CYCLONIC THERMAL DRYING OF BIOSOLIDS

C Lane

Abstract

Biosolids have been a problem for operators of sewage treatment plants because the traditional on-site dewatering approach does not produce a market-ready product. A new system, Cyclonic Thermal Drying, is being trialled by Logan City Council to determine its potential to reduce volume, weight, odours and removal cost. A pilot trial is producing results that meet this objective as well as rapid processing, compact design and portability. Some local authorities may see these characteristics as offering advantages for particular situations though operating costs and biosolids characteristics may be limiting for some applications.

Background

Logan has for the past 25 years been one of the fastest growing areas in Queensland, with a current population of 170 000. The Loganholme Water Pollution Control Centre (LWPCC) was built in the 1980s with the capability of expansion to meet the sewerage needs of the developing city. Each day there is an average of 40 million litres flow of sewage through the plant, generated by residential and commercial consumers.

Logan Water is the branch responsible for sewage treatment for Logan City Council (LCC). Logan Water biosolids are currently produced by dewatering BNR sewage sludge by belt filter to a concentration of about 15% solids and loading some 70 tonnes per day of cake into a sludge hopper where it waits to be transported off site for further processing.

A successful application for an Advanced Wastewater Treatment Technologies grant from the Queensland State Government has enabled LCC to assess in detail a proposal to supply and operate pilot scale equipment to dry biosolids to reduce volume, weight, odours and reduce the cost of removal of biosolids from the LWPCC. The key objectives of the project are to:

1. Determine the biosolids quality that can be produced by the system
2. Identify the operational costs of the system
3. Assess the characteristics of the dried biosolids which will impact on its ability to be beneficially used

Trials of a newly developed system.

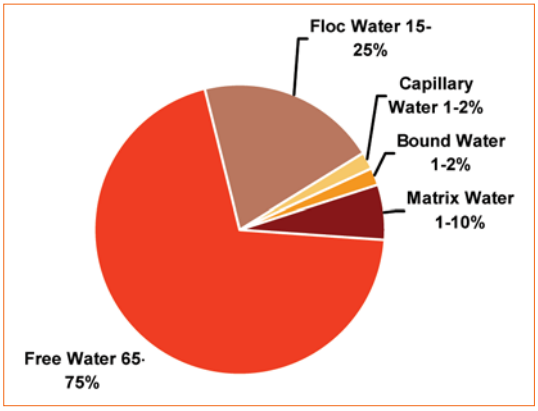

Figure 1. Biosolids water distribution.

Process Description

Logan Water has been investigating dewatering best practice and have considered a number of options. In October 2002 a new invention called "Cyclonic Thermal Drying" was patented in the USA by the Global Resource Recovery Organization. (www.grro.net)

The primary pathway of water removal is the mechanical removal of the liquid.

Figure 2. Current Belt Filter, producing 70 tonnes per day of 15% cake.

Cyclonic thermal drying utilises the effect of high volumes of high velocity air, in centrifugal rotation, flowing over multitudes of exposed material surfaces, created by high rates of collisions and impacts. The cyclonic process and equipment causes separation of the various material components via differences in their specific gravity, particle size and/or particle shape.

The system removes water from the material via several pathways, but the majority of the water that is removed does not change phase, i.e. liquid to vapour, but remains as a liquid which is atomised. Atomisation of the water creates very fine (around 10 – 200 microns in diameter) spherical liquid water droplets which are separated via particle size rather than specific gravity and carried away with the air stream. Thus the major pathway for water removal is mechanical (non-phase change) with minor water removal via evaporation (phase change via air vapour extraction).

Shear and impact forces act to bring the water to the surface of the particles. Through agitation or splitting of the particle, more surface area is exposed and more water is liberated from the surface. The centrifugal force physically separates the water from the solids due to differences in their specific gravities. The heavier mass will rotate at a different speed and cause sheer separation. The liberated water will continue to rotate and fracture into smaller and smaller particulates and become atomised. A minor amount of water is removed via air - water vapour interactions and the implications of the psychometric chart and evaporative cooling.

As the solid material continues through the process the surface area to volume ratio increases and the material is agitated to expose the water. Air velocity, material temperature, material surface area/volume ratio, vapour pressures, system pressures, water constituency and ambient conditions are parameters that must be considered in determining the extent of water removed using the drier.

The approximate percentages by weight of the various moisture constituents in biosolids are shown in Figure 1.

The moisture associated with the material is in part free and separable by gravity; in part trapped in the interstices of floc particles and separable by mechanical dewatering; in part held by capillary action, and separable by compaction; in part chemically bound within the bacterial cell, and separable only by destruction of the cell; and in part chemically bound within a synthetic matrix (polymers), and separable only by destruction of the matrix. The water that is chemically bound in a synthetic matrix is extremely difficult to remove with low heat processes and may prove to be the upper limit of water removal via this drying process.

Pilot Trial

Logan Water began testing a trailer-mounted "Tempest" pilot plant in September 2006 using undigested, unstabilised BNR sludge cake which has been dewatered to 15% solids cake by belt filter, currently produced at the rate of 3 t/hr throughout a 24 hour period.

The pilot drying unit was the smallest model available and the feed-rate chosen for the trial was initially 1 t/hr of cake (Table 1). Higher feed rates up to 4 t/hr were tested to determine the effect on product quality.

The belt-dried biosolid cake (15% solids) is fed by an auger from the hopper where it is introduced into the high velocity air-stream eductor then circulated through a pre-cyclone before entering the main drying cyclone for approximately two minutes. Dried biosolid granules are extracted from the base of the cyclone through an output auger. The air stream passes through a wet scrubber where the water droplets coalesce along with any fine dust and are drained off and returned to the treatment plant. There is no noticeable odour because of the very large dilution and dissipation by the input air stream and the passage through the wet scrubber.

Figure 2 shows the existing belt filter.

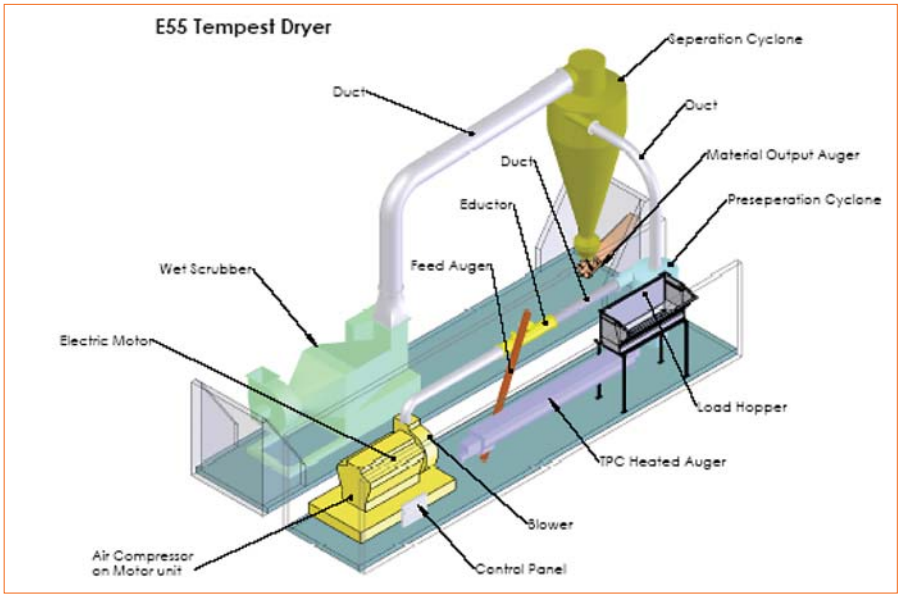

Figure 3. Cyclonic Thermal Dryer general layout (diagram courtesy of Global Resource Recovery Organization).

Figure 3 is a diagram of the process and Figure 4 is a photograph of the containerised pilot plant.

Figure 5 compares the consistency of the dried product with the belt filter cake.

Results

Pilot trials are still proceeding but preliminary results are summarised in Table 1 together with estimates of the operational costs.

Improvement on Current Processes

- The drying process successfully removes large quantities of water from biosolids without expending large quantities of energy.
- A large volume and weight reduction occurs.
- The process produces a dry, friable, stable end product with no pathogen regrowth.
- The process is fast.
- The Pilot Plant equipment fits inside a standard shipping container which is easily portable.
- Setup time is fast as it takes 1 person less than 30 minutes to produce dried material from a cold start.
- An additional significant improvement is the enclosed processing allowing a clean

Table 1. Preliminary results of Pilot Trials.

Feed Biosolids cake from belt press- solids	15%
Dried Biosolids from dryer- solids	85%
Dried Biosolids Pathogens after Output Auger	900 cfu/g dry wt
Dried Biosolids Pathogens after 2 weeks storage	<100 cfu/g dry wt
Temperature Reached	105°C
Process Detention Time	<2 minutes
Dimensions (without trailer)	12.2m x 2.4m x 2.6m
Air velocity	440 kph
Operation Cost (labour, maintenance and fuel)	$30.60/wet tonne feed Biosolids cake

Figure 4. Trailer-mounted Cyclonic Thermal Dryer.

Figure 5. Feed biosolids (left) and the dried product (right).

atmosphere for workers instead of the odorous environments in which some presently have to work.

Financial Benefit

Estimated ongoing financial benefits resulting from the drying system are:

- Reduced power consumption because of high efficiency drying compared to thermal dryers.
- Reduced storage areas because of volume reduction.
- Reduced removal cost from site because of weight reduction. Less truck movements. Because the dried material can be stored longer, removal can occur at more convenient times.
- Ease of handling and transport compared to biosolids cakes. No water is able to drip from transport vehicles and if there was a spill it is easier to clean up dried granules than sloppy, muddy cakes.
- Reduced maintenance and repair costs through protection of exposed surfaces of plant and equipment from moisture and H_2S attack.

Community Benefit

- Large sections of the community in cities and towns are currently subjected to odours emanating from sewage treatment plants, evidenced by the consumer complaints received. A very dry biosolid is virtually odour free.
- A granulated product may be more conveniently used for transport and application.
- Product with reduced weight and volume will mean fewer truck movements.

By eliminating a primary source of odour release and thereafter being able to identify and treat any secondary sources, odour-free treatment plants will eventually be achieved.

Implications

The average price for biosolids disposal in southeast Queensland for councils with similar situations to Logan is in the vicinity of $34 per wet tonne of belt filter cake.

The pilot unit that we tested is a superseded model and the newer versions are improved.

We have estimated that installation of a full-scale plant to deal with our 70 tonne/day (with repayment of principal over 10 years) is $33.60/t cake feed. No dollar value for the dried product is included.)

The dried biosolids means more beneficial uses become available for consideration. For example, the Queensland Environmental Protection Agency has approved in principle the use of the LCC biosolids for agriculture application. A turf farm business has been developed by Logan Water as an activity to utilise recycled water for irrigation, supply turf to the local area and more profitably utilise LCC's land assets. As turf crops are harvested, there is a requirement to fertilise and replace organic topsoil. Dried biosolids is an odour free soil additive well suited for this application.

Dried biosolids are likely to be successful as a soil conditioner for agricultural and landscaping applications. Sale of product may be possible because of the need for recycled organic products for agriculture. Southeast Queensland soils are mostly carbon depleted and with higher organic content soils being more moisture retentive, then there could be a profitable demand for a recycled organic product.

Another potential use which could be generated by an efficient and economic dryer would be to dry biosolids and other sludges from external sources. Other local authorities and businesses face the same costs as Logan Water does for sludge dewatering and biosolids removal so there would be opportunities to reduce drying and transport costs by using a portable dryer. Cyclonic Thermal Drying has the advantage of being compact and fast. Local participating producers would benefit by reducing their disposal costs without capital outlay.

Wider Applications

This AWTT/ LCC project was to supply and install pilot scale equipment to dry biosolids cakes to reduce volume, weight and odours. So far the manufacturers in the USA (GRRO Inc) have successfully applied the machines to:

- Paper sludge being dried to reduce cartage and reduced land fill costs
- Paper sludge being dried then pressed into pellets for furnace fuel.
- Biosolids and paper sludge being dried then used in composting operations
- Biosolids drying
- Food drying and chemical drying
- Piggery Manure

Conclusions

The primary aim of the pilot project was to demonstrate the feasibility of an onsite, compact biosolids drying plant which can produce a reduced volume and weight, low pathogen, granular, free flowing product from the point of traditional dewatered cake discharge. This approach would eliminate the need for extensive on-site storage prior to stabilisation treatments and thereby eliminate issues associated with generation of odours from stockpiled biosolids. It is also expected that the drying and granularisation approach would dramatically reduce the difficulty of handling biosolid cakes through being able to use conventional soil handling equipment and techniques.

Logan City Council believes that the project is innovative in its approach to biosolids drying which will directly benefit State and Local Government in Queensland.

A further paper dealing with investigations on marketing and applications for the product is in preparation.

The Author

Chris Lane is the Executive Technologies Administrator with Logan City Council and was Project Director for the trial. Email chrislane@logan.qld.gov.au

References

Global Resource Recovery Organisation Inc. www.grro.net