PIMPAMA WWTP DEWATERING OPTIMISATION

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1.0 INTRODUCTION

Following the commissioning of the Pimpama WWTP in September 2008, optimisation activities have ensued. Sludge dewatering and removal costs constitute approximately 20% of the plant operating costs and are consequently a prime focus for optimisation.

The Pimpama biological treatment process is currently loaded at one third of capacity; the bioreactor is operated at an exceptionally long sludge age to bring the solids concentration up to an acceptable level, averaging 2700 mg/L. Bioreactor mixed liquor is wasted directly onto belt presses with an integrated gravity section. Powder poly is batched and dosed at an average rate of 2.6 kg poly / dry tonne solids (kg/dt).

The dewatered cake total solids have averaged 14.3%, which is acceptable in comparison with other installations, however the solids capture rate has been exceptionally poor at 73%, failing the performance criteria specified for this equipment.

This paper will describe work undertaken to optimise the dewatering performance.

2.0 EQUIPMENT CRITIQUE

To optimise dewatering performance it is essential to accurately measure the applied poly dose. This requires measurement of the:

- Sludge flowrate
- Sludge concentration
- Poly flowrate
- Poly concentration

The sludge flowrate is measured with magnetic flowmeters. The sludge concentration is measured daily and changes only slowly due to the large volume of the bioreactor. However, measuring the poly flowrate and concentration was problematic.

The plant designers had elected not to install poly flowmeters and instead estimated the poly flowrate from the speed of the positive displacement dosing pumps. This required drawdown tests to measure the flowrate at different pump speeds and the calculation of regression parameters defining the relationship between pump speed and flowrate. The calibration cylinder was installed at an elevation that made it only possible to fill when the batching tank was nearly full, being approximately 15 mins out of every 2 hours, making it inconvenient and time consuming to perform drawdown tests. When these calibrations were performed it was found that the plant commissioners and control system programmers had confused the pump speed units of % with Hz, and consequently the pump was delivering half the dose that the control system calculated.

A semi-continuous poly batching system was installed in which poly overflowed from the batching tank into the dosing tank, rather than comprising separate batching and dosing tanks. When this system batches, the powder poly is added for only a fraction of the time that the make-up water is added, resulting in the plug of high concentration poly flowing through the system, despite the presence of mixers. The concentration of poly being drawn from the system was measured at intervals while a volume equivalent to one batch was drawn from the system. The results, presented in Figure 1, confirm that the concentration of poly varies by between 0.202% and 0.228%.

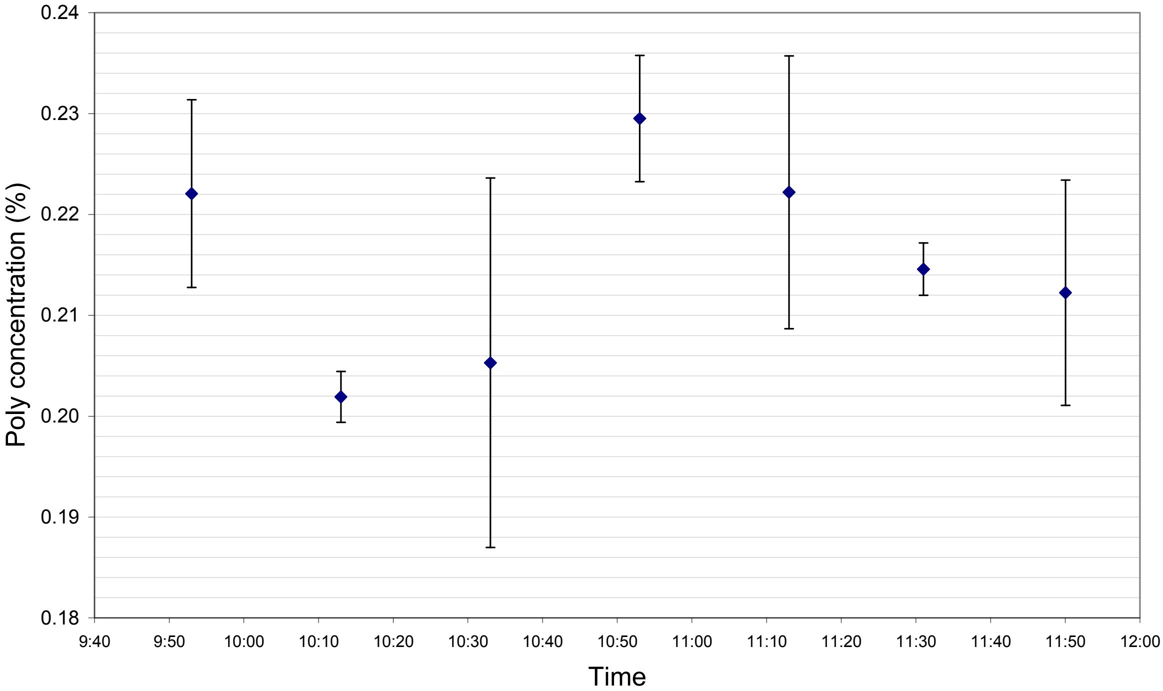

Figure 1: ***Poly solution concentration consistency***

3.0 POLY TRIALS

3.1 Aim and Method

Our poly supplier, BASF/Chemiplas, advised there was a possibility that alternative polymers could improve the dewatering performance, in particular the poor solids capture rate. We agreed to investigate this line of enquiry by performing an initial jar test screening followed by full scale belt press trials if a promising alternative poly was identified.

BASF/Chemiplas screening identified one alternative powder poly with the same cationic charge but a higher molecular weight and one cross-linked liquid poly that displayed good flocculating performance in the jar.

It was believed that the poor capture rate was caused by shallow cake thickness with a substantial proportion of solids becoming enmeshed in the belt, sliding under the doctor blades and being washed off into the filtrate. Innovative lab-scale testing by BASF/Chemiplas was performed using a small sample of belt which demonstrated that less sludge stuck to the belt when flocculated with the liquid poly, raising the likelihood that this poly may improve the capture rate to an acceptable level.

The alternative powder poly was batched and dosed over the course of a three day trial. The batching equipment onsite was unable to batch liquid poly, so it was initially batched in a 1000 L container for a one day trial, then in a portable liquid batching system for an extended one week trial.

For each dose rate, three samples of dewatered cake and three samples of filtrate were collected and analysed for solids concentration. Feed solids concentration was measured once per day as it does not vary significantly over the course of several hours.

There are many settings on a belt press that can be varied, including belt speed, sludge feed flowrate, belt tension, dilution water flowrate, poly injection location and poly dose rate. Our strategy was to keep these settings as constant as possible with the exception of belt speed and poly dose rate. Trials were conducted at the normal belt speed setting of 50%, and at reduced belt speed settings as low as 25% to produce a thicker cake, based on the theory that the capture rate could be improved with a thicker cake that clung together, rather than becoming enmeshed in the belt.

3.2 Results

The dewatered cake produced by the alternative powder poly was not significantly drier than the baseline. The capture rate with the alternative powder poly was a couple of percent higher at a higher poly dose rate, but not high enough to be considered adequate. No further results are shown.

The results from the liquid poly trial are presented in Figure2, showing both cake solids and capture rate as functions of poly dose rate. This data includes both normal belt speed and slow belt speeds.

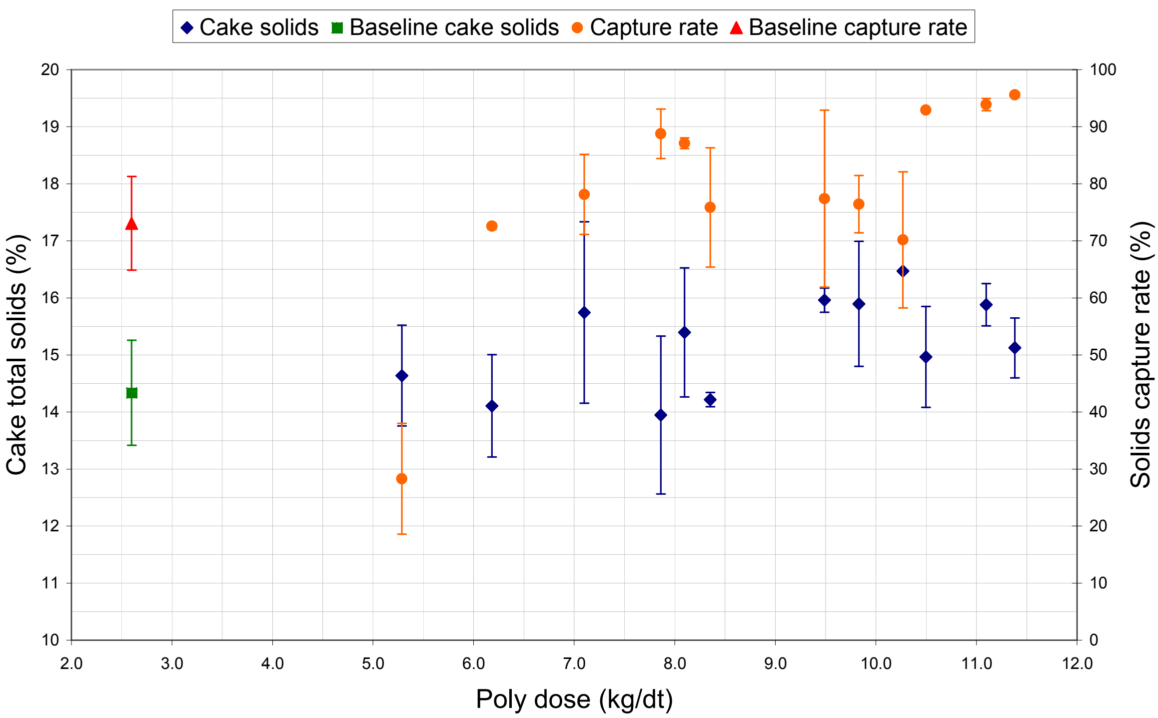

Figure 2: ***Liquid poly trial results***

Figure reveals that the capture rate can be lifted above 90% at dose rates greater than 10.5 kg/dt. At this dose the cake solids are likely to be approximately 15.0% - 15.5%. These results were achieved at a slow belt speed. The results measured at 8.1 kg/dt were also of interest, being 87% capture rate and 15.4% cake solids. These results were achieved by heavily loading the belt press to achieve a thicker cake. It was interesting to observe that results measured at higher dose rates did not achieve better results unless the belt press was heavily loaded.

Therefore two scenarios were carried forward for costing:

- Poly dose of 8.1 kg/dt, achieving 15% cake solids and 87% capture rate.
- Poly dose of 10.5 kg/dt, achieving 15% cake solids and 93% capture rate.

As previously stated, the baseline powder poly performance from historical data was:

- Poly dose of 2.6 kg/dt, achieving 14.34% cake solids and 73% capture rate.

4.0 COST ANALYSIS

4.1 Method

The liquid poly scenarios were costed on the basis that a mass of dry solids equivalent to the baseline were wasted. Therefore these scenarios will require less run time to achieve the same dry solids production due to the improved capture rate.

To determine whether switching to liquid poly permanently would reduce costs it was necessary to perform an analysis of total dewatering costs, constituted by these categories:

- Biosolids haulage
- Poly
- Maintenance
- Electricity

Maintenance costs can be further broken down into corrective and preventative categories. Reduced run hours will reduce the wear on the machines and reduce the frequency of corrective maintenance requirements. Preventative maintenance, performed monthly and six monthly was assumed to be unaffected by reduced run hours and has been excluded from this analysis. An estimate of corrective maintenance costs per run hour was made by accounting for all spare parts and labour spent on the machines over the previous 3.5 years of service.

Electricity costs were calculated, taking into account service water pumps for spray bars, filtrate pumping, belt press drives, sludge feed pumps and poly batching and dosing. Both peak and off-peak electricity rates were captured by these calculations.

4.2 Results

Corrective maintenance costs were calculated to be approximately \$2.50 per run hour.

The electricity consumption breakdown for dewatering equipment is presented in Figure and shows that over half the electricity is consumed by the service water pumps to provide cleaning of the belts. The belt press drive constitutes less than 2% of dewatering electricity consumption.

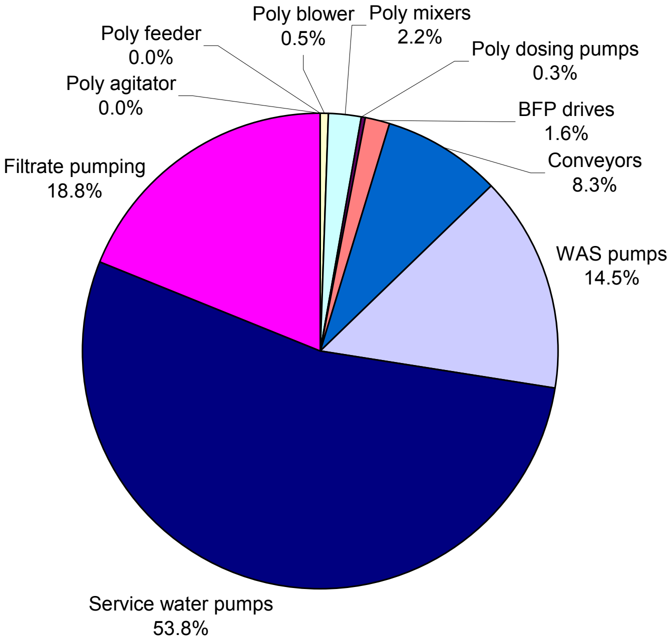

Figure 3: ***Dewatering equipment electricity consumption breakdown***

It was calculated that baseline total daily dewatering costs were approximately $1000, as shown in Figure 4. By comparison the scenario of liquid poly dosed at 10.5 kg/dt was calculated to cost approximately $1100 per day - reduced costs for electricity, maintenance and biosolids haulage were more than offset by the increased expenditure for poly. The scenario with liquid poly dosed at 8.1 kg/dt was calculated to cost approximately $1050 per day.

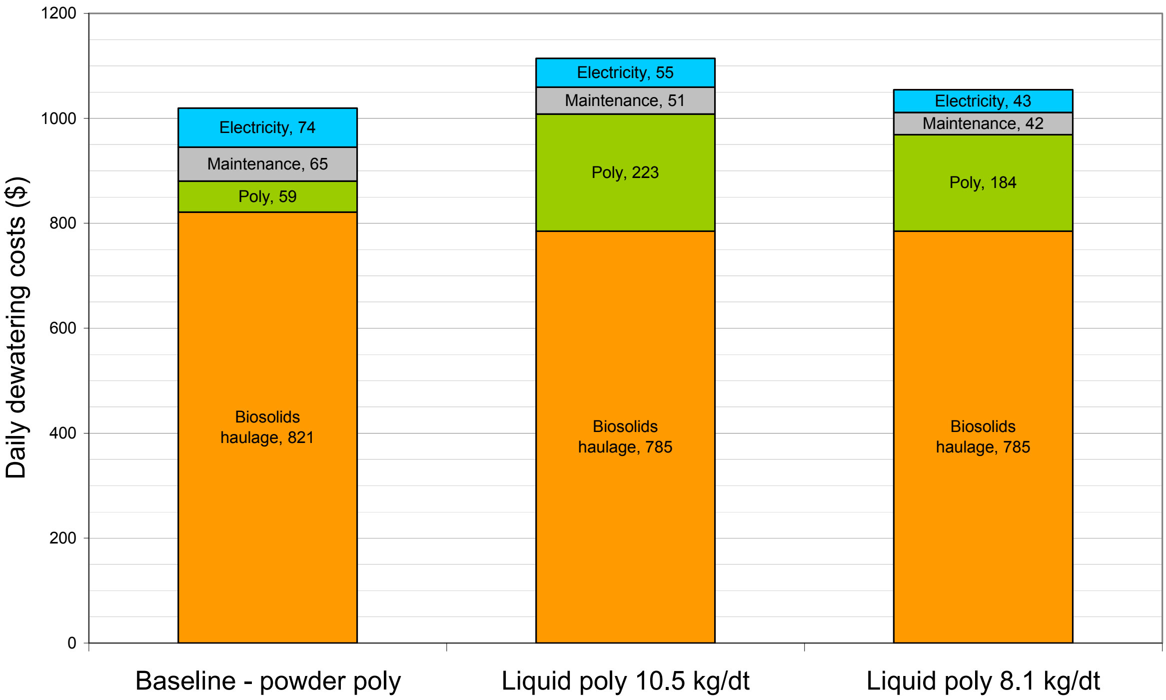

Figure 4: ***Total dewatering costs scenario comparison***

4.3 Sensitivity Analysis

The greatest degree of uncertainty in the costing is likely to be caused by uncertainty of the cake solids achieved under the liquid poly dosing scenarios. It can be seen in Figure 5 that the error bars are quite large and indicate that the cake solids could be anywhere between 15% and 16%. The previous costing used 15% to be conservative, but to test the sensitivity of the costing to cake solids, the costing has been recalculated using a cake solids of 16% for the liquid poly scenarios, with the results presented in Figure.

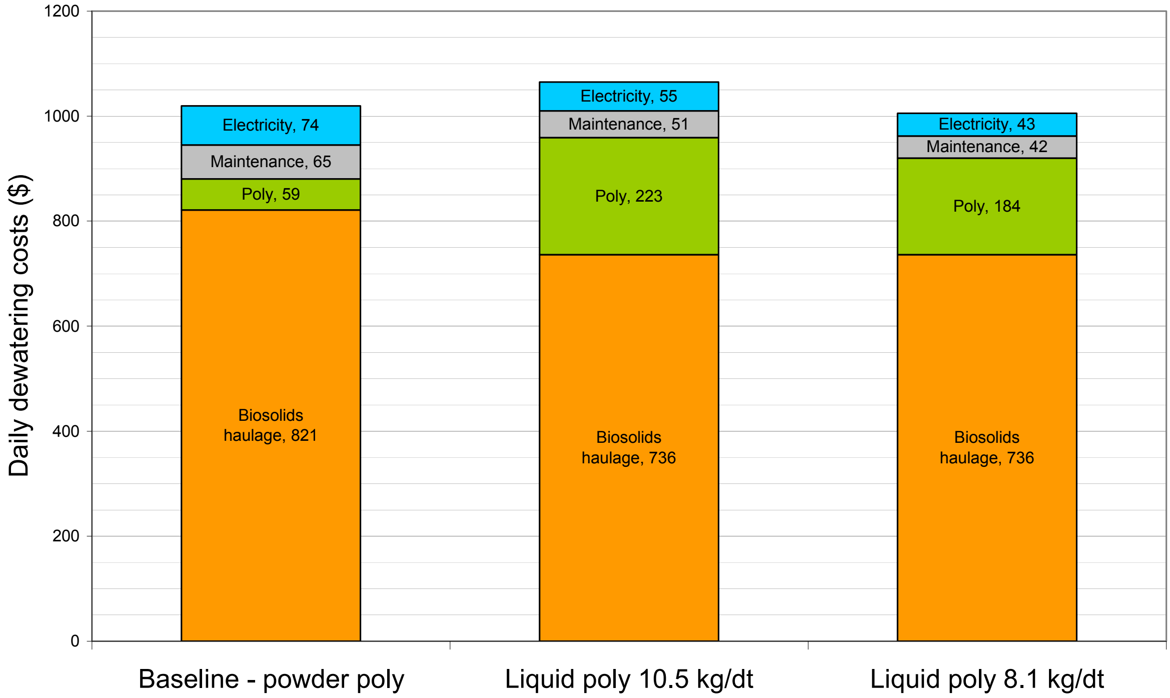

__Figure 5:__ ***Sensitivity analysis of total dewatering costs***

The liquid poly scenario dosed at 10.5 kg/dt is now only 5% more expensive than the baseline and the 8.1 kg/dt scenario is approximately equivalent to the baseline.

5.0 CONCLUSIONS

Based on the total dewatering costing, it was determined not to proceed to liquid poly dosing permanently. The liquid poly dosing costs would need to be substantially lower than the baseline to justify the capital expenditure required to install liquid poly batching equipment.

A substantial increase to the biosolids haulage rate in the future would make the use of liquid poly more attractive and may alter the outcome.

6.0 ACKNOWLEDGMENTS

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