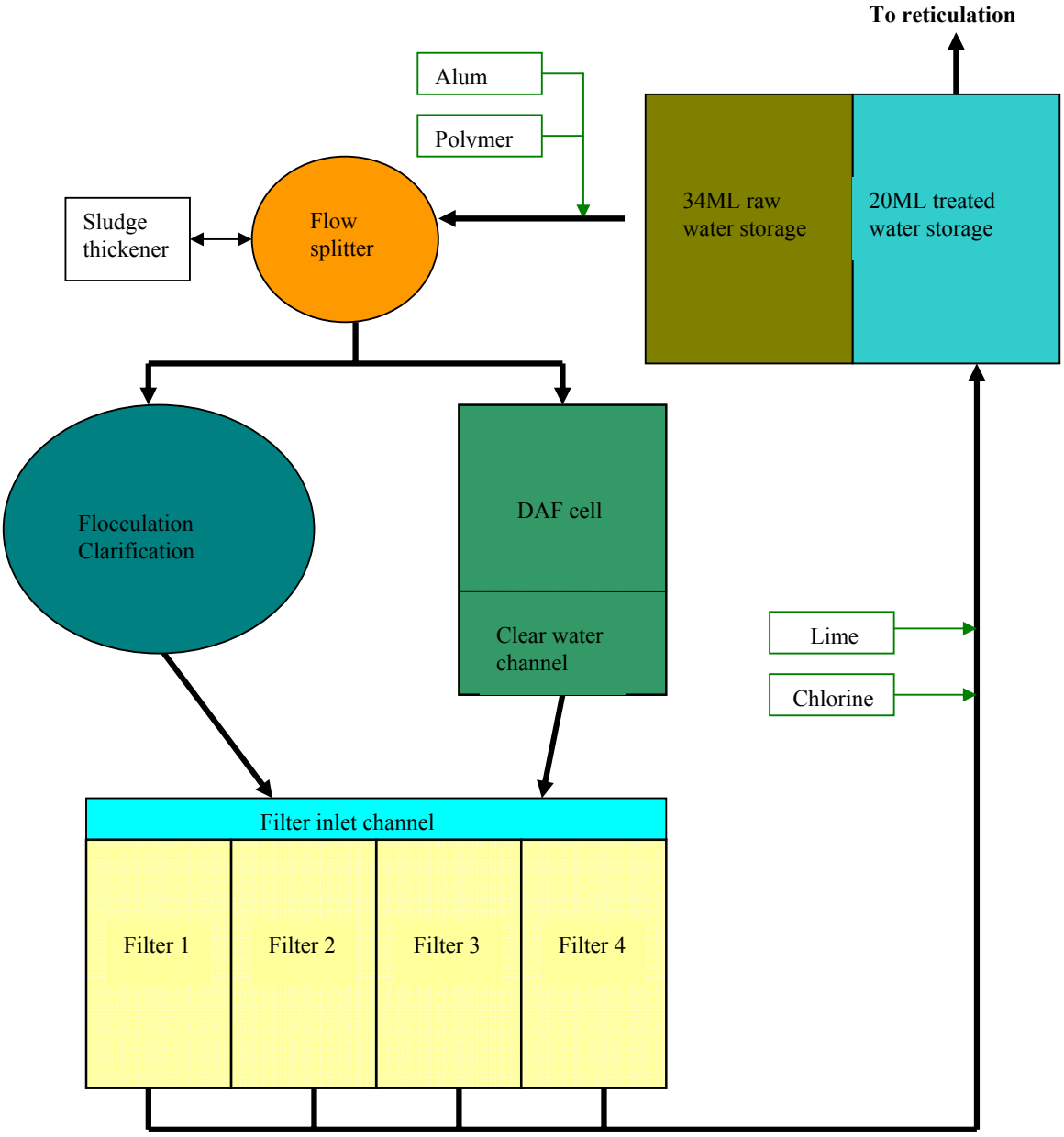

Figure 1: ***Basic schematic of the water flow and treatment process at the Warrnambool WTP***

1.2 Phytoplankton in the water supply

The presence of phytoplankton in the water supply of a water treatment plant is generally of concern to the operator as it can affect the plant performance and the quality of the end product.

Phytoplankton present in the water supply affects the treatment process by; clogging filters - shortening the filter run time, increasing the occurrence of disinfection by product, increased chance of microbial growth within the distribution system and more frequently, taste and odour complaints from customers. In addition to these observations, if certain types of phytoplankton, such as cyanobacteria are present in the end water product they can be toxic to the consumer.

Traditionally the presence of phytoplankton in the water supply has been combated with two common approaches used either in series or independently; (a) chemical treatment and (b) intense filter backwashing. Chemical treatment takes many forms and includes the use of copper sulphate, UV light, pre chlorination, or altering the coagulant and flocculant doses to achieve settling of the phytoplankton. The use of chemicals to kill the phytoplankton in the water can cause some species to release toxins which cause taste and odour problems within the reticulation. Altering the coagulatant and flocculant doses requires intensive monitoring as alternate species of phytoplankton differ greatly in their morphologies, sizes and shapes and often have protruding appendages such as spines or bristles. To achieve adequate flocculation and consequent settling of phytoplankton there must be enough flocc present to fill the gaps between the appendages (Hang-Bae Jun *et al.*, 2001). Intense backwashing is essentially a reactive approach and completed out of necessity as particular types of phytoplankton commonly referred to as filter clogging algae block the filters used in water treatment, increase the filter head loss and reduce the filter run time

The aim of this study is to identify if the clarifier or DAF cell is most effective treatment process in reducing phytoplankton abundance in the water.

2.0 METHODOLOGY

2.1 Sampling

- Sub surface samples were taken on a regular basis from the raw water source, clarifier and DAF cell.
- The raw water source sampling point was the laboratory raw water tap, by taking the samples at this point it meant that if the plant was to change from pumping to gravity during the study period the results would not be affected.
- The clarifier sample was taken just prior to the launders and care was taken to exclude any bore water from the sample.
- The DAF cell sample was taken in the clear water channel.
- All samples were taken in a 500ml polyethylene bottle and preserved 1:100 with lugols solution for later analysis.

2.2 Analysis and Enumeration

- Samples were gently inverted for 30 seconds and then 100ml of the sample was transferred to a 100ml measuring cylinder which was covered with parafilm to prevent evaporation.
- The samples were left to settle for approximately 24 hours or at least 1 hour for every cm in height of the cylinder.
- The sub sample was then decanted leaving only the bottom 10mL of solution in the measuring cylinder.

- 1mL of the solution was dispersed into a calibrated Sedgwick-Rafter microscopic slide for counting
- The slide was left for 1.5 hrs to settle
- The slide was examined under x200 magnification
- The cells were counted according to the method outlined in Hötzel and Croome (1999)
- 30 fields were examined and the cells counted
- The abundance of cells/mL was then calculated according to the following equation for each sample.

$$C[cells/mL\ ] = \frac{N \times 1000mm^3}{A \times D \times F}$$

Where: N = number of cells or units counted
A = area of field (mm^2)
D = depth of field (Sedgwick-Rafter chamber depth) (mm)
F = number of fields counted

3.0 RESULTS

Figure 2 demonstrates that for each set of samples the DAF sample exhibits the least abundance of phytoplankton. As the phytoplankton could not be speciated it is impossible to obtain from these results, whether the DAF cell is more effective at removing a particular type of phytoplankton than another for example, filter clogging algae. However it could be reasonable to assume that the reduction is applicable to all species of phytoplankton.

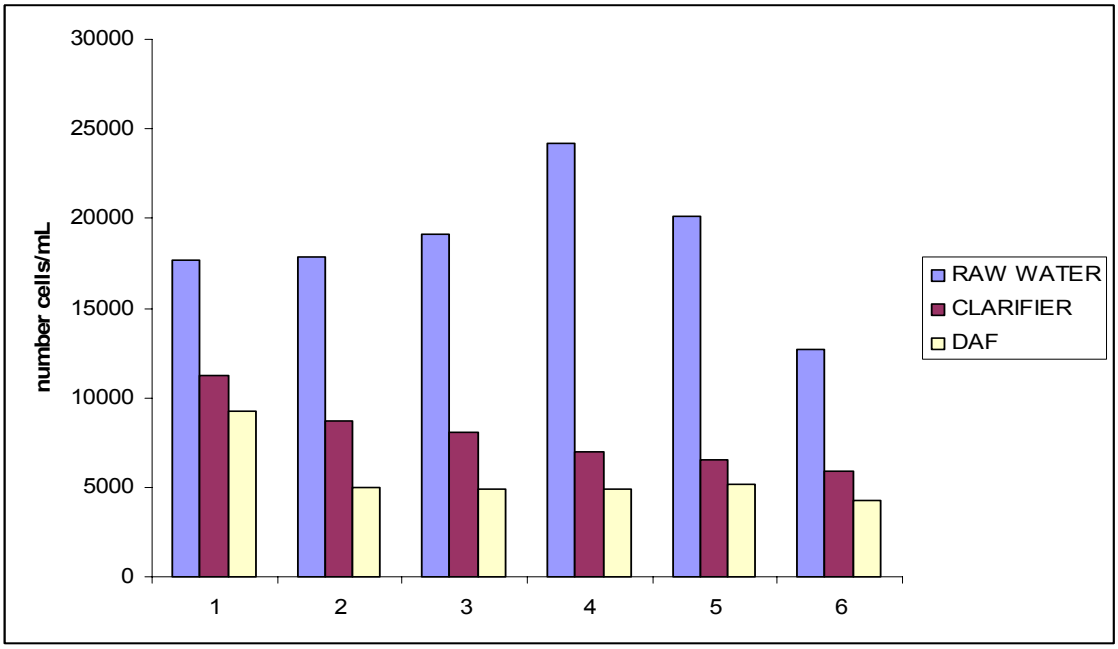

Figure 2: ***Graph showing the abundance of phytoplankton in each of the samples***

4.0 DISCUSSION

As shown in Figure 1 the Warrnambool WTP has only one coagulant and one flocculant dosing point for the water that that feeds both plants. Thus it can be assumed that any difference in the abundance of phytoplankton at the end of each treatment process is due to the process itself and not chemical optimisation. However, chemical dosage will influence the settleability of phytoplankton and therefore if the dose is optimised the clarifier should perform better than if it was not optimised. Figure 3 shows clearly that the DAF cell reduces a higher percentage of phytoplankton than the clarifier on all tested occasions. This observation is supported by plant experience - during mild filter clogging algae outbreaks filters 3 and 4 have exhibited longer run times than filters 1 and 2. As shown on Figure 1 the DAF cell feeds its clear water into the filter inlet channel at a point more likely to influence filters 3 and 4 and the clarifier's inlet is more likely to influence filters 1 and 2.

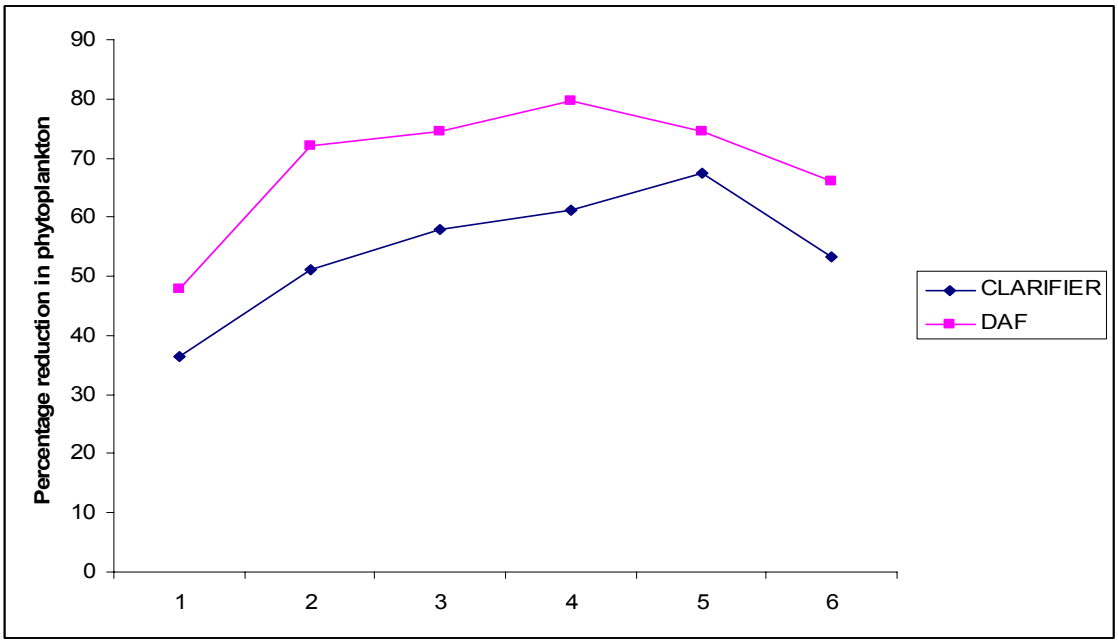

Figure 3: ***Graphical comparison of the efficiency of the DAF cell and clarifier in reducing phytoplankton from the water***

Throughout the study period the plant was run as per usual and the coagulant and flocculant dosages were determined so as to produce an end product with as low turbidity as possible. However these doses did not remain constant throughout the study period and it is possible that variations in these doses may account for some of the observed inconsistencies in the efficiency of both of the plants.

It is important to note that there are errors inherent in the counting of phytoplankton in water samples and thus the results given in this paper can simply be an informed estimate of the actual true numbers. However the reproducibility of the results, in that the DAF cell consistently out performs the clarifier in reducing phytoplankton from the water supply does indicate that the observations are valid.

5.0 CONCLUSION

On the dates that sampling was undertaken it can be concluded that the DAF cell was more efficient in reducing the abundance of phytoplankton from the water supply than the clarifier.

6.0 ACKNOWLEDGEMENTS

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