SUBSTITUTION OF FERRIC CHLORIDE WITH MAGNAFLOC 1597 IN AUTOTHERMAL THERMOPHYLLIC AERATED DIGESTION (ATAD) SLUDGE DE-WATERING PROCESSES

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ABSTRACT

This paper highlights the processes employed by Campaspe Asset Management Services (CAMS) in the identification and assessment of an alternate flocculant/coagulant for the de-watering of sludge post Autothermal Thermophyllic Aerated Digestion (ATAD) at the Bendigo Water Reclamation Plant (WRP).

Specifically, the paper outlines the rationale behind the replacement of the non-organic product ferric chloride with the organic product Magnafloc 1597. The alternate organic product Magnafloc 1597, traditionally used in the sugar refining industry was as yet un-trialled in Australia with ATAD sludges.

Ferric chloride, used for six years at the Bendigo site, created ongoing issues for operational staff with safe use and storage, effective conditioning of sludges pre-de-watering, cost and end product uses.

Both chemicals were trialled in over several months. The results of this trial allowed for the replacement of ferric chloride with Magnafloc 1597 as the sludge conditioning agent. Improvements were realised through a more efficient treatment of sludge, safer work environments and a more sustainable end product.

KEY WORDS

Centrifuge, De-watering, Ferric Chloride, Magnafloc, Autothermal Thermophyllic Aerated Digestion (ATAD)

1.0 INTRODUCTION

The Bendigo WRP is an activated sludge wastewater treatment plant using biological nutrient removal and duel media filtration, treating to a Class B effluent standard. Waste activated sludge (WAS), prior to 1999, was directly de-watered through Tema gravity drainage deck and filter belt technology. In 1999 Coliban Water contracted Henry Walker Eltin (HWE) to design build and operate (DBO) the current sludge handling facility. Their technology of choice at that time was to treat wasted activated sludge from the BNR plant through the ATAD process. The ATAD process produces a T1/C2 class biosolid through aerobic digestion and heat pasteurisation. Three 250 kL tanks were constructed with dissolved air flotation thickeners using the existing filter belt equipment for de-watering.

From 1999 to 2005 the ATAD sludge was de-watered through the filter belt presses using ferric chloride as the sludge conditioning agent. Ferric chloride was identified at that time as the most effective flocculant/coagulant for use with ATAD sludges. Filtrate from the de-watering operation was pumped off the immediate site and treated as a side stream.

In August 2005, following the insolvency of HWE, Coliban Water took control of the Bendigo WRP solids handling facility placing the operation under their operational contract with CAMS.

CAMS was appointed to assist in the refurbishment program of the sludge handling assets and to improve efficiencies at the site. Both companies agreed to look at the operability of the de-watering facility and move towards a more robust and safer technology.

As a result of investigation at the facility, a large number of safety concerns were identified with the existing de-watering equipment and continued use of ferric chloride. As a consequence of this both an alternative source of de-watering technology and sludge conditioning chemistry were pursued.

2.0 DISCUSSION

2.1 Corrosion Effects

Ferric chloride is a Class 8 dangerous goods and requires appropriate storage and handling. It is an extremely aggressive corrosive. Ferric chloride is introduced into the sludge stream just prior to de-watering.

As a result of the atomised mists produced through the filter belt operation a perfect mechanism existed for the dispersal of this corrosive substance. All equipment within the filter belt press room was severely effected by corrosion. All valves, steel pipe work, walkway gratings, pumps and associated fittings exhibited extensive corrosion to the point where some pieces of equipment were inoperable and access to the area unsafe. The main entry doors were corroded to the point that they would no longer close.

Figure 1: ***Corroded Wash Pump***

Figure 2: ***Corroded Ferric Dosing Pump***

Figure 3: ***Doors Jams Corroded*** **Figure 4:** ***Corroded Valve***

2.2 Operational Safety

Deemed to be a hazardous material causing burns, eye and respiratory irritation ferric chloride posed a significant risk in the day to day operation of the de-watering facility.

As the new operators of the sludge handling facility, CAMS set about mitigating the major Occupational Health and Safety (OHS) risks associated with the existing filter belt press operation.

Figure 5: ***Existing Filter Belt Presses***

The use of ferric chloride posed safety concerns through the atomised mists produced during press operation. Plumes of mist created through filter belt washing dispersed throughout the building and were not captured, extracted or vented. During the course of the day operations staff were constantly exposed to this mist containing residual ferric chloride.

Figure 6: ***Atomised Ferric Chloride***

2.3 Replacement De-watering Equipment

As a consequence of the existing condition of the filter belt presses and unsafe working environment created by their use, the existing de-watering facility was decommissioned and replaced with an 80 m^3 per hour centrifuge. This centrifuge was secured under a rental agreement with a local de-watering company. An operational benefit gained

through the use of centrifuge technology was increased dry solids content of the de-watered sludge. Centrate from the facility was again treated off the immediate site.

2.4 Chemical Selection Process

One of the sites current chemical suppliers included Ciba Speciality Chemicals Pty Ltd. Through extensive consultation with this company an alternate flocculant/coagulant to ferric chloride was to be sourced.

The chemical had to deliver on a number of key performance criteria;

- non-hazardous and non-corrosive
- the ability to deliver the equivalent de-watering characteristics as ferric chloride
- be cost equivalent or better

Ciba, after extensive overseas research, recommended and sourced a product that had yet to be used in Australia with ATAD sludges. This product was Magnafloc 1597.

2.5 Product Trials

Both ferric chloride and the new product Magnafloc 1597 were trialled through the centrifuge for several months to ascertain the suitability of Magnafloc 1597 to deliver on the performance criteria. These trials were implemented jointly by CAMS and Ciba.

Product Safety

A detailed assessment of the properties of both products indicated that Magnafloc was able to deliver on first performance criteria. The outcome of a product comparison is detailed in Table 1.

Table 1: ***MSDS Comparison of Ferric Chloride to Magnafloc 1597***

Criteria	Ferric Chloride	Magnafloc 1597
Active Ingredient	Ferric chloride	Low mol wt cationic resin
Molecular Structure	Inorganic	Organic
Dangerous Good	Yes	No
Hazardous	Yes	No
Safety Risks	Moderate	Low
Ventilation/ Respiration	Yes when aerosolised/misted	Yes when aerosolised/misted
Environmental Impact	High	Moderate

It was also noted that whilst vapours were generated through the operation of the centrifuge using Magnafloc 1597 exposure to these vapours was less hazardous as indicated by the MSDS. Anecdotal evidence from operations staff performing the trials indicated that offensive vapour levels were not experienced when using the Magnafloc 1597 product.

De-watering Characteristics

Both agents were good sludge conditioners, producing a sludge cake in the order of 18-23% dry solids. Only one adverse difference was seen in using the two chemicals. Significant quality differences were seen within the centrate.

Table 2: *Average Centrate Parameters*

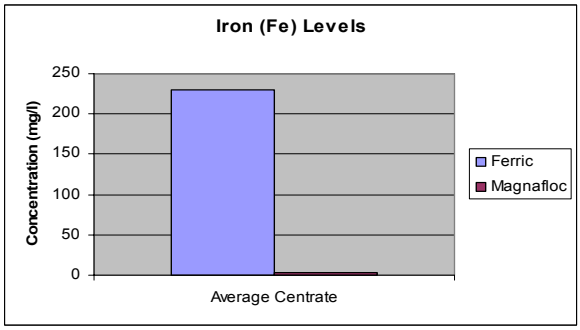
Parameter	Ferric Chloride	Magnafloc 1597
pH	4.0-5.0	8.0-9.0
Iron	230 mg/L	3 mg/L
Phosphorus	55 mg/L	510 mg/L
Alkalinity	1000-1200 mg/L	1800-3000mg/L
COD	5000-6000 mg/L	4000-6000 mg/L
Ammonia	1300-1600 mg/L	800-1500 mg/L

As outlined in Table 2 centrate quality varied significantly with three parameters only.

The pH of the centrate when using ferric chloride was in the range of 4.0-5.0 compared to 8.0-9.0 for Magnafloc 1597. This pH shift in using the new product benefited two areas of operation, less corrosive and more effective centrate treatment.

The second parameter of significance was iron. The iron content of the centrate produced using Magnafloc 1597 was in the order of 100 times less.

Concentrations of iron in the sludge were reduced by six fold when using Magnafloc 1597. This allowed for a significant reduction in the iron content of the end product biosolids. This reduction was seen as a future advantage in maintaining a commercially viable agricultural product when minimal research has been conducted on the impacts of iron within soils.



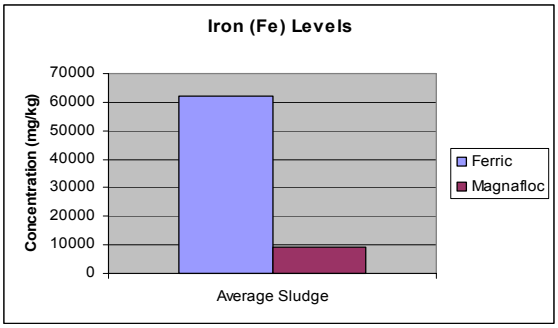


Figure 7: *Iron Content of Centrate*

Figure 8: *Iron Content of Sludge*

The third parameter of significance was phosphorus. The phosphorus content of the centrate produced using Magnafloc 1597 was in the order of 10 times more. This was a result of ferric chloride having a significantly greater binding capacity of phosphorus within the sludge.

During the course of the trial it was decided that to effectively treat the centrate this flow would be redirected from the off site treatment area to the head of works. As the Bendigo WRP process is BNR the treatment of phosphorus levels within the centrate had to achievable. It was found during the course of the trial that the biological process removed a proportion of this phosphorus. Residual phosphorus moving through the plant

was effectively removed through the addition of alum at the tertiary process.

2.6 Costs

It was found that significantly less Magnafloc 1597 is required to achieve the same cake solids when using ferric chloride. The equivalent dose rates for ferric chloride and Magnafloc 1597 are detailed in Table 3.

Table 3: ***Dose Rates for Ferric Chloride Compared to Magnafloc 1597***

Chemical	Dose Rate (tonne/tonne dry solids)
Ferric chloride	0.50
Magnafloc 1597	0.10

However Magnafloc 1597 is around six times the cost of ferric chloride. During the course of the trial it was found that the change over to Magnafloc 1597 was cost neutral. Any financial gains in flocculant/coagulant savings have been absorbed by additional alum dosing to remove phosphorus in the centrate treatment. In the future it is anticipated that more efficient BNR treatment will present as cost savings within the business.

3.0 CONCLUSION

After extensive trials of ferric chloride and Magnafloc 1597 using centrifuge de-watering a clear decision on the preferred chemical was made. The selection of Magnafloc 1597 over ferric chloride was chosen principally on OHS grounds to improve the working environment of the operational staff. Minimal changes have been shown to the sludge de-watering characteristics when using either ferric chloride or Magnafloc 1597. Negligible cost impacts were realised.

As a consequence of delivering on all performance criteria Magnafloc 1597 replaced ferric chloride at the Bendigo WRP de-watering facility.

4.0 ACKNOWLEDGEMENTS

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Coliban Water and Campaspe Asset Management Services.

5.0 REFERENCES

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