FACT SHEET

CHARACTERISTICS AND ACCUMULATION OF SLUDGE

Sludge Handling and Management Investigation
Fact Sheet Series
May 2014

Sludge in Pond Systems

Almost all conventional piggeries and beef feedlots in Australia currently use pond-based systems to treat their effluent. Over time, settleable solids in effluent will result in a steadily growing layer of sludge in the base of a pond. This causes a loss of volume, which reduces the treatment capability of the pond. The nutrient and solids in the pond liquid will become more concentrated, causing more sludge and more odour to be generated. Eventually, sludge must be removed to ensure the pond maintains sufficient performance.

Definition of Sludge

The term – sludge – is widely used for a range of materials containing a mixture of water and solids. The solids component can be inorganic material (any materials such as debris, sand or rocks plus the ash component of organic wastes), slowly digestible organic material or dead microbial cell mass. The ratio of water to solids can vary considerably. As the solids content increases, the sludge's characteristics and handling requirements change. The particle size and Particle Size Distribution (PSD) can vary from very fine material to larger particles. Some particles can be cohesive (i.e. they tend to stick together) while other particles such as sand are non-cohesive. Figure 1 shows the general properties of different sludge derived from different sources.

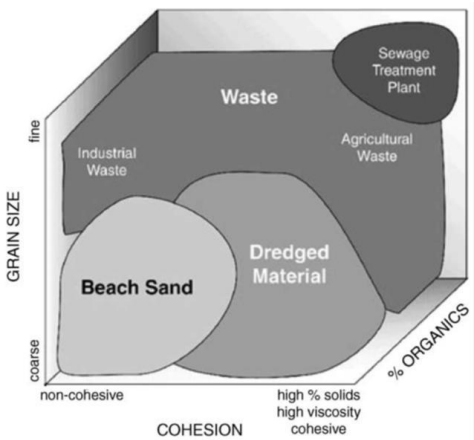

Figure 1 – General properties of sludge from different sources

For piggery and feedlot wastes, Figure 2 shows the range of total solids in a solid / water mixture and the characteristics and handling options for different ratios. The actual properties of sludges derived from various sources vary, even at the same total solids (TS) content. Hence, the following terms and their relative TS contents are a general guideline rather than a fixed rule.

- Effluent – material with TS content of <5 per cent, can be pumped and behaves like other Newtonian fluids.
- Slurry – material with TS content 5–15 per cent, they behave in a non-Newtonian manner and require specialised pumping equipment.
- Sludge – material with TS content >15 per cent, too thick to pump and must be handled with bulk mechanical methods.

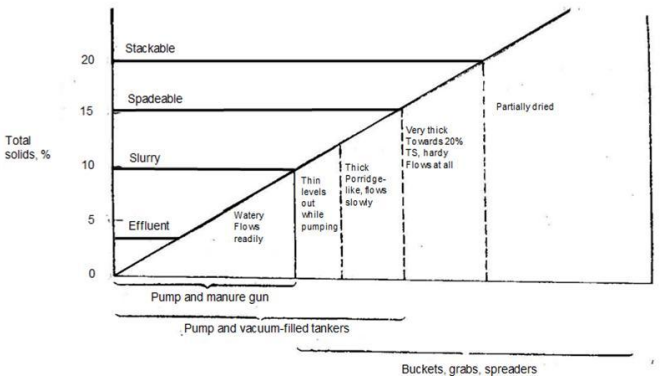

Figure 2 – Handling characteristics of manure at different moisture contents

Components of Sludge

There are three components of effluent, slurry and sludge: physical, chemical and biological.

- Physical – general information on sludge and slurry processability and handleability.
- Chemical – presence of nutrients, salts and toxic/dangerous compounds, necessary in the case of utilisation in agriculture.
- Biological – microbial activity and organic matter/pathogens presence, thus allowing the treatment design and safety of use to be evaluated.

Sludge Accumulation

The solids content of waste entering the pond system can be reduced through pre-treatment methods, thus limiting sludge accumulation. The separated solids can then be treated (composted) or applied directly to land. Pre-treatment methods include solids separators and sedimentation basins.

The depth and spatial variability of sludge in an effluent pond can vary widely depending on loading rates and the position of the inflow and outflow points. It is typically measured by probing at a number of points of the pond. The probing method is time consuming, poses health and safety risks and the accuracy of the measurement itself is subjective.

More recently, infrared sensing, sonar and GPS have been used as a rapid sludge measurement tool that can be operated from the pond banks instead of in a boat. The depth to sludge layer can be determined by the time lapse between the transmitted and reflected signals from a transducer.

Three different layers are likely to be found within an anaerobic pond (Figure 3).

1. Inert material (rocks, sand, feed etc.) accumulate near the inflow pipe(s) and drift to the base of the pond (Figure 3). This sediment is solid in nature with an easily identifiable interface between the other layers.
2. A moderately viscous slurry above the first layer, high in nutrients, bacteria and organic matter. This slurry layer can be handled by pumps designed for higher solids applications.
3. Finally, above the sludge layer is a liquid layer low in solids, moderately rich in nutrients, and easily pumped with irrigation pumps.

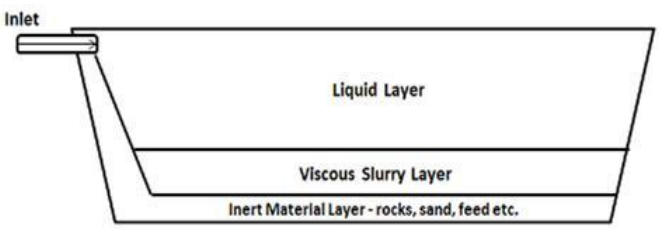

Figure 3 – Typical pond sludge accumulation layers

Sludge accumulates continuously in all effluent treatment ponds, but mainly in the primary anaerobic pond. Research shows that sludge accumulation can vary significantly depending on the TS concentration of the wastewater and the treatment methods used.

The sludge accumulation rate escalates when sludge exceeds 30 per cent of the pond volume (Hamilton 2010).

The ASABE standards state that sludge accumulates at 0.00303 m3 (ASABE 2004) or 0.00137 m3 (ASABE 2011) per kg TS added. Using the ASABE standards and the National Environmental Guidelines for Piggeries the sludge accumulation rate for a 100 sow piggery is either 592 m3 (ASABE 2004) or 268 m3 (ASABE 2011) per year.

Regardless of the sludge accumulation rate, maintaining sufficient treatment volume in the pond is very important. The National Environmental Guidelines for Piggeries recommends that the need for desludging should be investigated if the total solids reduction in the anaerobic pond falls below 50 per cent or the total solids concentration of the treated effluent exceeds 1 per cent.

Sludge Distribution

An understanding of pond sludge distribution assists the design and management of a sludge-removal system. Sludge distribution in anaerobic ponds has been found to be highly uneven (Figure 4). Sludge levels are often found to be higher at the inlet, outlet and in the corners. Patterns of sludge distribution are often attributed to pond geometry and inlet layout. Research showed ponds with steep sides provide favourable conditions for uniform distribution of sludge, and five inlets instead of one resulted in more even sludge distribution. Local climate conditions are important and sludge distributions can change throughout the year.

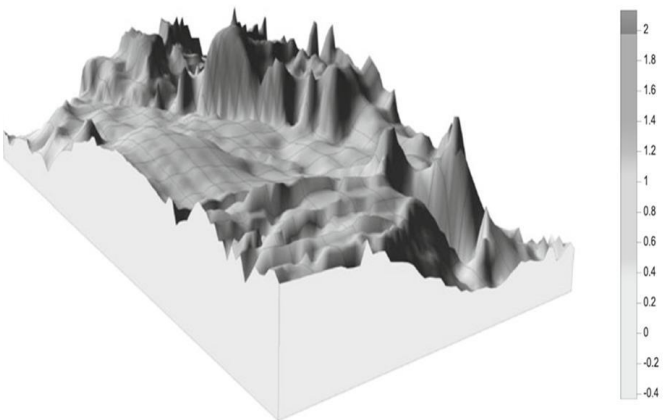

Figure 4 – Sludge distribution in a primary pond (Keffala et al. 2013)

AUSTRALIAN Pork™

Fact Sheet

Introduction to Pond Desludging

Desludging provides an opportunity to use sludge in place of expensive fertilisers. Desludging ponds has always been problematic. The challenge has increased with recent moves towards synthetically-lined and/or covered ponds for reducing the likelihood of leakage and for capturing GHG emissions to generate renewable energy for use on-farm.

Great care is needed when desludging these ponds to prevent damage to the synthetic liners and/or covers. Equipment such as excavators and agitators are generally unsuitable in these systems. Dewatering the sludge removed from the ponds can also be difficult, odorous and time consuming. More information is provided in the removal of sludge from ponds factsheet.

Key Points

- **Sludge is a mixture of water and solid materials (solids content > 15 per cent)**
- **Sludge has three components; physical, chemical and biological**
- **Settleable solids accumulate in anaerobic ponds over time forming a solids (sludge) layer at the base of the pond**
- **Several sludge accumulation rates given based on prior research – current ASAE 2011 – 0.00137 m3 / kg solids added to a pond for piggeries**
- **Sludge distribution is highly variable but is more likely to occur at the inlets, outlets and the corners.**

References and Further Reading

Hamilton, D 2010, 'Sludge accumulation in two anaerobic/facultative lagoons treating swine manure from breeding farms in Oklahoma', Transactions of ASABE, vol. 53, no. 2, pp. 529-536.

Keffala, C et al. 2013, 'A review of the sustainable value and disposal techniques, wastewater stabilisation ponds sludge characteristics and accumulation', Environmental monitoring and assessment, vol. 185, no. 1, pp. 45-58.

Tucker, RW et al. 2010, National environmental guidelines for piggeries - Second Edition, APL Project 1832, Australian Pork Ltd, Deakin.

Other Fact Sheets in this Series

- Dewatering Sludge
- Removal of Sludge from Ponds.