BARWON WATER BIOSOLIDS MANAGEMENT PROJECT OPERATIONS

Paper Presented by:

Tony Davies

Author:

Tony Davies, *Operations Manager Barwon Water Biosolids Management Project,*

Water Infrastructure Group

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ABSTRACT

The Barwon Water Biosolids Management Facility is the first of its kind in Australia, and the largest in the Southern Hemisphere and has now been operating for 18 months. The innovative, small footprint, fully enclosed thermal drying plant produces T1 Treatment Grade pelletised biosolids that are suitable for reuse as farm fertilizer and soil conditioner that can be safely handled and easily transported immediately after processing.

T1 classification for biosolids is the microbiological criteria and measure used to inhibit bacterial regrowth and odour. T1 is the highest classification.

The plant operates 24/7 and has capacity to treat 60,000 tonne of biosolids per annum. The plant receives biosolids at >13% from seven wastewater treatment plants in the Geelong region and produces pellets at >90% dry solids. The Facility is one of the projects in the water sector to be delivered as a Public Private Partnership. Water Infrastructure Group designed and built the plant, and now operates it under a 20-year contract.

This paper will discuss the treatment process and the unique challenges involved in operating this Australian-first plant to provide a reliable 24/7 biosolids treatment service, including:

- Embedding operators in the construction and commissioning phase to understand issues and capture knowledge
- Operating a new technology and liaising with the European suppliers
- Effective process for working with contractors during commissioning and operations and transferring knowledge and skills to ongoing operational staff

1.0 INTRODUCTION

The Barwon Water Biosolids Management Project provides a sustainable, long-term management solution for the beneficial use of 100% of the biosolids produced at Barwon Water's seven water reclamation plants.

Figure 1: ***Aerial view of the Barwon Water biosolids management facility***

Previously, wet biosolids (85% water) were transported to be stored and air dried. The Thermal Drying Facility commissioned in September 2012 as part of the Project, has provided a 30% decrease in Barwon Water's sewage treatment emissions for 2012-13.

The small footprint, fully enclosed thermal drying Facility is the first of its kind in Australia, and the largest in the Southern Hemisphere, to achieve T1 Treatment Grade pelletised biosolids.

It produces very dry (90+% dry solids) pellets suitable for use as farm fertiliser and soil conditioner that can be safely handled, easily transported and reused immediately after processing.

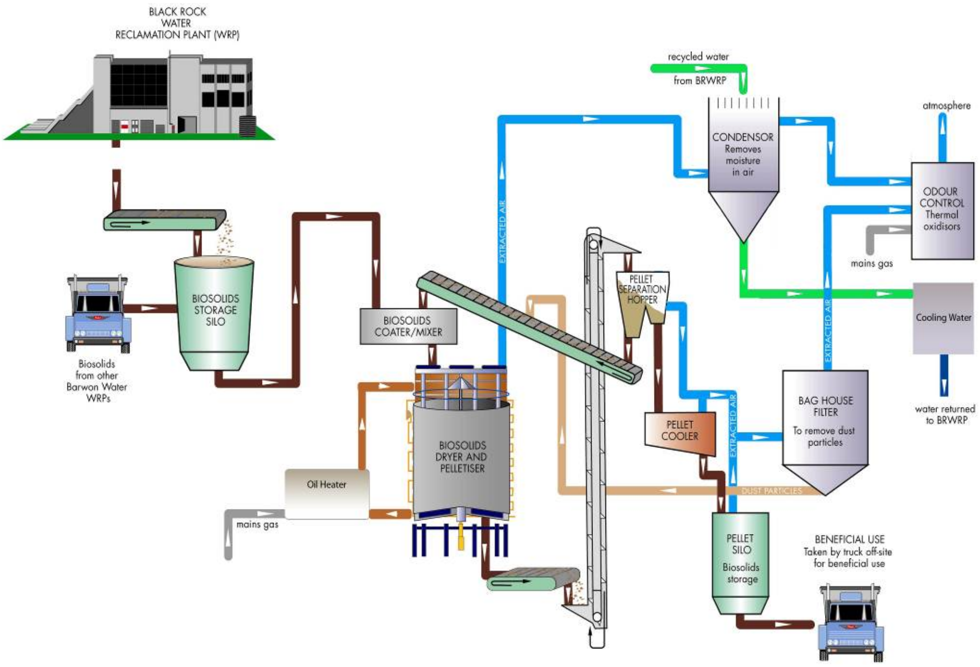
The Facility was delivered as a Public Private Partnership. The PPP approach was critical in introducing a new technology to Australia and delivering this Australian-first facility.
Barwon Water has contracted the delivery and operation of the Project to Plenary Environment, which has contracted the operations and maintenance to Water Infrastructure Group for a 20 year term.

2.0 DISCUSSION

The Facility provides a model for Australia for sustainable biosolids management to address the environmental issues associated with biosolids stockpiling, disposal and reuse.

The Facility consists of the following processes:

- Biosolids pumping system, delivery and storage,
- Drying,
- Pellet storage,
- Thermal oil heating,
- Odour and air control, Regenerative Thermal Oxidiser(RTO) and biofilter
- Process and return process water,
- Auxiliary equipment: nitrogen production, water cooling, chemical dosing



<u>Figure 1:</u> ***Overview of the drying process***

2.1 Embedding Operators in the Construction and Commissioning Phase to Understand

Issues and Capture Knowledge

Prior to commissioning, Tony Davies was brought on board as the Operations Manager for the Barwon Water Biosolids Management Project. Tony travelled to Europe to study similar plants. A key difference with these plants was that they treated digested sludge compared to the aerobic sludge produced and dewatered at the Barwon Facility.

This difference identified a number of characteristics which need to be considered and are generally not in Australia as the projects do not cover this type of process. The design and characterisation of the wet biosolids parameters such as amount of fibre (protein), amount of sand and silt, and organic content and after drying the calorific content.

Another issue we found with storing aerobic biosolids was that it started to digest. This created methane gas which was then trapped in the stored biosolids causing expansion of the biosolids in the silos and release of methane gas. The release of methane gas was vented through the air management system which is part of the plant design for odour control. The expansion of the biosolids required monitoring and management as this reduced storage capacity.

2.2 Operating a New Technology and Liaising with the European Suppliers

A range of issues that had to be dealt with included:

- Adjustments and optimisation of the process
- Sludge leaking from bottom of silos – unique moving floors
- Coater mixers
- Pellet samples
- Nitrogen purging, oxygen level management, water sprays, etc.
- Intrinsically safe areas / explosive environment
- Odour and gas management – RTOs, biofilters, enclosed building
- Hot oil system

The biosolids are stored in four silos with a capacity of 250m3 each. These are six metres diameter by nine metres high. The silos have a sliding floor system to aid in the removal of biosolids and prevent building up and 'hanging up' of biosolids in the corners of the silos.

It was found that as the biosolids depth increased in the silos the biosolids at the bottom got wetter due to water separation, this resulted in water leaking out of the gland on the silo moving floor systems. This was partially fixed by changing the moving floor programme to not operate unless the silos were getting low.

The HARDPELLETISER uses a heat convection process to evaporate water through a vertical, multi-stage, indirect drying unit. This unit produces dried, hard, round and dust-free pellets in a single and safe operation. Biosolids particles grow layer by layer and dry out to become hard pellets in a process similar to how pearls grow in oysters.

In the Coater mixer, the pellets and biosolids are mixed. The Coater consists of a cylindrical shaped enclosure with rotating paddles that coat the wet biosolids onto dry pellets. The amount coated onto dry pellet is dependent on the coater speed and the amount of dry pellets being recirculated.

In the dryer, the moisture content of the biosolids is reduced from 15%ds to >90%ds. The rake arms scrape the pellets along trays either working from the outside in or inside to the outside over 14 trays. Each tray has a labyrinth which is heated by hot thermal oil pumped through each tray, from the top of the dryer to the bottom, to keep the dryer temperature at approx 140^{o}C.

The pellets as a result of reticulation grow in size and fall into the separation hopper with the effect of Granular convection. (*Granular convection is a phenomenon where granular material subjected to shaking or vibration will exhibit circulation patterns similar to types of fluid convection. It is sometimes described as the Brazil nut effect when the largest particles end up on the surface of a granular material containing a mixture of variously sized objects; this derives from the example of a typical container of mixed nuts, where the largest will be Brazil nuts).*

The smaller pellet particulates fall between the voids of the larger pellets and return to the coater to be processed again with a coating of wet biosolids. The larger pellets extracted from the dryer are cooled by a fluidised bed cooler to less than 40oC then transferred to storage silos for collection and loading into trucks.

The pellet sizes depend on various criteria such as the speed of dryer, rotating rake arms, the temperature inside dryer, the wet biosolids feed rate and moisture content. This can also change with the wear and tear of equipment.

To manage these variables and monitor the size of the pellets, we implemented a size sieving procedure to determine the size distribution and grading similar to that for sands and non-cohesive soils.

The fibre and sand/grit content of the pellets creates other variables in the treatment process that have to be managed. The sand and silts cause the pellets to be very abrasive and this causes wear on all the moving parts. Special hardened metals are utilised to try to minimise wear. The wear is very much like attacking the metal with an angle grinder.

The fibre causes the biosolids to matt, bind together and build up in slow moving areas of the process. This needs to be monitored and removed during programmed shutdowns.

The steam created during the drying process is passed through a condenser to convert steam from its gaseous state to liquid state, process water supplied from the Barwon Water Black Rock Water Reclamation (BRWRP) is used as the cooling water, gases from the condenser are burnt at high temperatures (about 800^{o}C) in Regenerative Thermal Oxidisers (RTO's).

The condenser water flows from the condensers to cooling towers to reduce the temperature to less than 35^{o}C to meet the requirements of the trade waste agreement so it can be discharged back to the BRWRP.

The building has been designed so as to capture odours and take advantage of a slight negative pressure so that odours are not emitted from the building. The lower level odours are treated in a biofilter. Before the air gets to the biofilter it passes through a conditioning chamber, which uses the heat from the RTO's and water to create a healthy environment at the biofilter by controlling the temperature and humidity.

Due to the combustibility and explosiveness of dried bio-solids and bio-solid dust respectively that are present within the KSBe Drying Process, the atmosphere within the

Dryer requires attention and control in some circumstances to mitigate potential catastrophic risks.

During normal operation, the system is made safe from potential risks as oxygen is precluded within the Dryers through the process of water evaporation. However, during start-up and shutdown times when water evaporation is minimal the level of oxygen is controlled within the Dryer, utilising injection of 98% pure nitrogen and water individually or in combination.

The environment in the pellet storage and conveyor is also managed with nitrogen to ensure inert atmosphere within the storage silos.

2.3 Effective Process for Working with Contractors During Commissioning, Operations and Transferring Knowledge and Skills to Ongoing Operational Staff

The process for working with contractors and construction staff involved:

- *Regular meetings and a clear communication process*
  Regular meetings were held during the commissioning phase between project managers/ commissioning team and operations to achieve a smooth commissioning and operations start up. This aided the Operators as we understood what was required during the commissioning phase and it helped in reporting on issues and the rectification of these issues.

- *What would you do differently next time*
  I would not change the way the commissioning phase was done as the project managers/commissioning team listened when operators raised issues during commissioning. I would always encourage this as part of the construction phase w and would always like the operational procedures and asset management systems completed before the operations phase commenced.

- *Complexity of 24/7 operations – OHS – 2 people / lone worker / iPads*
  The facility is operated 24/7 due to the nature of the process and the Operators employed for the commissioning phase were employed through a third party, this in itself created issues as one had to work and manage the personnel between your own employer policies and contractors policies. The contractor made weekly visits to site to check on its staff wellbeing; which was good. Working on site with different employers can be tricky as policies between businesses can be slightly different and personnel will use the policy that benefits them the best.

  The 24/7 operations requires a working shift operation. This was quite easily resolved at the start as different shift formats were formulated and the final decision of which shift arrangement the staff wanted was made by a majority ruling by the operators. This ended up being 12 hr shifts, 2 days, 2 nights and 4 days off. The biggest issue with the roster system was if someone called in sick, or had leave, it was then a ring around system to see if someone would fill in on the shift.

- *Knowledge sharing between workers and shifts – iPads*
  The operator’s changeover at shift change was usually a 15 minutes debrief, as the changeover team would get to site 15 minutes before their actual shift started.
  This worked well with a good exchange of information to provide continuity in operations. It was very important to ensure smooth operations and all KPI’s are being met.

- *Importance of asset management – MEX – set up before commissioning not after operations commences*
  Water Infrastructure Group uses the Asset Management system called MEX to manage assets on the Operational sites. The setup of the assets in MEX could have been done better. Due to the different nature of the plant and equipment the maintenance requirements to adequately maintain the assets required the creation of new and quite different asset maintenance policies and tasks. It took a while to set up the data which was not fully available to operators to schedule and undertake the routine tasks in an organised manner. An attempt at creating excel spreadsheets to do maintenance was tried, but as there was too many tasks on the spreadsheet the operators found they did not have enough time to complete the tasks during their shift whilst performing normal operational duties. Having the MEX system fully operational for each asset and a reasonable number of tasks per Work Order the maintenance has improved and operators are performing the tasks well.

3.0 CONCLUSION

I have 25 years' experience in operating and managing wastewater treatment plants. This biosolids processing plant provided a range of unique experiences which are not normally seen when operating a wastewater treatment plant. Many aspects are quite complicated. The plant has a much greater level of materials handling equipment hence a large variety of mechanical equipment similar to an industrial plant.

The major challenge is managing the environment in the Dryer to ensure the oxygen levels are below that which can lead to an explosion.

All in all I have enjoyed the challenges the operation of this plant provided which have been quite different to the range of wastewater treatment processes.

4.0 REFERENCES

Keppel Segher. Biosolids and Sludge Solutions HARD-Pelletiser – The Pearl Process

Control Philosophy

Biosolids Management Plan