BIOSOLIDS - BASIC FACTS AND HANDY HINTS

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31st Annual Qld Water Industry Workshop – Operations Skills
University Central Queensland - Rockhampton
4 to 6 July, 2006

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Biosolids is really just a more acceptable name for sludge. There is sludge everywhere in one form or another. During this presentation, we are going to take quick look at the different forms of sludge and explain the basic requirements for sludge handling, processing and disposal. Along the way, we hope to provide some handy hints that will help your understanding of sludge management**.**

1.0 Surveys

The very first process of any sludge management project is to accurately measure the sludge volume and solids concentration.

Trying to directly measure the depth of settled sludge in a lagoon is extremely difficult and inaccurate. History has shown people using all sorts of devices and techniques to directly measure the depth of sludge. The problem is that once you penetrate the sludge, it has a tendency to move and or release gasses that tend to buoy the sludge column being measured. Other techniques involve lowering a tube into the sludge and having a mechanism to close the bottom end prior to withdrawing. This works OK with very fine suspended sludges but has a lot of difficulty with thicker sludges. The thicker sludges will not flow into the tube as it is lowered and subsequently, the withdrawn sample height is significantly less that what it should be (producing a false result). The sludge survey should also work on the basis of collecting as many sample points as possible within the lagoon in order to clearly define any irregularities in the floor and clearly define the profile of the sludge mass. The greater the number of survey points, the more accurate the survey results become and the less important it is to be able to exactly pinpoint the survey location. We have seen some sludge surveys that become an exercise in positioning two men in a boat over a known location in a pond but so few samples were collected that the information generated had little value.

The most accurate sludge measurement method is where you indirectly measure the true depth of sludge by accurately measuring the total depth of the Pond and the depth of clear water. The mathematical difference is the exact depth of sludge. The true depth of the pond is measured by inserting a calibrated probe into the pond and feeling the bottom. The total pond depth is read and recorded directly from the calibrations on the probe. At the same survey point, the depth of clear water is measured by removing a core sample from the pond that contains a small proportion of sludge in the bottom. The clear water depth is measured as the depth of clear water in the perspex tube above the sludge layer. The little bit of sludge in the bottom indicates the sludge/ water interface and the depth of clear water above is a direct indication of the depth of clear water in the pond at that location. This sludge water interface or the depth of clear water can also be verified this measurement using a Infra Red Sludge level detector or similar. The aim is to accurately and reliably measure the insitu volume of sludge and then extract representative samples for Total Solids analysis. From the volume and total solids results, we can calculate the Tonnes of Dry Solids (TDS). TDS is the only reliable way to quantify an accumulation of sludge that will remain constant. Just expressing volume of sludge particularly in a pond environment is not an accurate representation of the mass of sludge. The volume will vary significantly between Summer and Winter due to changes in the rate of biological activity. Increased activity in Summer will generate an increase in gas production that will tend to buoy the sludge resulting in a larger volume but lower solids

concentration. The reverse applies in Winter.
Any costings for future desludging, processing and disposal are reliant on an accurate determination of the Tonnes of Dry Solids at an early stage.

2.0 The various forms of sludge

Sludge can be present in many forms. It can be a liquid. It can be a semi solid with fluid characteristics or it can be like a brown friable earth with construction properties. Each form of sludge has different handling requirements in terms of the type of mechanical processing equipment required. The actual form (or state of dryness) of the sludge tends to really dictate the options for the future management and processing of the sludge. For example, if the sludge has been stored in a sludge lagoon for a long period of time and it has stabilised into a thick gelatinous mass with grass growing on top, it would not be cost effective to rewet it to then dewater it through a centrifuge (unless site limitations and other issues were the driving force).

There are many options available for managing and processing sludge. The best option (and usually the cheapest), takes advantage of the current form of the sludge and utilises those characteristics to minimise the amount of work required to achieve the desired result.

3.0 Sludge volume reduction

The primary aim of almost any sludge processing operation is to reduce the moisture content in the sludge and therefore produce a dryer product for disposal. The greatest sludge volume reduction occurs at the lowest solids concentration. If sludge at 3% solids is dewatered to 6% solids, we have realistically produced a sludge mass of half the original volume but we have doubled the solids concentration. The sludge is very much a liquid at 3% solids and gravity separation processes are very effective. This is a significant volume reduction for an increase of only 3% solids. Sludge reduction compared to sludge drying inputs then become significantly different. Sludge at 60% will require significant inputs to change it to 70% for a marginal reduction in volume. This is due to the fact that the sludge at 60% solids is a brown friable soil material and the moisture content is bound up in the soil particles. A very small amount of water has to be evaporated to achieve the 70% solids and therefore a very small potential reduction in volume can be expected. The result though is that the brown friable soil is now dusty dry soil and can actually bulk out to a larger volume because there is more air voids between the soil particles.

The relationship between sludge volume and % solids can be seen graphically in Table 1 on the next page. The generalisations represented in the table work for most domestic type sludges. Care should be exercised when comparing sludges from other sources that don't start with a specific gravity very close to 1.

4.0 Sludge pumping.

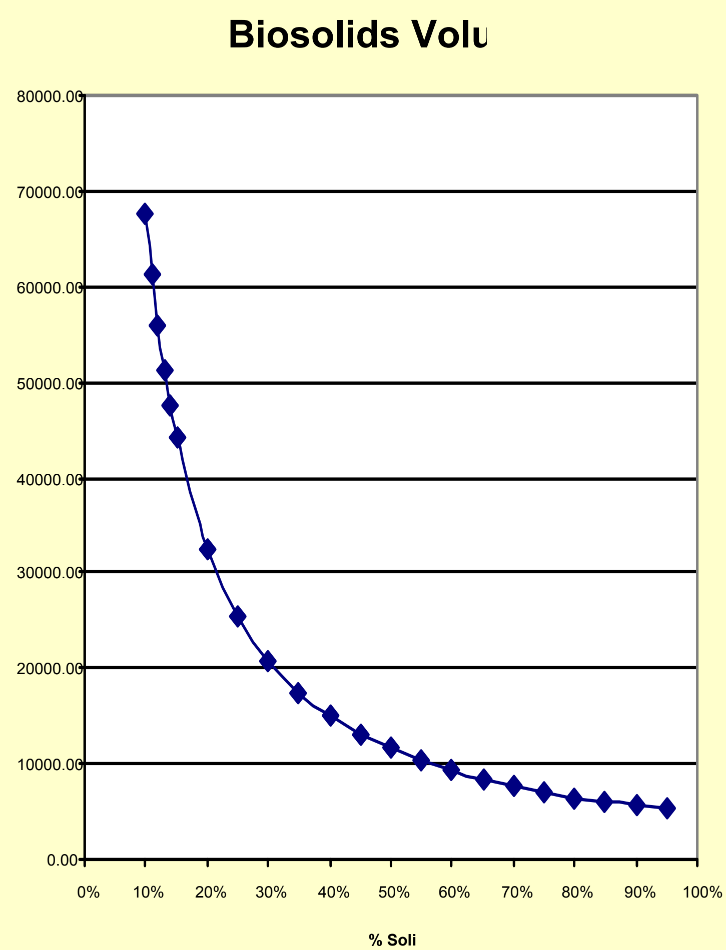
There is an enormous amount of equipment and technologies out in the market place to pump sludge. The real issue is to identify the correct equipment and technology that will reliably pump the sludge and associated other material over a long period of time. The correct sludge pumping equipment will be a balanced compromise between productivity, performance, wear, cost, duty requirements and downtime. A lot of pumps will pump sludge but when sand and grit is introduced, the wear rate will rise dramatically.

Similarly, a small amount of rag or debris will stop other pumps. The pump design and construction should allow for ease of maintenance and rag removal as well as suitable materials of construction and performance.

<u>Table 1:</u> ***Biosolids Volume Approximator****

How many tonnes of dried so **7,050** TDS

% Solids	Volume Cu Metres
10%	67541.03
11%	61144.30
12%	55815.66
13%	51308.59
14%	47447.03
15%	44101.85
20%	32410.22
25%	25416.28
30%	20770.18
35%	17464.88
40%	14996.94
45%	13086.69
50%	11566.38
55%	10329.29
60%	9304.28
65%	8442.13
70%	7707.71
75%	7075.25
80%	6525.46
85%	6043.58
90%	5618.15
95%	5240.13
62%	8942.10



** Based on information from Dewatering Municipal Wastewater Sludges Design Manual (US EPA, October 1982)*

In a sludge pumping situation, the pump will automatically pump water before it pump sludge. This is because the water will be able to flow to the pump much more readily than the sludge.

How many times have you seen people try to pump out a lagoon and only succeed in pumping out the water leaving the sludge behind. In this situation, you need to either systematically move the pump around the lagoon so that you introduce the sphere of influence of the pump suction to the sludge or you have to install mixing equipment that will suspend the sludge in the water column so that it can be pumped.

5.0 Sludge mixing.

There are a number of reputable suppliers for a variety of sludge mixing equipment. The use of submersible mixers allows settled material to be resuspended. This enables the homogenous slurry to be reliably pumped. Other examples for the use of submersible mixers include attachment to the end of an excavator boom.

The excavator then simply drives around the perimeter of the sludge lagoon using the mixer to blast large volumes of settled sludge, rag and debris from the batters back out into the middle of the pond for easy access by a dredge or pontoon based pump. The mixer is used to direct large volumes of water into the settled sludge. It is the large volume of water that has the power to lift, mix and transport the sludge out towards the centre of the ponds. Submersible mixers are also mounted on floating pontoons. These are used to pre condition and mix sludge lagoons prior to dewatering with centrifuges or belt filter presses.

The advantage of the mixing operation is that it is not reliant on the sludge passing through a pump, nor is it reliant on the pump being in contact with the sludge until a homogenous mixture has been produced.

As observed at many locations, another benefit of the mixer use is that you can get an increase in biological activity due to the contact between food and micro-organisms. This is evident by increased gas production in many ponds that have been mixed. Another observation when using a mixer is that the mixing action will liberate gasses contained within the sludge mass as the sludge mass disintegrates. These gasses are normally released to the atmosphere and may cause odours at the source.

6.0 Odour mitigation and management

The extended digestion periods have proven to be the most effective method to reduce the potential for odours from downstream sludge processing operations. Extended digestion significantly reduces the volatile solids content and therefore reduces the potential for any of the typical fresh putrid sludge odours. Our experience certainly reinforces the fact that long term storage and digestion of sludge will produce a product with very little odour. We have to say very little because odour is very subjective and different people will react quite differently when there is even a change to an existing odour.

You have to assume that the processing or beneficial reuse of the biosolids will create a different sensory experience (odour) than what the neighbours are accustomed to. For instance, when a farmer ploughs his paddock, he produces an earthy, musty type of odour. Whilst it is not offensive, it is different to what his neighbours are accustomed to. When biosolids are applied to land, the same musty odour is produced but there is more likelihood of complaint. Community consultation and education may be an effective way to minimise the risk of odour complaints from those that experience a new type of odour.

7.0 Centrifuges and Belt Filter Presses

Centrifuges and belt filter presses are both simple devices used to generate a force on the sludge. As a result, the sludge releases water and a dryer cake is produced. The force is created in a different way but the result is the same although the cake produced from both processes is totally different in appearance. The Water Industry is littered with claims and counter claims that one type is better than the other and this model is better than that model.

The reality is that either a centrifuge or a belt filter press operating on a normal sludge will produce similar results in terms of cake dryness. The argument then addresses issues such as OH&S, power requirements, aerosols, maintenance costs, floor space, noise, daily cleaning and so on. There is no correct answer for which type of dewatering plant

is best in all situations. The best answer is to assess al the issues at your particular plant and then install the best quality piece of equipment that you can.
Quality usually means a dearer purchase price but it also means better performance and longer operating life.

Regardless of what the salesman says the consultant specifies or the glossy sales brochure details, the dewatering plant will only produce cake at rate and moisture content that is physically possible. This is determined by the size of the actual dewatering unit and the type of treatment provided by the Treatment Plant. This assumes optimised operating condition and flocculation for all conditions. The actual sludge presented to the dewatering plant will vary in terms of stabilisation and solids content from plant to plant and even over time at the same plant.

Pre conditioning of the sludge and optimisation of the type of polymers and the poly injection points has the potential to generate the greatest improvement in dewatering efficiency.

Figure 1: ***Centrifuges Ready for Action***

8.0 Dredging

Floating dredges specifically designed for desludging operations are used which are fitted with a 4 metre wide auger heads that physically concentrates the sludge at the pump suction (see Figure 2). This results in substantially higher solids output than conventional suction dredges.

The dredge actually removes the lower and therefore thicker layers of sludge from the bottom of the lagoon first. This ensures a relatively high solids concentration in the dredge discharge. The sludge is pumped from the dredge via 225mm HDPE pipeline. The dredges normally utilise a four winch system for movement within the Lagoon. The four winches provide the operator with a means to accurately and systematically dredge the entire floor of the Lagoon, even in strong wind conditions.

Dredge productivity is proportional to the volume and depth of sludge available. It is far more productive to dredge sludge from a deep lagoon than it from a very large shallow sludge. Normally it would cost as much to remove the last 10% of sludge from the bottom of the lagoon as it did to remove the top 90%. In an operating lagoon system, the remaining 10% provides the biomass required to maintain treatment capacity anyway.

9.0 Air drying

The aim of any sludge drying process is to generate a product that can be transported and stockpiled. The wetter the sludge is to start with, the more effort and cost it will take to produce the desired product. The drying process also generates a significant sludge volume reduction as the drying increases.

An example of this is that 1 tonne of dry solids @ 3% solids occupies $34m^3$. The same 1 tonne of dry solids @ 20% occupies $5m^3$ and at 70DS it only occupies $1.1m^3$

As drying progresses, the sludge characteristics and appearance changes. Wet sludge will be black and dry sludge, brown. You can break open a clod of drying sludge and observe the distinct colours. The colour change also coincides with another very important fundamental change in the sludge. When it is black, it has no construction properties or road bearing strength. You drive through it rather then over it with a bulldozer. When it changes to brown (at about 43% solids) it instantly has construction properties and can be used it to build water retaining structures and haul roads. The residual moisture content between 43% and 65% solids provides the best working conditions in terms of compaction properties and dust minimisation. At 70% solids and above the compaction potential decreases and adversely dust production increases. Dried biosolids with a solids concentration of 90% has been observed to blow away on relatively windy days.

In its simplest form, the air drying operations normally consist of spreading the stabilised biosolids onto a clay drying pan to an average depth of 400mm. The biosolids are then windrowed on a daily basis using Swamp Dozers and 4WD articulated tractors. This process is designed to remove and incorporate the thin crust that forms on the surface of the biosolids. The formation of the crust inhibits further drying by forming a natural insulation barrier across the surface. The incorporation of the crust both removes the insulation effect an exposes fresh biosolids to the drying properties of the sun and wind. The dried crust also aids in the solidification of the wetter biosolids by providing structural support for the formation of windrows.

Figure 2: ***Dredge in a Lagoon***

Figure 3: ***Turning the Solids***

The air drying process is dependent on the mechanical manipulation of the biosolids for the sole purpose of accelerating the drying process by means of evaporation. Other tangible but secondary benefits of the air drying process include the following:

- Aeration of stockpiles and windrows from constant mechanical turning operations.
- Reduction and dissipation of odours due to the aeration and turning operations described above.
- Formation of a brown friable soil type product suitable for beneficial reuse.

- Production of a homogenous product that has consistent texture, appearance and moisture content.