Cyclonic Thermal Drying of Biosolids

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Abstract

We have installed pilot scale equipment to dry biosolids to reduce volume, weight, odours and to greatly reduce the cost of removal of biosolids.
The Cyclonic Thermal Dryer works the same way as a cyclone does in the way that it picks up the biosolids and the air flows around the biosolids at a rate of 300km/h+ which helps dry the biosolids. The main drying process is the T.P.C.(Tempest Product Conditioner) which heat up to 120 Celsius. Most of the bacteria are killed by collision and cell rupture. The dryer can take the end product from the belt press at 14 to 16% solids and mix it with a dried product to bring it up to 30% then put it though the Cyclonic Thermal Dryer. The end product out of the dryer will have 60 to 90%+ of the moisture content removed. The Cyclonic Thermal Dryer gives us quality control of the end product by varying mix rates and temperatures . Biosolids dried in this process are likely to be more successful as a soil conditioner for agricultural and landscaping applications because of the nature of the final product. The Cyclonic Thermal Dryer is portable, compact and fast. It can be moved into areas that do not have power as it runs on diesel fuel.

1) Introduction

Logan Water Technologies has been investigating dewatering best practice. In October 2002 a new invention called "cyclonic thermal drying" was patented in the USA. This should not be compared to a traditional thermal drying system because the primary pathway of water removal is the mechanical removal of the liquid. Cyclonic thermal drying utilises the effect of high volumes of high velocity air, in centrifugal rotation, flowing over 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 shape. In the cyclonic thermal drying system, three phases are being processed and separated: water, solids, and air. The different types of equipment that makes this happen from the beginning to the end of the Cyclonic Thermal Dryer are described next.

1.2) **List of Equipment in the Cyclonic Dryer.**

1) The Caterpillar Diesel engine runs the hydraulics and heats the Tempest Product Conditioner
2) Exhaust valve directs the exhaust from the engine and can be used for heating the Tempest Product Conditioner or can be directed out of the unit by the exhaust bypass lever located in the engine compartment.
3) Water jacket heat recovery valve. This works by the same technique as the exhaust valve.
4) Material feed rate adjustment. The adjustment of feed rate is of considerable importance to the drying process, as this controls the speed of the product though the dryer.
5) T.P.C (Tempest Product Conditioner) Auger. The T.P.C is a heated auger with exhaust gasses passing through the auger shield and the engine water jacket passing through the centre axle of the auger, heated up to help dry the biosolids.
6) External Air Feed System. The material feed eductor requires a 650cfm @75psi external compressor.
7) Exhaust Fan
8) Wet Air Scrubber
9) Recycle Loop
10) Mill Cyclone The combined air and material is conveyed through a duct to the mill cyclone this creates additional turbulence and striking action on the material to help split the particles and remove the water content.
11) Separation Cyclone. This allows for additional retention time for the material to be in contact with the air stream. The solids are separated from the air stream and flow downward to the rotary air lock. The water vapour and air stream are exhausted to the wet air scrubber.
12) Temperature Chart Recorder
13) Hydraulic Motor Control
14) Material hopper
15) Discharge Auger

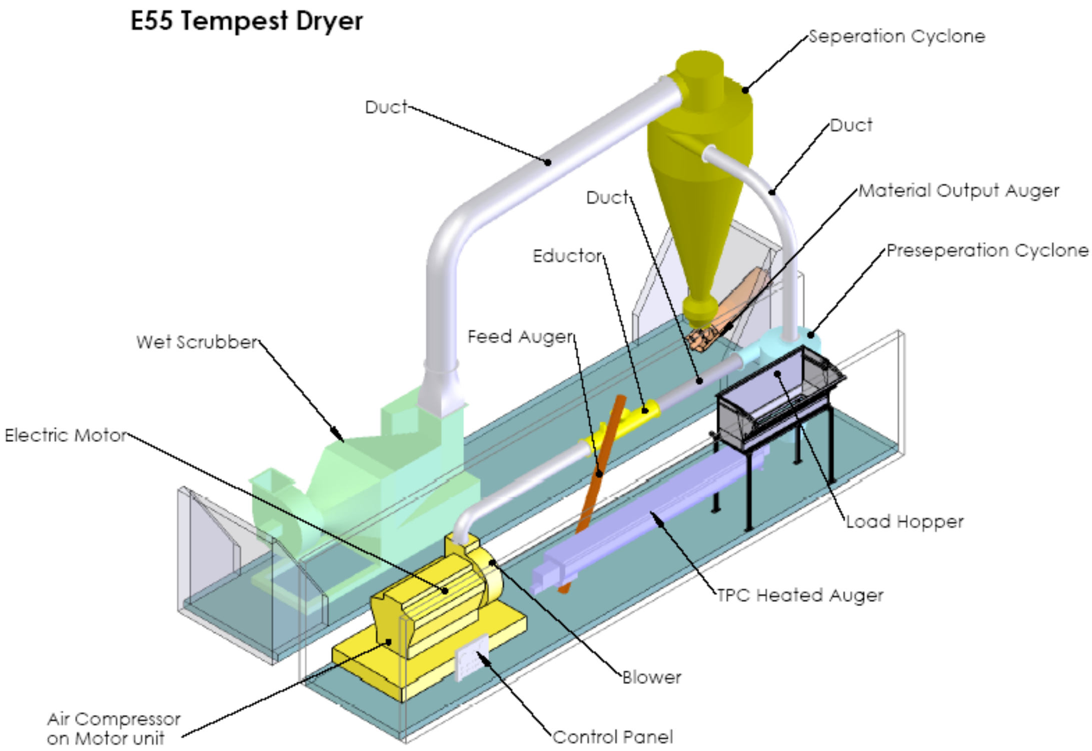

FIGURE 1 This shows a lay out of a Cyclonic Thermal Dryer

2) .DISCUSSION

2.1 Cyclonic Thermal Drying of Biosolids

The drying of biosolids

At Logan City Council we normally put our sludge though the belt press and this produces a cake of 14 to 16% solids. Compare this with Solar Drying where you might get 36 to 40% solids at the end product. So we wanted to look for something that would reduce our transport of biosolids off site as this could cost $800,000 or more a year. We also preferred a product that could be reused as a top dressing or fertilizer. To do this, we also need to drop the pathogen count from 3 million cfu/g dry wt from the biosolids off the belt presses to <1000. This would work the same for Solar Drying, as you would get a pathogen count of 50,000 to 60,000. cfu/g dry wt.

So Logan City Council bought a Cyclonic Thermal Dryer from the USA as a trial to see if we can get the results we need to reduce costs. This is the first Cyclonic Thermal Dryer in Australia. This drying system has the potential to dry to 99% solids which makes it like dust, but with the running of the system you can get around 60% to 99% solids through changes that can be made to the system. Therefore changes can be made in so many different ways e.g. mix rates, dry to wet ratios and the temp of the T P C and speed of the T P C will allow us to produce a product that can be used for different applications.

2.3 Mix Rates

Mixing is needed to help put the biosolids through the dryer, as biosolids on their own are too wet straight off the belt press, therefore you need to mix the wet with a dry product like top soil at first, so you can start production once you have product running through the dryer. Then take the final product and remix it with the wet and after 3 or 4 runs it will be 80%

biosolids and 20% soil, done through the return auger or a pug mill mixer. This graph and table below shows the results of the test run done on each mix rate. Keeping the T P C at the same temp of 98.8 Celsius and at a speed of 15 rpm, which allows us a total of 2 t/hr of mix product going though the Dryer at any time.

List of mix rates and solids

Mix rates WET /DRY	**FINAL PRODUCT SOLIDS** **SOLIDS**
1)50/50	64%
2)60/40	58.80%
3)70/30	61.20%
4)40/60	81.20%

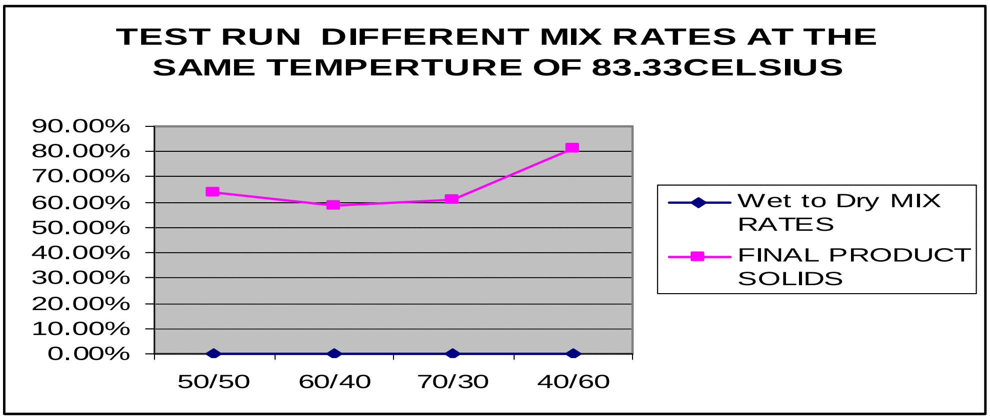

Figure 2 Shows different mix rates and their outcomes at the same temperatures.

At the commencement of the drying system with the mixture of the product at 50/50 mix, we started with a total of 2 tonne and finally with the water removed we were only left with 0.52 of a tonne and as you can see, we can reduce mass significantly and this means that the cost of removing the Biosolids off site is greatly reduced saving thousands of dollars. But we still needed to make the product safe to use as a top dressing or fertilizer, therefore we changed the speed and temperature of the T.P.C to treat and remove the pathogens in the Biosolids.

Here are some of the results of the test runs. In the table below on the 28/9/06 the first test were completed by the lab for pathogens. As you can see, the pathogen count is low, measured in colony forming units per grams dry weight, but we need to see if we can get it to 0 count of pathogens.

TEST RUN FOR DRYER AND LAB RESULTS ON PATHOGENS

DATE	(Celsius) TEMPERATURE OF T.P.C	(%) FINAL PRODUCT MOISTURE TEST	(rpm) TPC SPEED	LAB TEST FOR PATHOGENS FINAL PRODUCT (cfu/g)
16/08/2006	62.78	34.42	16	
16/08/2006	77.78	38.52	14	
16/08/2006	93.33	24.39	11	
16/08/2006	88.33	29.47	13	
17/08/2006	88.33	35.52	21	
17/08/2006	101.11	37.02	17	
28/09/2006	101.67	21.81	15	895
26/10/2006	104.44	21.54	17	0
20/12/2006	110.56	11.67	12	0
21/12/2006	116	8.76	15	0

Table 1 Shows test runs and some of the lab results so far in the trial.

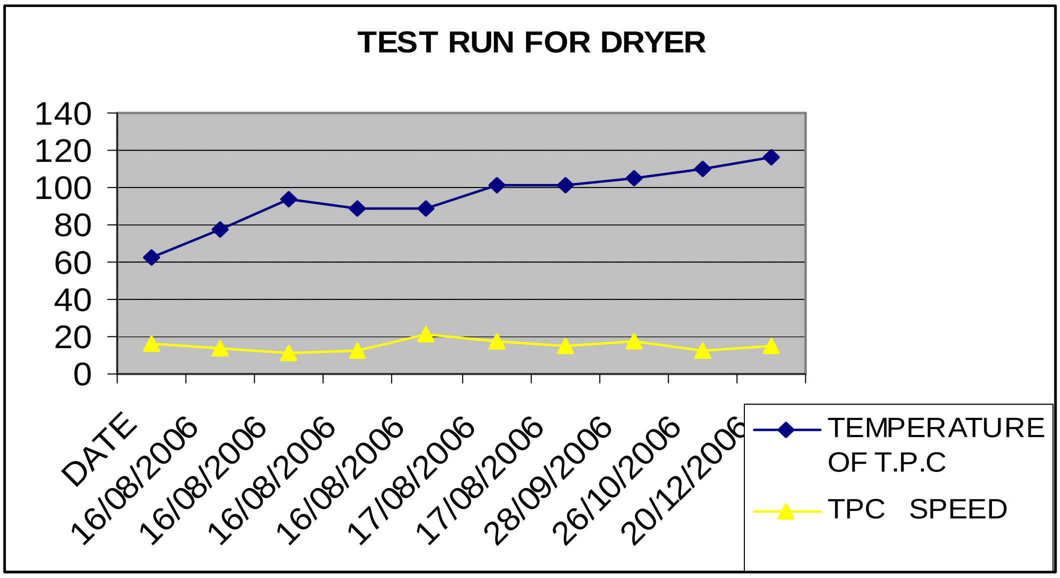

Figure 3 shows that the speed of the T.P.C which is run in rpm and temperature run for this trial is done in Celsius

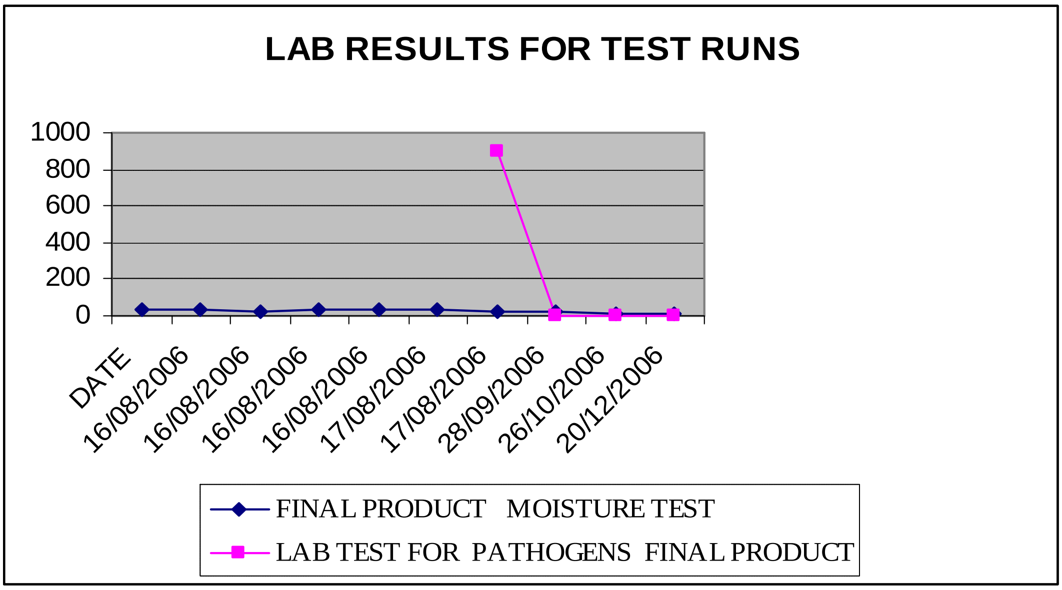

Figure 4 Shows LAB results for the trial run. The pathogen test is done in cfu/g and the moisture is done in percentage.

3) <u>CONCLUSION/S</u>

At the end of this trial we reached the 0 pathogen count by changing the temperature and the run speed of the T.P.C. The count for pathogen was reached by increasing the temperature and with a mixture of 50% of wet biosolids cake and 50% dry biosolids. In the picture below you can see a 2 tonne mixture of 60% wet biosolids and 40% dry was put through the dryer and we were left with less than 0.5tonne of product. So this shows that we are on the right path to saving money and having a product that can be reused with in the community.

This is the start after mixing at.
60% biosolids and 40% dried biosolids
and a pathogen count of millions

This is the finished product
at 75.43% solids and a pathogen
count of 0

Financial Benefit

The drying approach would dramatically reduce the difficulty of handling biosolid cakes through being able to use conventional soil handling equipment and techniques. Less odours emanating from sewage treatment plants during operation and transfer. A very dry biosolid is virtually odour free.
Product with reduced weight and volume will mean fewer truck movements on the roads and highways.

Community Benefit
By eliminating a primary source of odour release and thereafter being able to identify and treat any secondary sources, sewage treatment plants during operation and transfer. A very dry biosolid is virtually odour free.
Product with reduced weight and volume will mean fewer truck movements

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