

# Effluent Technical Note

## Odour mangament for storage ponds

**Odour from farm dairy effluent is increasingly an issue as herd sizes grow and urban boundaries get closer to operating farms. Odour issues can also be a regional council compliance concern if offensive or objectionable odours are detected beyond the property boundary. Management of odour is often referred to in effluent consents.**

Odour is generated during the incomplete anaerobic (low/ no oxygen) breakdown of organic matter in effluent. Sources of odour include ponds, tanks, solids separation systems, sludge piles, feed pads, and silage stacks. Effluent application, the de-sludging of ponds and muck spreading operations also release odour.

For this reason, it is sensible not to construct ponds, yards, pads, stock housing or other odour generating facilities near property boundaries. Many district and regional councils will have minimum distance requirements, however you should also note the direction of the prevailing wind and what will be 'downwind' of your pond or facility.

If a neighbour complains to the regional council about an odour the council will come out to your farm and assess the situation for frequency, intensity, duration, offensiveness and location of the odour. Infringement /abatement notices may be a potential consequence.

### *Keeping the neighbours happy*

If you are planning an activity you know will generate some odour, such as spreading a large solids pile or desludging a storage pond, consider these handy tips:

#### **Handy tips**

- Schedule effluent activities from Monday to Thursday to avoid odour immediately before the weekend.
- Spread effluent in the morning to take advantage of warming conditions which help disperse the odour.
- Avoid spreading when the wind is blowing towards the neighbour
- Let the neighbour know when you are planning some activities. If they know they are likely to be more accommodating (and appreciative of your thoughtfulness). They may be planning an outdoor event in which case you might be able to reschedule spreading to another day.
- Note- it can take a couple of days for the odour to disperse after spreading.

### *Identifying the source*

If a neighbour complains about an objectionable odour or you notice some issues yourself you must investigate further. This is not generally a problem that disappears quickly.

#### **What is the problem?**

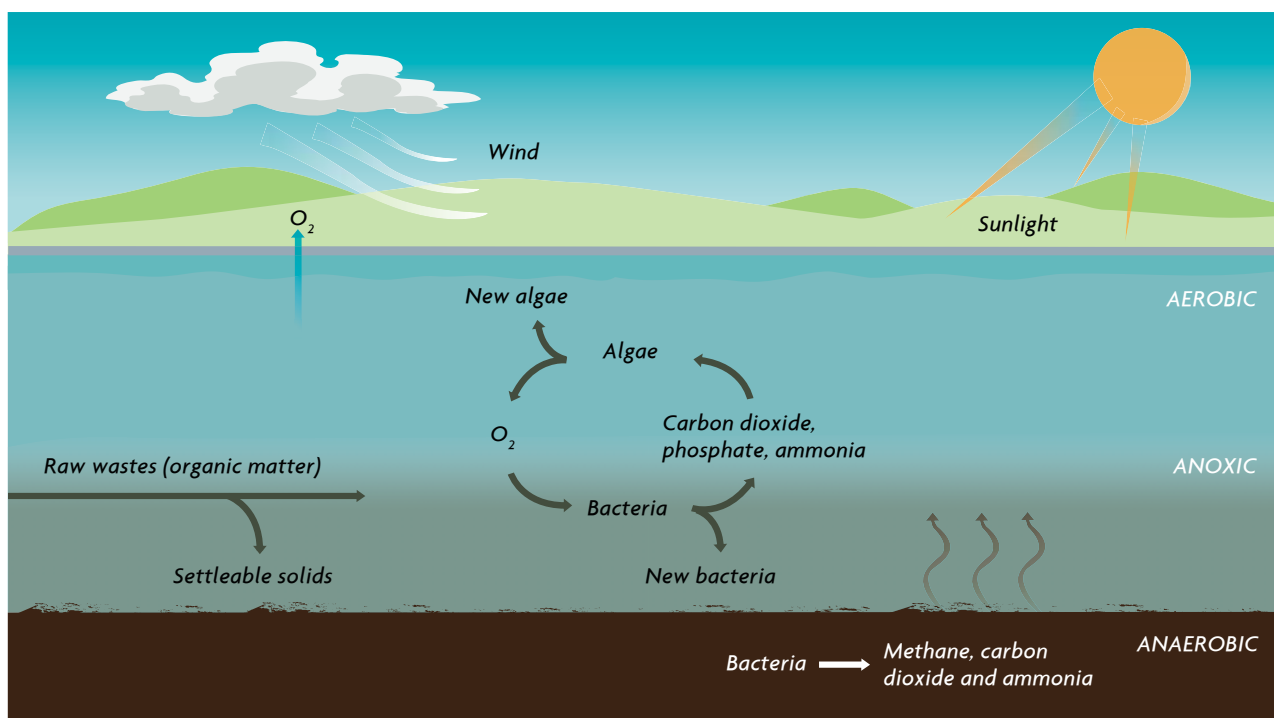
Often the main culprit is the effluent storage pond although it does pay to check that there's not a problem with effluent stored in the mainlines. This can happen if it's been a significant time since you last irrigated.

If satisfied that the issue is the storage pond itself, try and diagnose the type of smell using the table below.

Compound	Description
Hydrogen Sulphide	Rotten eggs
Methyl Mercaptan	Decayed cabbage, garlic
Ethyl Mercaptan	Decayed cabbage
Dimethyl sulphide	Decayed vegetables
Ammonia	Sharp, pungent
Volatile organic compounds	Varies between compounds- solvent type/putrid/sickly

## How does an effluent storage pond work?

Before proceeding further with diagnosis and fixing the problem it's often handy to understand the processes going on within the pond itself.



A typical farm dairy effluent storage pond is usually 3-4 metres deep so it often has a mixture of zones with different biological processes occurring. At the bottom is a deep sludge layer with anaerobic activity producing methane and carbon dioxide as well as hydrogen sulphide. Above that is the anoxic layer which has some oxygen. Different bacteria live there that use some of the nutrients from effluent. They come up from the sludge to reproduce and as they die off they settle to the bottom. At the top layer is some aerobic activity where algae use sunlight and nutrients to reproduce. The algae die off and also settle to the bottom of the pond. This happens on a continual basis. In deep ponds you can get inversions where the temperature change generates a mass movement of water stirring up the pond, suddenly releasing gas and odour.

## What is causing the pond to smell?

Odours from ponds are caused by a mixture of gases. The type of pond and the way the pond is operated and maintained impacts on odour production. These gaseous compounds are produced all the time but usually at low levels that are not an issue. However, occasionally they get out of balance and produce an 'odorous' episode.

The main gas that is likely to cause the majority of issues for dairy effluent ponds is hydrogen sulphide with ammonia gas more of an issue with large volumes of effluent solids.

### Hydrogen Sulphide

It comes from the anaerobic (no oxygen) layer of ponds produced by bacteria that reside there. In a healthy pond Hydrogen Sulphide (H<sub>2</sub>S) moves from the anaerobic layer to the aerobic layer and is changed by a different bacteria into sulphur oxide gases (not quite as smelly), which are then released to the atmosphere.

This process can go wrong, resulting in the release of odorous hydrogen sulphide to the atmosphere. The following reasons may cause the process to go wrong;

- A fast increase in temperature can cause anaerobic bacteria to grow rapidly, producing more hydrogen sulphide;
- Extended period of low sunlight ;
- Low dissolved oxygen levels;
- Low pH (pH < 7.5).

### Why is the pond giving me grief now?

There are a variety of reasons why the pond goes into an odorous episode that include overloaded or shock-loaded pond systems and seasonal climatic conditions.

#### Overloaded/shockloaded

An overloaded pond is when the wastewater received by the pond system is regularly at a higher concentration and/or volume than what the pond was originally designed for or is biologically capable of managing. Overloading of ponds may happen when stocking numbers are increased or sludge builds up in the pond

A shock-loaded pond happens when either a large volume or high strength effluent is discharged into the pond at one time,- for example if spoiled milk or a large amount of feedpad scrapings was dumped into the pond. Shock-loading can upset or kill-off bacteria so they cannot breakdown organic matter.

#### Seasonal climatic conditions

Odour issues have been found to be particularly common in spring when the temperature increases and effluent collected over winter starts breaking down.

Anaerobic bacteria operate best in warmer conditions. When temperatures rise,

- more hydrogen sulphide is produced
- Less dissolved oxygen is available for aerobic bacteria, so less breakdown of hydrogen sulphide

## Dealing with the odour issue

If this is the first time you've dealt with an odorous pond or it only happens occasionally, you can consider a few options.

Getting some air into the pond combined with chemical dosing with some lime is the best first step to rectify the problem if you detect the hydrogen sulphide smell. It's necessary to get the odour under control before you continue with irrigating.

### **Stirring alone is unlikely to solve this issue, you do need some chemical intervention as well!**

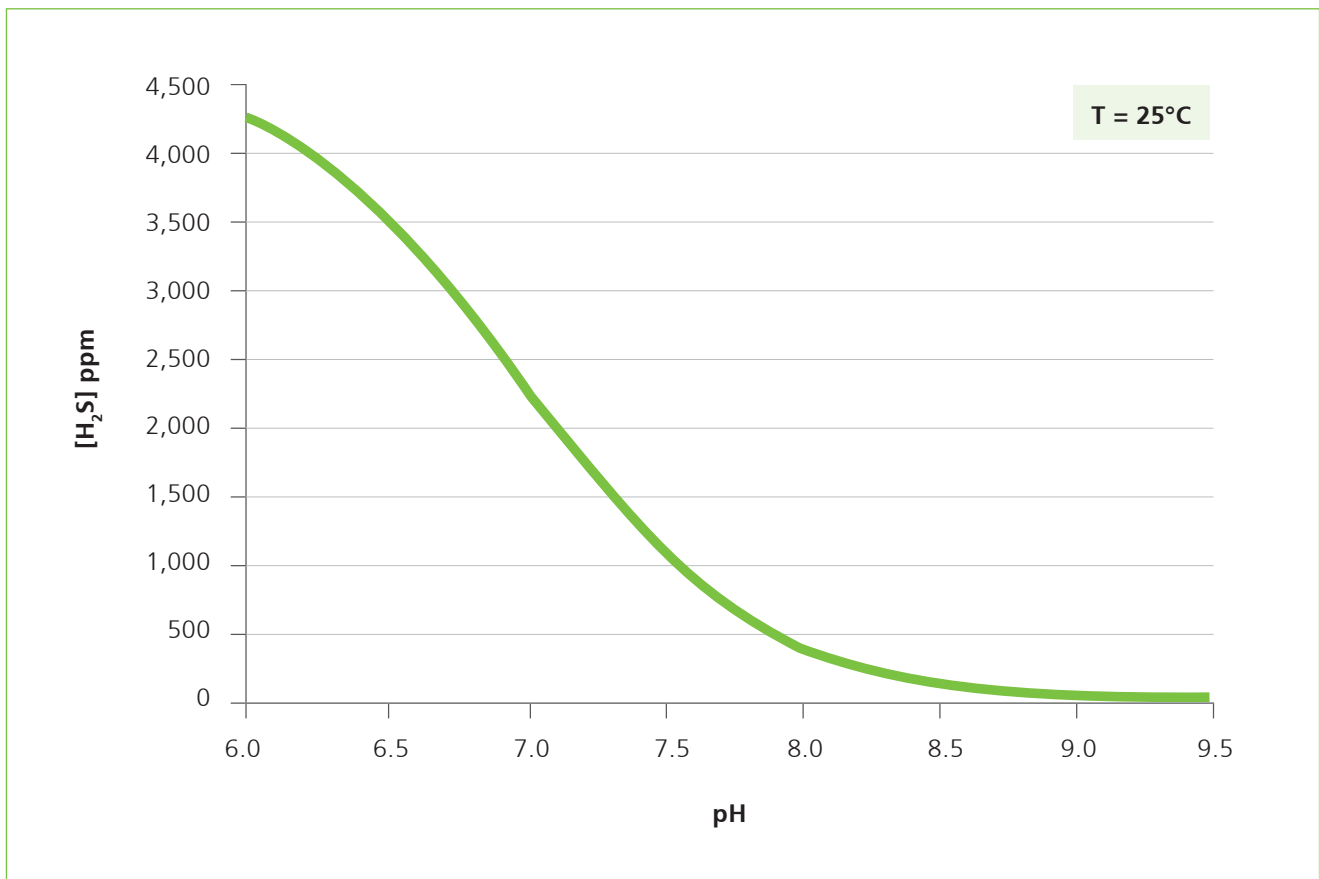
If your pond does not have a stirrer then you might want to contact a spreading contractor as most will have tractor driven stirrers to help stirring the ponds before the contents are spread.

Odour problems can arise when the pH drops below 6.5. This condition can be temporarily corrected by applying lime to increase the pH.

*We recommend adding 16 kg per day of agricultural lime per 1000 m<sup>3</sup> of pond volume until the pH has stabilised at an appropriate level. This should be added by sprinkling in and mixing well.*

### **How does lime work?**

An anaerobic pond will have a pH range of 7 to 8 (slightly basic). Odour problems can arise when the pH drops below 6.5. This condition can be temporarily corrected by applying lime which increases the pH. As shown in the graph below hydrogen sulphide reduces when the pH is increased. However, it is preferable not to go too alkaline as there is the potential to generate ammonia, another odorous gas.



## What about other chemicals?

There are a number of other chemicals that may also help reduce the odour although they tend to be more expensive than lime and some care is to store and handle them.

Sodium or calcium nitrate is also worth considering and can be purchased from a chemical store. Adding a nitrate source is a proven technology for hydrogen sulphide control.

To determine the dosage rate it is best to collect effluent sample from the pond and send it to a lab so they can measure the BOD content. BOD is essentially a procedure involving the measuring of oxygen consumed by living organisms in the sample.

The dosage is calculated as 50% of BOD<sub>5</sub> concentration in the pond which can range from 90 to 500 g/m<sup>3</sup>.

Anaerobic microorganisms will preferentially reduce nitrate rather than sulphate when both are present. The reduction of nitrate does not liberate odorous compounds unlike the reduction of sulphate.

*If the pond is very smelly while you are waiting for the lab results, we suggest you treat the pond with a dose rate of 50 g sodium or calcium nitrate per m<sup>3</sup> of pond volume. For an average pond of 1,500 m<sup>3</sup> then you will need 75 kg of sodium nitrate. If there is still major odour after a couple of days, consider a second dose at the same rate. Ensure it is well mixed!*

Precautions when using these chemicals are to:

- Ensure you read all safety information provided with the product
- Store the chemicals as stated in the safety sheet
- Personal protective equipment such as overalls, chemical goggles, gloves and face mask should be worn.

If these chemicals and aeration do not get the odour under control it is worth contacting a waste water treatment engineer to provide further advice. There are other chemicals that may be effective you will need some expertise in using them.

## What about other pond additives?

There are a number of companies claiming they have solutions to pond odour although most have no scientific data to back their claims. Sometimes they are just selling lime or sodium nitrate and often more expensively than from a chemical store. Although anecdotally some farmers have reported some success with these products they generally do not offer a long term solution.

Biological additives are also sold by some companies that may act to alter the microbial community. Some may act by liquefying the crusts and sludge in ponds but very few companies disclose how their product works or provide scientific data to support their claims. Many have been tested in the human waste water treatment industry but often found wanting.

## What about covering the pond?

Impermeable or permeable covers can prevent odour from being released to the atmosphere however they are not commonly used within New Zealand. Research from Europe has found that a sealed lid can give reductions in ammonia or hydrogen sulphide emissions of up to 95%, while covering with floating straw or pellets can give reductions of around 50% - 80%.

Impermeable covers with gas collection systems, trap all gases, so they can either be reused as an energy source or treated through a biofilter or flare.

Permeable covers reduce emissions by acting as a partial barrier to reduce gas transfer, as well as a biofilter for biological treatment of odorous compounds.

## *What about emptying the smelly pond?*

Commercial spreading contractors can be employed to empty the pond and spread the contents onto land. Follow the handy tips above for spreading. It will really smell strongly for a few days until the odour disperses. The effluent should be spread thinly on the paddocks and then given time for the odour to disperse and the material to break down before allowing animals back onto the paddocks. This time to breakdown will be dependent on the application depth.

## *My pond has turned an interesting colour?*

### **Green**

A green looking pond is usually in good condition and should not produce any objectionable odour, apart from very occasional episodes. If there is however a green scum on the surface then this is likely to be blue green algae and this may increase in population and then die off suddenly releasing toxins and odour.

### **Black-greyish**

A black–greyish pond can be a sign of a high sludge level and highly concentrated effluent in the pond causing anaerobic activity.

### **Pink**

A pink pond that is bubbling is a sign of the establishment of purple sulphur bacteria (PSB). PSB mitigate odour release by using sulphur to respire and thereby reducing the amount of hydrogen sulphide produced. Such a pond is most likely recovering from an odorous period so there should be little odour from a light pink pond.

### **White/Milk**

This colour is likely to be due to an increased anaerobic activity as the water temperature rises. The release of sulphide and hydrolysis products is likely to turn the water milky and smelly.

### **Blue-greenish**

This colour is likely to be caused by an excessive proliferation of cyanobacteria. This will lead to the release of bad smells and the production of toxins in the water. Cyanobacteria may bloom with warm temperatures and high nutrient levels. It is a sign that the pond is receiving a high organic loading. Treatments include aeration/mixing, hydrogen peroxide, and possibly algaecides. Expert advice from a waste water treatment engineer may be needed if this is occurring in the pond.

## *How to avoid pond odour problems?*

There are some sensible strategies to avoid having to deal with an odorous dairy effluent pond.

### **Siting**

If installing a new pond, consider the distance to neighbours, the prevailing wind direction and topography before deciding on the final site.

Siting a pond in a sensible location is the single most important factor to avoid potential conflict. On existing farms with close neighbours other strategies may be necessary to minimise odours. Many district and regional councils will have minimum distance requirements, but you should also take care to note the direction of the prevailing wind and what will be 'downwind' of your pond or facility.

For existing ponds where the siting and design cannot be changed, other strategies are necessary to avoid odour emissions.

## Planting trees between neighbours and pond

Although a long term strategy, trees in shelter belts can absorb odorous compounds. They create turbulence that disperses odour upward, particularly under stable night time conditions. Studies indicate that under variable climatic conditions, windbreaks can improve odour dispersion.

More information on trees

The tree species in a windbreak should be selected using the following factors:

- High leaf surface roughness (plants with leaf hairs, leaf veins, and small leaf size)
- Complex leaf shapes
- Large leaf areas
- Medium to rapid plant growth rates

It is usually best to select several different species of trees and shrubs for windbreaks. This helps prevent the loss or destruction of the entire windbreak if insect pests or tree diseases occur on certain species. Having diversity also offers a better chance for a tree surviving during alternating seasons of drought and/or wet soil conditions. Tree shelter belts will obviously restrict wind run and reduce the amount of dispersion and dilution provided by natural wind run. Tree belts may also reduce perceived odours by providing a visual barrier between the effluent storage pond and neighbouring properties. In effect, this may be a more important consideration than the actual reduction in measurable odours achieved with tree belts.

## Regular desludging of ponds

Odour issues can occur when ponds are being desludged as this process mixes the sludge layer at the bottom of the pond. When the sludge is removed, the gases are brought to the surface and are released into the air.

If you leave sludge to build up in the pond for too long, the pond itself can turn odorous very quickly. If the right temperature and pH conditions align, the effluent can turn into a black odorous liquor overnight. It is important to regularly monitor the sludge layer and desludge the pond.

## Solid separation prior to effluent storage

With increasing use of feedpads, stand-off pads, covered housing and more supplementary feeds coming onto the farm, effluent has a much higher solid content. If this is stored directly in ponds the sludge can build up very quickly and lead to odour issues. For intensive operations it is strongly recommended to install solid separation and manage the solid and liquid components separately.

## Pond mixing

Effluent storage ponds should include a stirring or mixing system.

Agitation increases dissolved oxygen, reduces odours and encourages oxygen transfer through algae and direct transfer mechanisms. Mechanically mixing the pond is already a feature of many dairy farms in New Zealand. There are a variety of agitators from tractor PTO driven propellers to electric motor mixers; either pontoon or shore mounted. On farms where there is no existing electrical supply to the effluent storage pond, the installation of an electrical mixer is likely to be an expensive option.

## Pond aeration using wind

Increasing the exposure of the pond to wind will help induce oxygen transfer into the pond. The wave action has a limited ability to increase the oxygen transfer to the lower layers of deeper ponds.

## Wind aeration systems

A number of systems use wind turbines to compress air, which is then released into the pond through a diffuser. The diffuser can be set at any height in the pond or at any location. These devices have no moving parts in the pond, which allows for easier maintenance. The wind powered compressed air system relies on a constant source of wind power, although some systems can operate at relatively low wind speeds.

There are a number of options to use wind for pond aeration. These systems are frequently used other countries for in municipal/industrial wastewater ponds, amenity ponds and lakes. These systems provide options for different applications within dairy pond systems. Each system needs to be investigated for suitability on a site by site basis. Desktop research did not provide literature evidence of these systems for farm dairy effluent in New Zealand. The Solar Bee mixer has been used in Wanganui since 2007 on a recreational lake.

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