LOW ENERGY AERATION AND PROBIOTICS RESOLVE SLUDGE MANAGEMENT ISSUES!

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ABSTRACT

Sludge management at Woolgoolga Water Reclamation Plant has been greatly assisted by the recent introduction of low energy aeration with probiotics into the existing sludge management system. The existing sludge management system was nearing capacity, with drying beds in continuous use and sludge lagoons constantly full. Low energy aeration was installed on Sludge Lagoon 1, which is fed with waste activated sludge. Probiotics are also added to this lagoon at a rate of 4 L/day. The supernatant and a small amount of sludge overtops into Sludge Lagoon 2, with all sludge carryover being contained in the second lagoon. Since the introduction of the low energy aeration with probiotics, the sludge production has been greatly reduced and the sludge dewaters more rapidly, resulting in only one sludge lagoon being full while the other is almost empty. This system has greatly eased the sludge management at Woolgoolga, resulting in reduced sludge production, eliminated recirculation of sludge, and has ultimately saved a considerable amount of money.

KEY WORDS

Low energy aeration, probiotics, sewage sludge

1.0 INTRODUCTION

Sludge management at Woolgoolga Water Reclamation Plant has been greatly assisted by the recent introduction of low energy aeration with probiotics to the existing sludge management system. This paper outlines the sludge management problems experienced at Woolgoolga Water Reclamation Plant, briefly describes the theory and technology of low energy aeration with probiotics, analyses the results of Coffs Harbour Water's trial of the technology, and discusses opportunities for utilising this product both within Coffs Harbour Water's operations and the wider industry.

2.0 BACKGROUND

Woolgoolga Water Reclamation Plant (Figure 1) is a 12,000 EP Sequential Batch Reactor plant, with an Average Dry Weather Flow of 2,200 kL/d. The Mixed Liquor Suspended Solids is typically 2800 mg/L, with approximately 16 kL wasted to the sludge lagoons each day. At Woolgoolga Water Reclamation Plant, sludge can be wasted directly into either sludge lagoon, with supernatant from each lagoon being returned to the head of the works, and sludge removed from each lagoon via a sludge pontoon.

The existing sludge management system consisted of two sludge lagoons operated on a duty/standby basis, with sludge dewatered on traditional drying beds. This system was nearing capacity, with drying beds in continuous use and sludge lagoons constantly full, resulting in occasional recirculation of sludge back to the head of works. The operator was constantly trying to clear the drying beds before the sludge was completely dry, so that fresh sludge could be transferred out of the sludge lagoons, allowing room in the sludge lagoons for Waste Activated Sludge.

These issues were exacerbated during periods of wet weather, with increased flows and reduced sludge drying opportunities. Odour was also an issue with the current system.

These ongoing sludge management issues have been acknowledged by management, with $1.5M allocated for future augmentation of the sludge management system, including provision of a third sludge lagoon and a centrifuge. Having observed the effectiveness of low energy aeration with probiotics at Macksville Sewage Treatment Plant (Nambucca Shire), Coffs Harbour Water established a trial of low energy aeration with probiotics at Woolgoolga Water Reclamation Plant in August 2009.

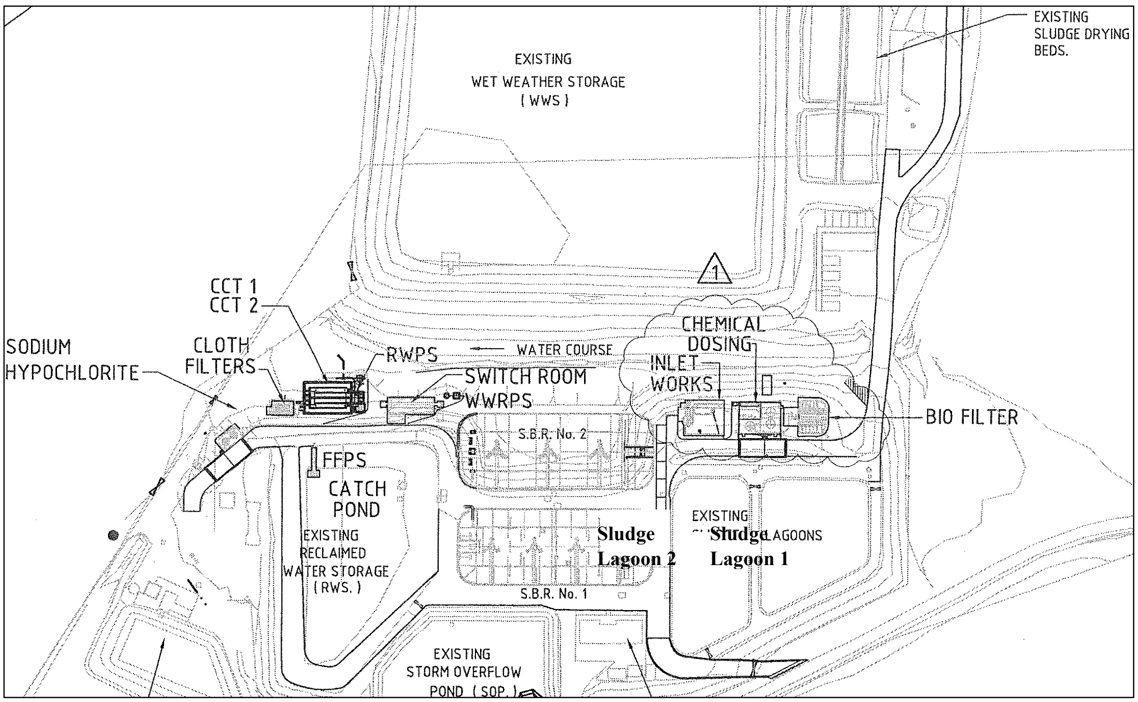

Figure 1: ***Woolgoolga Water Reclamation Plant***

3.0 THEORY OF LOW ENERGY AERATION WITH PROBIOTICS

(This section has been provided by Shane McKibbin, For Earth).
The basis of the aeration and probiotics being applied to a sludge lagoon is to reactivate the sludge in the lagoon for further biological breakdown of the organic solids. By increasing volumes of specific bacteria and also maintaining dissolved oxygen in the surface levels, organic breakdown of the wasted sludge will continue. The retention period in most sludge lagoons is beneficial to the process for offline sludge lagoons, but as experienced at Woolgoolga Water Reclamation Plant, online sludge systems can be successful at maintaining sludge loads within the lagoons/tanks.

4.0 TRIAL

At the commencement of the trial (August 2009), Sludge Lagoon 1 was completely full of sludge, with Sludge Lagoon 2 approximately 75% full. The sludge pontoon was located in Sludge Lagoon 2. Typically, the sludge pontoon would have been transferred to Sludge Lagoon 1, with sludge wasted to Sludge Lagoon 2 until it became full, and then swapped back. However, for the first phase of the trial, Sludge Lagoon 1 was isolated, with no sludge wasted into it, and no sludge withdrawn.

The supernatant return to the head of works was retained, and this did operate during times of wet weather. The first phase of the trial was planned to run until Sludge Lagoon 2 became full, and additional sludge storage volume was required.

Low energy aeration was installed on Sludge Lagoon 1, consisting of floating piping with 27 aerators fed by a 4.0 kW compressor. Auto dosing of the probiotics was established to accurately control the dose rate and the distribution throughout the lagoon. The total cost of the system, including aerators, compressor, auto dosing system, pipe work and a small amount of electrical modifications, was approximately $22,000. The lagoon is aerated at a rate of 3,500 L/min, with 4 L of probiotics added each day.

By October 2009, Sludge Lagoon 2 was full, and phase 2 of the trial commenced. The system was reconfigured such that the lagoons were connected in series, with sludge wasted into Sludge Lagoon 1. The supernatant return from Sludge Lagoon 1 was isolated, and an overflow from Sludge Lagoon 1 to Sludge Lagoon 2 was established. Sludge was withdrawn from Sludge Lagoon 2 using the sludge pontoon and supernatant from Sludge Lagoon 2 was returned to the head of the works. The supernatant from Sludge Lagoon 1 and a small amount of sludge overtops into Sludge Lagoon 2, with all sludge carryover being contained in the second lagoon.

5.0 RESULTS

During the first phase of the trial (closed system), the solids concentration in Sludge Lagoon 1 was reduced by 28% from 42,195 mg/L to 30,490 mg/L. Other parameters, including Aluminium, Total Phosphorus, Total Nitrogen and Total Organic Carbon were reduced by 12-20 %, as shown Table 1.

Table 1: ***Results for Phase 1 of the trial***

	TSS (mg/L)	Al (mg/L)	TP (mg/L)	TN (mg/L)	TOC (mg/L)
Sep 2009	42,195	2,056	1,020	1,109	5,320
Oct 2009	30,490	1,650	838	950	4,700
Change	-28%	-20%	-18%	-14%	-12%

The operators observed a number of changes to Sludge Lagoon 1 throughout the initial phase of the trial, including:

- Sludge was noticeably softer and thinner;
- Sludge build up around the bank was easier to wash in;
- Odours reduced.

During the second phase of the trial (operating in series), the solids concentration in Sludge Lagoon 1 was reduced by an additional 47% from 30,490 mg/L to 16,130 mg/L. Other parameters, including Aluminium, Total Phosphorus, Total Nitrogen and Total Organic Carbon were reduced by 1-55 %, as shown in Table 2.

Table 2: ***Results for Phase 2 of the trial***

	TSS (mg/L)	Al (mg/L)	TP (mg/L)	TN (mg/L)	TOC (mg/L)
Oct 2009	30,490	1,650	838	950	4,700
Dec 2009	16,130	747	827	794	4,030
Change	-47%	-55%	-1%	-16%	-14%

The measured reduction in solids concentration in Sludge Lagoon 1 is illustrated in Fig 2.

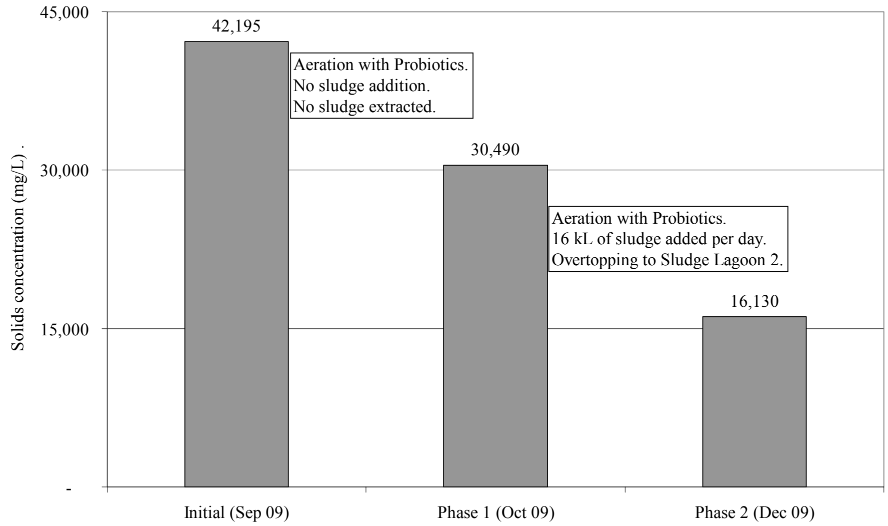

Figure 2: ***The solids concentration in Sludge Lagoon 1 decreased throughout the trial***

The operators observed a number of changes to both sludge lagoons throughout the second phase of the trial, including:

- Sludge continuing to get noticeably softer and thinner;
- Some sludge transferring from Sludge Lagoon 1 to Sludge Lagoon 2 with supernatant;
- No sludge build up in Sludge Lagoon 2;
- After several months of loading the drying beds, Sludge Lagoon 2 was almost empty.

Production of dry sludge from the drying beds was reduced due to the impacts of low energy aeration with probiotics. Production of dry sludge decreased by 46% when compared to the same time in the previous year, as shown in Figure 3 This result is particularly good considering Sludge Lagoon 2 was full in October 2009, and practically empty in February 2010.

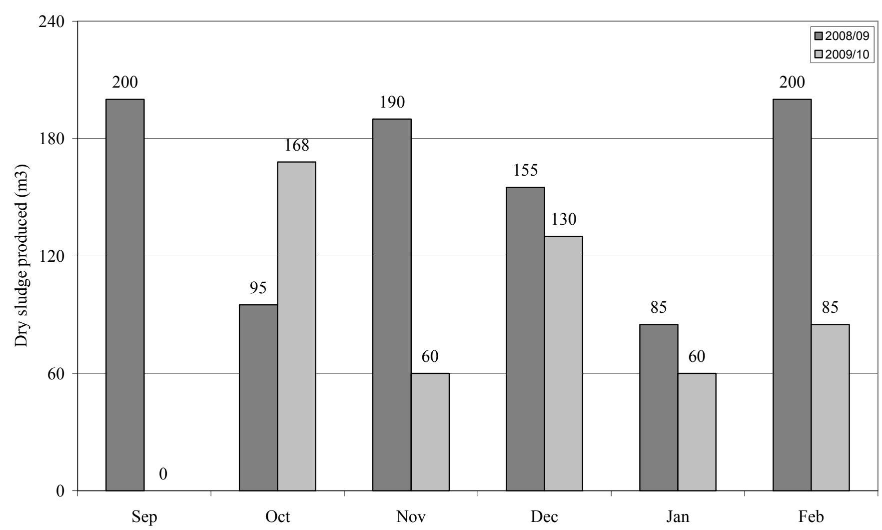

Figure 3: ***Production of dry sludge decreased significantly***

5.1 Financial Results

After the initial set up costs of $22,000, the sludge management operating costs have reduced by approximately $1416/week, as detailed in Table 3.

Table 3: ***Financial comparison of traditional sludge management and probiotics***

	Traditional System	**Probiotics**
Electricity	Minimal	Minimal
Operator's time	10 hrs/wk @ $27/hr = $270	2 hrs/wk @ $27/hr = $54
Clearing drying beds, transport and disposal of sludge	39m^3/wk @$75/m^3 = $2925	21m^3/wk @$75/m^3 = $1575
Probiotics	Nil	$150/wk
Total	$3195/wk	$1779/wk

It is expected that there will be a further reduction in the volume of sludge dried on drying beds now that Sludge Lagoon 2 is essentially empty. However, the anticipated reduction is not measureable at this stage.

5.2 Operator's Observations

(This section has been provided by Mick Piggott, Superintendent Woolgoolga WRP)
Sludge lagoons are not filling up as quickly as before. The sludge is a lot thinner and more evenly mixed from top to bottom. Sludge dewaters a lot quicker on the drying beds. It now takes about 10 days to dry compared to 3-4 weeks previously. When pumping down the lagoon, a lot of water is pumped off before reaching the sludge layer. Sludge production is greatly reduced, saving time and money.

6.0 DISCUSSION

6.1 What Has Been Achieved At Woolgoolga WRP?

On 8 September 2009, after the trial had been running for about a month, there was 42.2g/L (4.2%) solids in Sludge Lagoon 1 (the aerated lagoon). On 1 October 2009, after another month with no inflow or outflow, there was 30.5 g/L (3.0%) solids in Sludge Lagoon 1. At that point, Sludge Lagoon 2 was full, so Waste Activated Sludge was fed into Sludge Lagoon 1, the overflow from Sludge Lagoon 1 into Sludge Lagoon 2 was established, and wasting from Sludge Lagoon 2 to the drying beds was commenced. Since then, the sludge lagoons have been operating in series. Significantly less sludge has been cleared from the drying beds over that time. On 17 December 2009, after two and a half months of operating in series, there was 16.1 g/L (1.6%) solids in Sludge Lagoon 1. The Mixed Liquor Suspended Solids concentration has remained fairly constant over that time.

In summary, a small capital investment in innovative technology has resulted in sludge production being reduced by half, leading to reduced operating and sludge disposal costs, and delayed an expensive augmentation of the sludge management system.

6.2 How Can Coffs Harbour Water Use This Technology In Other Circumstances?

Coffs Harbour Water has extended the use of probiotics and low energy aeration to:

- Corindi Water Reclamation Plant – Low energy aeration has been installed on the single sludge lagoon and probiotics are hand dosed. The sludge lagoon is no longer crusted over, and visual observations indicate the sludge is significantly thinner, with less produced and quicker dewatering.
- Moonee Water Reclamation Plant – Probiotics are dosed into the existing aerated sludge digester. The sludge is a lot thinner with a reduced dewatered volume (sludge is dewatered on a belt press).
- Sawtell Water Reclamation Plant – Probiotics were dosed into an overloaded sludge lagoon, which had completely crusted over, and was causing an odour nuisance. Within a week, the sludge crust had broken down to the point where the sludge lagoon was able to be mixed. The odours started to reduce within a few days, and dropped significantly over a few weeks.

Coffs Harbour Water has investigated the use of probiotics and low energy aeration to reduce the quantity of sludge produced at Karangi Water Treatment Plant. However, probiotics with low energy aeration are not suited to this application due to the high concentrations of chemicals, such as Lime and Alum, and low biological content of this sludge.

6.3 How Can The Industry Benefit From This Technology?

This new technology may resolve a number of sludge management issues throughout the industry. The success of the technology is dependent on a number of factors, including:

- Commitment by management to experiment with new technology;
- A positive attitude from the operators;
- Plant configuration conducive to retrofitting this technology; and
- A willingness to trial new products and learn from experiences.

7.0 CONCLUSIONS

The introduction of the low energy aeration with probiotics at Woolgoolga Water Reclamation Plant has resulted in:

- Reduced sludge management problems;
- Reduced sludge management operating costs; and
- Reduced capital expenditure.

This system has greatly eased the sludge management at Woolgoolga and has ultimately saved money. Odour modelling may have to be carried out to quantify the observed odour reductions, with the results fed into an odour model to demonstrate compliance with DECCW criteria.

8.0 ACKNOWLEDGEMENTS

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