ATAD PROCESS FOR THE TREATMENT OF BIOSOLIDS FOR BENEFICIAL RE-USE

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ABSTRACT

The operating principles of the Autothermal Thermophilic Aerobic Digestion (ATAD) process and its field of application with respect to the beneficial reuse of biosolids are explained with particular reference to the plant in use at the Bendigo Water Reclamation Plant.

The ATAD process is widely used in the USA and Europe for the stabilisation of biosolids. It is a thermophilic process operating in a temperature range of 50-70°C without external heat input, this provides for pathogen inactivation and volatile solids reduction sufficient to meet EPA guidelines for beneficial reuse. Advantages of the process include rapid treatment, stable process with minimal supervision, ability to accommodate widely varying loads, and a small land foot print. Downsides to the process include high energy use, need for odour collection and treatment and a moderately difficult sludge to dewater.

The plant in use at the Bendigo WRP is supplied with thickened sludge from DAF's, employs a range of different aeration and mixing techniques, supplements aeration with pure oxygen and finally produces a 20% solids product using centrifuges. The plant is capable of meeting Victorian EPA Treatment Grade 1 (T1) specifications.

KEYWORDS

Biosolids, ATAD, re-use, thermophilic, odour, sludge

1.0 INTRODUCTION

The acronym ATAD refers to a process known as Autothermal Thermophilic Aerobic Digestion. The process operates in the temperature range of 50-70°C which is in the thermophilic range, it generates it's own heat and is therefore autothermal, it includes aeration and hence the reference to aerobic and reduces the volatile organic fraction of the waste thereby being a digestion process. These qualities of the process will be further drawn out in the discussion sections of this paper.

The ATAD process was developed for municipal utility use in the United States Of America (USA) in a research program conducted at Cornell University funded by the United States Environment Protection Authority (USEPA) during 1980-82 (Jewell, WJ et al, 1982). The aim of the study was to prove that it was possible to safely reduce pathogens in waste primary and secondary sewage sludge using a simple autoheated aerobic digestion process. The process was found to be capable of relatively simple, trouble free operation and able to reduce microbial pathogens and viruses to below detectable limits and significantly reduce parasite ova.

The ATAD process is widely used in north America and Europe with hundreds of installations. In Victoria it is an EPA recognised treatment process for producing up to T1 grade biosolids (EPA Victoria, 2004).

2.0 DISCUSSION

2.1 Operating Principles

The ATAD process uses a combination of heat from the mechanical aeration system and the naturally exothermic metabolic processes of the bacteria growing in the tank. These heat sources are diffuse and of relatively low power so the reactor vessel must be insulated to prevent excessive heat losses from the system. The small amount of heat available also limits the amount of water in the raw sludge fed to the system, if the sludge is allowed to become too thin then the chilling effect of the extra water fed will overcome the heat generated within the reactor. While the original work on the system in the USA indicated that the solids content of the feed could be as low as 2% solids, operational experience at BWRP suggests that the minimum is more like 4%.

The sludge is thickened by either a gravity thickener or, more commonly, by Dissolved Air Floatation (DAF). BWRP uses two DAFs to thicken waste sludge from the activated sludge plant from <0.5% solids to approximately 5% solids (Figure 1).

Figure 1: ***DAF thickened sludge***

In order to obtain a sufficiently thick sludge, and to prevent the loss of solids in the subnatant from the DAF, a polyment floculant is used. This may not be necessary in a more modern DAF using higher pressures in the saturator. It is important to minimise the loss of solids in the subnatant as this makes the solids accounting for the plant difficult. The thickened sludge is scraped from the top of the DAF by rotating arms and flows by gravity to a sump from where it is pumped to the ATADs.

The ATAD itself is a circular concrete tank (see figure 2), in order to minimise the heat loss from the tank it is lagged. This is achieved at the BWRP ATAD system with a layer of 25mm expanded polystyrene foam around and over the ATAD, standard colourbond cladding protects the foam from UV and mechanical damage (see Figure 3).

Figure 2: ***ATAD tank at BWRP***

Figure 3: ***Foam insulation on ATAD tank***

The final process requirement is air (oxygen) and mixing. Internationally there are two systems that are commonly applied, these are the Fuchs Sprial Aerator and the pump recirculated venturi aerator (or jet aerator). Both types have been used at the BWRP as well as Sinkair aerators. The Sinkair aerators were found to be insufficiently sized and it was not possible to install larger units due to physical constraints. The Fuchs aerator performs well as an aerator but requires supplementary mixing. The jet aerator has worked well and provides excellent mixing performance.

The feed rate of the thickened sludge is determined by the Mean Cell Residence Time (MCRT) that the BNR plant is operated at, for the BWRP this is nominally 25days. The ATAD tanks are sized to give a minimum average MCRT for the thickened sludge of 6 days, as there are no sludge recycles in the ATAD system the MCRT is the same as the hydraulic retention time.

The treated sludge from the ATADs is discharged to a storage tank which can store up to two days production. This tank provides for hydraulic balancing between the continuous ATAD process and the intermittent dewatering process.

ATAD treated sludge is generally dewatered by filter belt presses or centrifuges, it is significantly more difficult to dewater than the untreated sludge. At BWRP, centrifuges are used for dewatering, achieving 20% dry solids in the final product. This is sufficiently high to enable cartage in standard semi-trailer trucks. In order to achieve this result, a combination of a coagulant and floculant is used. The centrate from the centrifuges contains a significant amount of nutrient, table 1 shows the average nutrient content of the centrate at BWRP.

Table 1: ***Average centrate nutrient content***

	Ammonia	Phosphorous	COD
mg/l	1000	490	6200

As with most biosolids processes, the ATAD process does generate offensive odours. Due to the enclosed nature of the process, odours can be readily extracted for treatment. The off gas contains methylmercaptans, ammonia, carboxylic acids (acetic, propionic and butyric acid), alcohols, ketones and a variety of other organic compounds. The odour from the process is largely attributed to the methylmercaptans and carboxylic acids which have a sharp, penetrating odour. The extracted off gases can be treated by standard odour scrubbing equipment. At the BWRP, the ATAD off gasses are scrubbed with an acid scrubber to remove ammonia, a caustic and sodium hypochlorite scrubber to remove methylmercaptan, carboxylic acids and organic compounds and then polished with a biofilter, see Figure 4. The final gas from the biofilter has a mild, sweet aroma and is not objectionable.

Figure 4: ***ATAD odour scrubbers at BWRP***

2.2 Process Control:

Process control for a continuous ATAD process is relatively simple. As the residence time is a direct function of tank volume (which is fixed) and feed rate, a maximum feed rate for each ATAD can be calculated based on the minimum MCRT. At the BWRP, this value is alarmed to automatically alert the operations staff if the ATAD is fed to hard for any reason. The other critical factor is maintaining the temperature appropriate for the desired grade of biosolids to be produced. While the BWRP ATAD process is capable of producing T1 grade biosolids, the Environment Improvement Plan for re-use is written to allow T3 grade. In order to meet T3 grade, a minimum temperature of 45°C is required, to meet T1 55°C is required.

The temperature of the process is controlled by maintaining the solids content of the feed as high as possible, generally between 4-6% solids, and supplying sufficient oxygen. Due to undersized aerators being installed at BWRP, aeration is supplemented with pure oxygen. This is supplied in liquid form and stored on site in a cryogenic pressure vessel, see figure 5.

Figure 5: ***Cryogenic oxygen pressure vessel***

The complication with maintaining treatment temperature is that the dewatering characteristics deteriorate with increasing temperature, at the BWRP it is found that if the sludge is treated to greater than 60°C the floculant and coagulant consumption increases significantly. If the temperature approaches 70°C, the chemical consumption is close to double that at 57°C.

The treated biosolids from the ATAD system at BWRP are reused on a farm approximately 50 kilometres from the plant. The biosolids are applied as a soil conditioner and partially substitute the use of other fertilisers.

The solids are transported to the farm directly from the centrifuge without further drying and incorporated into the soil within 3 days. This rapid transport of the biosolids reduces the odour risk in two ways, firstly the solids are incorporated within 3 days so there are not large stockpiles releasing odour and secondly, the reuse site is located in a very sparsely populated area which greatly reduces the risk of impacting other persons.

3.0 CONCLUSION

The ATAD process provides a rapid, reliable and easy to operate method of treating biosolids for reuse. Combined with rapid off site transport, it requires a very small foot print and manageable odour risk. The process has been used at the Bendigo Water Reclamation Plant for over 10 years and is an internationally recognised method of treating sewage sludges.

4.0 ACKNOWLEDGEMENTS

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