EVALUATION OF AN UPGRADE TO CSR VICTORIA MILL'S ACTIVATED SLUDGE PLANT

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Abstract

The performance of Victoria Mill's activated sludge treatment plant deteriorated recently as crushing rate increased. Recommendations for improvements from a 1991 study were implemented in part for the 1993 crushing season, and these were evaluated. There was some improvement in plant performance, but this may have been masked by greater than normal flyash and sugar spills during the 1993 crushing season. Observations throughout the season indicated that the upgrade made the plant much more resistant to major overloads, and faster to recover. Further recommendations from the 1991 study and 1993 evaluation are being considered for implementation for the 1994 season. In addition to changes recommended in operating procedures for the plant, a sugar spill recovery system is to be installed in the process house for the 1994 crush, and upgrade of the flyash plant has been aimed at reducing the incidence of spills.

Introduction

Victoria mill has operated an activated sludge plant for effluent treatment since 1973. It treats all liquid waste streams from the mill, including excess cooling water, losses to process drains and storm water runoff. The mill is licensed to discharge up to 3300 m^3 per day of treated final effluent to a local creek. The licence conditions require that this discharge does not exceed 20 mg/L Biochemical Oxygen Demand (BOD) or 30 mg/L suspended solids, with a minimum of 2 mg/L of dissolved oxygen (DO) and pH 6.0–8.5.

Until 1988, these licence conditions were met and the final effluent was suitable for direct discharge except under abnormal conditions, such as the end-of-season washdown or following a major spill, where effluent was pumped to lagoons. However, as factory crushing rate increased, compliance with licence conditions became the exception rather than the rule, so final effluent was held in large lagoons and discharged when it returned to a satisfactory condition. These lagoons risk being overloaded if poor quality effluent is pumped to them for long periods. A study to determine why the plant was unable to perform satisfactorily and how to rectify this was performed by Uniquest Ltd in 1991, (Krol *et al.*, 1992). The study made a number of recommendations which were implemented in part during the 1993 slack season. In addition, a Bailey Network 90 control system was installed to automate control of the plant. During the 1993 season, an undergraduate environmental engineering student performed a study similar to the 1991 Uniquest study to evaluate the results of the upgrade and recommend further improvements (Ferris, 1993).

KEYWORDS: Effluent Treatment, Activated Sludge, Waste Water, Ponds, Aeration, Control

Details of plant upgrade

Process flow diagrams before and after the upgrade are detailed in Figures 1 and 2. The primary clarifier, which is not normally present in such systems, dates back to the original design where the primary sludge population was predominantly anaerobic. This is no longer the case; therefore, this clarifier is redundant.

Changes made for the 1993 season were:

- Conversion of the previous weekend pond (storing washdown material for later release) to a continuous equalisation pond (buffer pond) with automatic level control.
- Replacement of an old 11 kW surface splasher aerator with a new 11 kW deep mixing/aerating device.
- Installation of a new 37 kW deep mixing/aerating device into the primary pond to improve mixing and to aerate the full depth of the pond.
- Automatic level control of the primary pond.
- Installation of a two stage pH control scheme to control the pH of incoming influent and the feed to the primary pond.
- Automatic control of the two clarifier sludge returns (to optimise sludge recycle rates and hydraulic loads).
- Automation of the sludge bleeding functions.
- Indication of pump status and flowrates throughout the system.

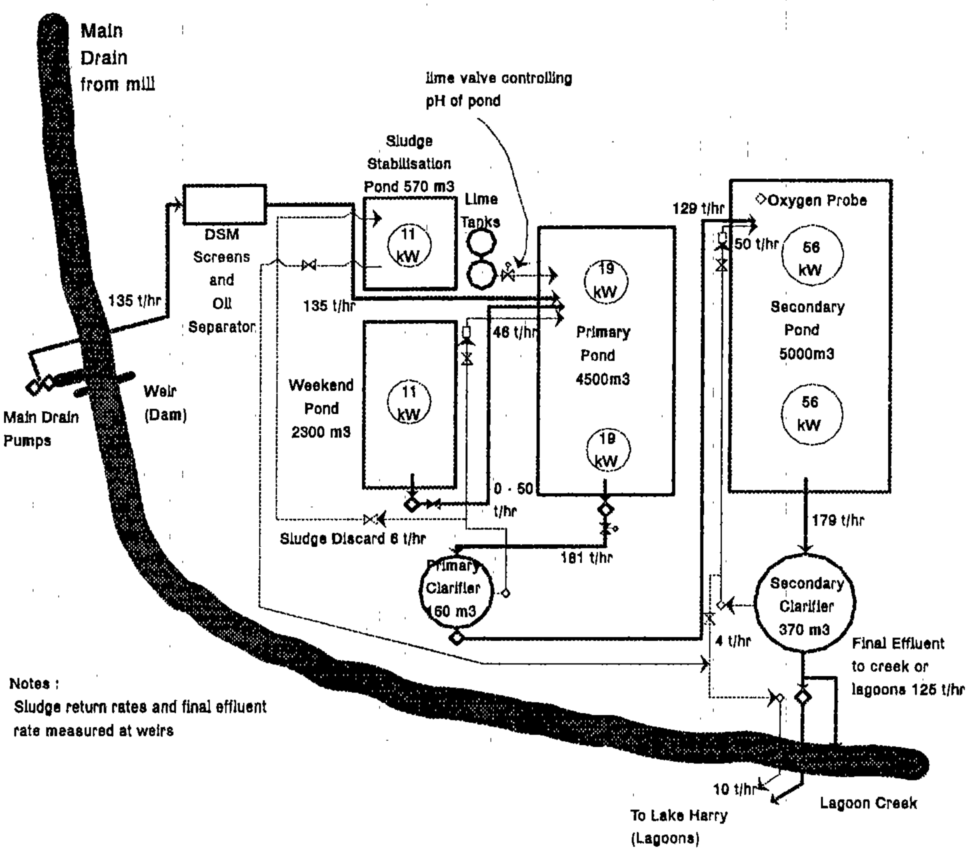

Fig. 1—Flow scheme of effluent treatment plant prior to upgrade.

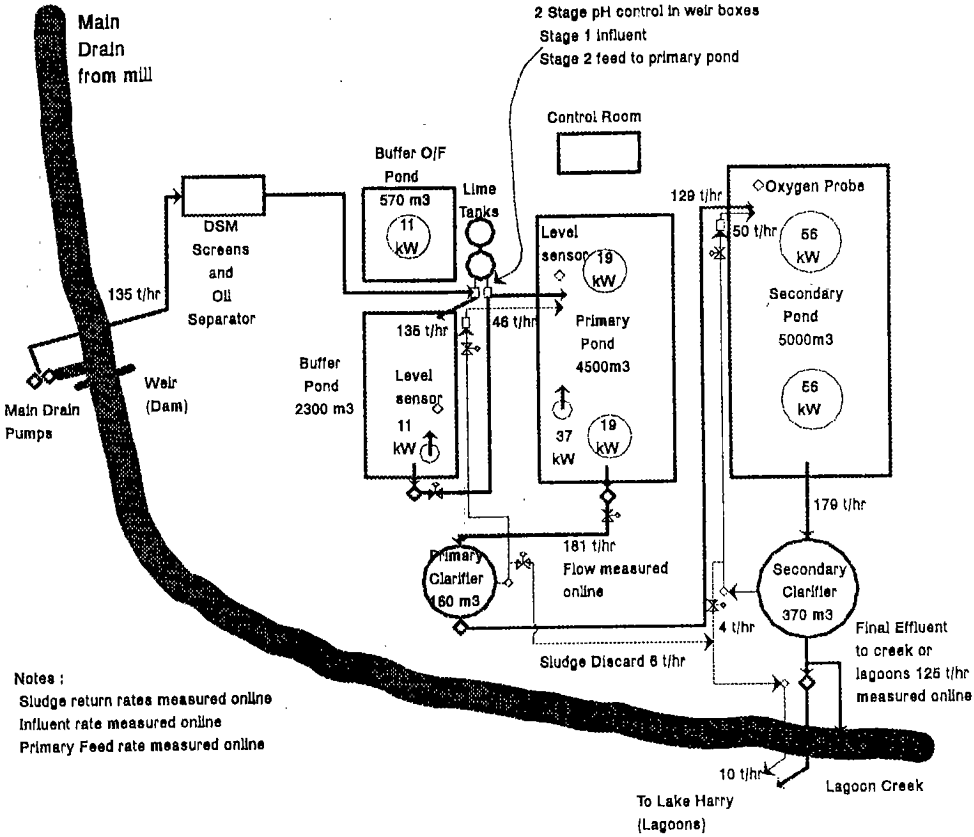

Fig. 2—Flow scheme of effluent treatment plant post upgrade.

In addition to the physical changes, improved nutrient addition and monitoring was implemented. As a result, $30,000 was spent on granulated urea, granulated Tec feed (a proprietary trace element fertiliser), and liquid phosphoric acid during the season. Records dating back to the 1970s show similar quantities of nutrients were used then. In recent years, far smaller quantities of nutrients have been added.

Uniquest made a number of recommendations that were not addressed in this upgrade. The most important were to change the primary clarifier to a duty in parallel with the existing final clarifier, and modifications to improve the plug flow character of the system.

Performance evaluation

Before any comparison of data is made it is important to note that the quality and quantity of influent to the plant fluctuates over a wide range, dependent on specific incidents and operating conditions within the factory, as well as seasonal and weather variations. These variations must be taken into account when comparing the performance of the plant over relatively short time periods (i.e., from a few weeks to even whole seasons). This was particularly significant in 1993 when teething problems with a new sugar handling system and regular flyash spills significantly increased the loading on the effluent treatment system.

A summary of results of the studies before and after the upgrade are detailed in Tables I and II. Note that effluent which does not meet licence requirements is pumped to large lagoons for further treatment and holding, instead of being discharged.

TABLE I—Performance of plant in terms of BOD, COD and Suspended Solids (ss) — Anon. (1973–1993).

	Infl. BOD mg/L	Infl. COD mg/L	Infl. Rate t/day	Effl. BOD mg/L	Effl. S.S. mg/L	COD mg/L	BOD removal t/day	COD removal t/day
Before (5 yr av.)	650	—	3050	86	80	—	1.7	—
Before (Krol *et al.*, 1992)	625	2080	2640	59	123	265	1.2	4.9
After (Mill analyses)	640	—	2905	48	38	—	1.7	—
After (Ferris, 1993)	650	1490	3300	105	57	147	1.8	4.4

TABLE II—Plant performance — effluent quality relative to licence requirements — Anon. (1973–1993).

	% BOD <20 mg/L (in licence)	% Sus. Solids <30 mg/L (in licence)	% Dissolved O_2 <2 mg/L (in licence)	% Total Compliance
Before (5 yr av.)	40%	36%	88%	34%
Before (Krol *et al.*, 1992)	11%	0%	100%	0%
After (Mill analyses)	54%	57%	95%	38%
After (Ferris, 1993)	60%	20%	80%	20%

Removal of oxygen demand: There was no significant improvement in the rate of BOD removal since the upgrade, ignoring the result from Krol *et al.* (1992). It is most probable that the rate of BOD removal in 1991 found by Krol *et al.* was low because the COD:BOD ratio (and consequently the concentration of non-biodegradable wastes) was unusually high. It was noted that during this trial the microbial population was considerably stressed. This may have been due to the toxic effects of an unusually large non-biodegradable oxygen demand.

The results in Table I indicate the incoming BOD to the plant has stayed relatively constant over the years, but the incoming COD varied by 80%. This is confirmed by individual results from the two studies, where influent COD varied from 400–6000 mg/L in 1991 and 200–3500 mg/L in 1993. This variation could be put down to boiler flyash spills and possibly oil spills, but this is unproven at this stage. Future work will focus on areas of waste minimisation, with a process house sugar recovery system being installed for the 1994 crush.

According to Krol *et al.* (1992) the available aeration equipment should have been capable of removing 3.25 t/day of COD (at a BOD:COD ratio of 1:1). The actual results vary between 4.4 and 4.9 t/day, which is better than can be expected. However, the demand on the plant is often significantly higher than this due to spills, and thus the final effluent BOD rises above the licence limit. This is compounded by the effect of suspended solids carryover in the final clarifier.

Reduction of suspended solids: There appears to be some improvement in the level of suspended solids in final effluent since the upgrade. These levels are still in general too high. A combination of solids loadings exceeding the design limit for the final clarifier, nutrient deficiencies and poor plug flow nature of the plant cause excessive carryover of suspended solids to the final effluent, Krol *et al.* (1992). It is worth noting that for every 1 mg/L of suspended solids over the normal 30 mg/L licence requirement the BOD is increased by 0.3 mg/L (Ferris, 1993). During the 1993 season the dissolved oxygen was often high while the BOD was still in the out-of-licence range. This is most likely due to the carryover of suspended organisms. Under normal circumstances at dissolved oxygen levels above 2 mg/L, and a healthy settling sludge, the BOD is well within licence requirements.

Conclusions

As stated, comparing the performance of the plant between any two seasons must be done carefully because the performance of the plant is greatly influenced by specific incidents within the factory and by seasonal factors. Bearing this in mind the performance of the plant was improved by 10% in comparison to the average compliance to licence conditions for the years 1988–1993. It should be noted that in the weeks following the study by Ferris (1993), i.e., the second half of the season, the final effluent was fully within licence requirements for more than 60% of the time. In addition, the system showed more resilience to, and rapid recovery from, shock loads in comparison with previous years.

Further work is required to improve the performance of the plant until it regularly achieves satisfactory final effluent quality. This will avoid the holding capacity and treatment capabilities of the lagoons known as Lake Harry being overtaxed. Ideally, the need to use these lagoons should be eliminated, except in extreme circumstances. In addition to work within the factory with regards to waste minimisation, the following recommendations will be considered for implementation in 1994 and later:

- Conversion of the lagoons to an artificial wetland (reed bed) to polish final effluent.
- Converting the primary clarifier to a duty in parallel with the existing final clarifier.
- Return secondary sludge to the primary pond.
- Operate a significantly lower concentration of solids in the ponds.
- Install further mixing/aeration power to the buffer pond.
- Install roughly 75 kW of additional mixing/aeration in the primary pond.

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