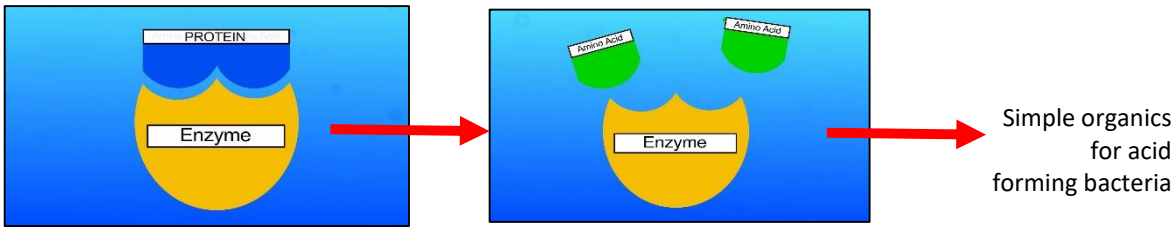
Anaerobic ponds

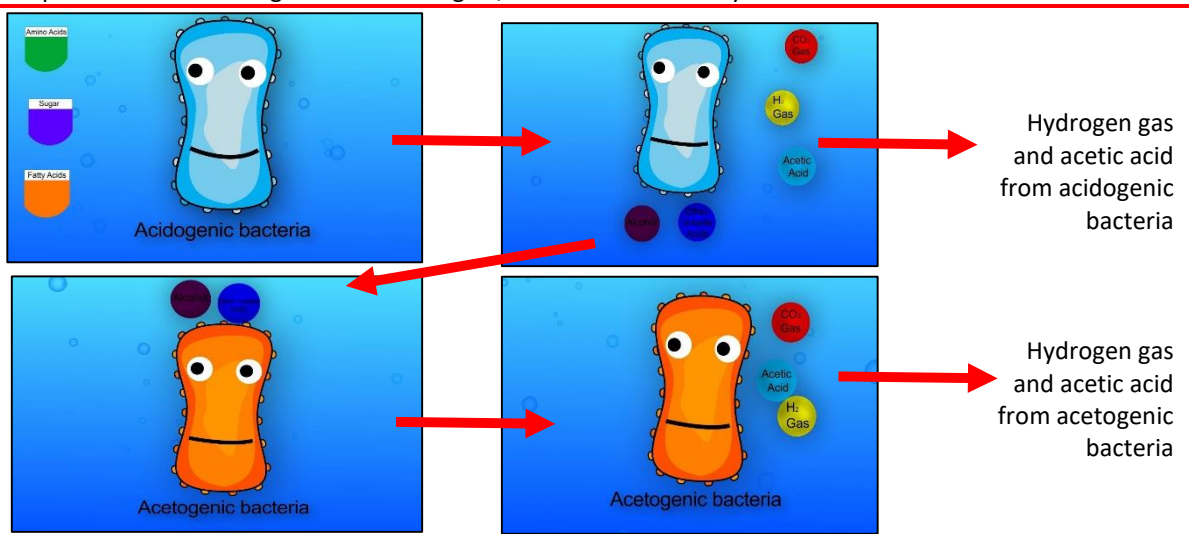
Anaerobic ponds play an important role in the treatment of meat processing wastewater. Their key function is to reduce the level of organic contaminants such as Biological Oxygen Demand over five days (BOD_5), Chemical Oxygen Demand (COD) and to a lesser extent oil and grease. They have little effect on nitrogen and phosphorus (nutrients) and pathogen numbers.

Anaerobic ponds contain a complex mix of bacteria that breakdown organic substances in the wastewater from meat processing plants.

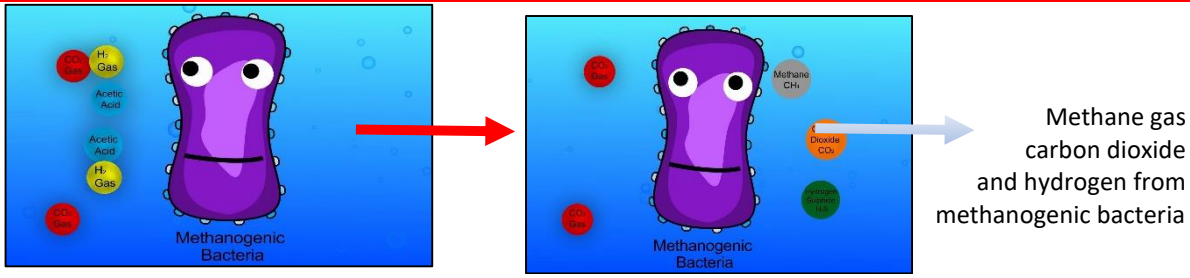
Figure 1: Three phases of anaerobic breakdown



The **first phase** enzymes excreted from bacteria breakdown fats, proteins and carbohydrates in the wastewater into simpler water-soluble organics such as sugars, amino acids and fatty acids.



In the **second phase** acid forming bacteria convert these simple soluble organics into carbon dioxide, hydrogen, and volatile acids including acetic acid and alcohol.



In **the third phase** methane producing bacteria convert the hydrogen and acetic acid produced by the acid forming bacteria into methane (CH_4), hydrogen (H_2) and carbon dioxide (CO_2). The biogas exits the waste water and so the BOD_5 and COD of the water are reduced.

There are four important things to know about anaerobic systems:

1. They work **entirely in the absence of oxygen** which makes them very cost effective to operate. Offensive odours can be a problem with anaerobic ponds due to presence of ammonia (NH_3) and hydrogen sulphide (H_2S), a rotten egg smell. No supplement can be added to prevent this without killing the pond.
2. Anaerobic systems **generate much less sludge** than aerobic treatment systems.
3. Anaerobic systems **generate large quantities of methane**, which is an energy-rich fuel. Methane can be captured and used for boiler fuel or for making electricity in gas engines. As such, the Australian meat processing industry has significantly adopted Covered Anaerobic Lagoons (CAL), in which a plastic cover is stretched over the pond to capture the biogas for use.
4. If the anaerobic system fails, the performance of the entire downstream pond system will collapse and produce non-compliant final waste water.

Table 1: Benefits and challenges of anaerobic ponds

Benefits	Challenges
• High removal of organic load • Tolerant to high Total Suspended Solids (TSS) and oil and grease levels • Cheap to build • No energy input required • Produces energy-rich methane • Produces less sludge than other technologies	• Offensive odours are produced • Effluent needs further treatment • Significant contribution to facility emissions if methane is not captured and burnt

Types of anaerobic treatment

Naturally Crusted Ponds

A deep (usually at least 3 metres) basin which over time forms a floating crust consisting of a mixture of paunch material and tallow. The crust may become covered in grass, reeds and other plant life. This crust plays an important role in that it insulates the pond and helps maintain high temperatures during winter months, helps minimise odour emissions, and minimises oxygen entry into the pond through the water surface.

Naturally crusted pond
Image: NB Foods, Oakey

Covered Anaerobic Lagoons (CAL)

CALs have plastic floating covers which seal the pond from the atmosphere and allow capture of the biogas. The CAL works biologically in an identical manner to naturally crusted ponds.
The main advantages of CALs are that biogas is captured either for flaring (to reduce carbon emissions by destroying the methane), or for other uses such as cogeneration or boiler fuel. Odour emissions are also better controlled.
The downside of CALs is their greater cost (usually about double that of naturally crusted ponds).

Mixed Vessel Anaerobic Reactors

Covered Anaerobic Lagoon or CAL
Image: Teys, Beenleigh

Mixed Vessel Anaerobic Reactor

Rather than using an earth dam, the anaerobic reaction can be contained in a suitably constructed tank or vessel if mixing is provided. The much higher cost of tanks relative to dams in Australia has limited the application of vessel reactors to smaller plants.

Legislative and regulatory requirements

Methane emissions from anaerobic ponds have become an important issue for meat processing plants that may be liable to pay for emissions under any future carbon pricing mechanism. Some meat processing plants currently report emissions from anaerobic ponds under the National Greenhouse and Energy Reporting System (NGERS).

For CALs, an additional layer of regulatory impact arises from the capture and use of the biogas. This involves compliance issues relating to various state-based agencies concerned with safety and gas fuels. CALs are likely to require licensing by the relevant state gas regulatory office that controls natural gas production.

Finally, there are significant health and safety concerns with anaerobic ponds, whether naturally covered or as CALs. These concerns relate to the potentially toxic (especially due to H_2S), flammable (methane), or suffocating nature of the biogas. This is of particular concern where there are inlet and outlet pits and other confined spaces where such gases can build up to dangerous levels.

Operator Responsibilities

Recommended day-to-day operator responsibilities include:

Inspection of Naturally Crusted Ponds

- ☐ Regular checks to the inlet and outlet for blockages and clear (preferably at least weekly).
- ☐ Check pond crust to ensure the crust has not disappeared on any part of the pond, or has not changed. A good method is to take a photo of the crust and compare monthly.
- ☐ Watch out for dysfunctional activity such as gas geysers spread across more than about a fifth of the pond surface or crust foaming.
- ☐ Check pond walls for damage.
  - Tree or shrub roots should be removed
  - Repair areas affected by rain erosion – it may pay to apply protective biodegradable matting which allows grass growth for uncovered ponds
  - Undertake measures to control burrowing animals such as wombats, rabbits, reptiles etc.

Gas geysers on crusted anaerobic ponds
Image: Courtesy of Johns Environmental

Foaming on crusted anaerobic ponds

Inspections of CALs

- ☐ Regular checks of the inlet and outlet for blockages and clear (preferably at least weekly).
- ☐ Check for over-inflation of the cover – Most covers are designed to remain relatively flat on the pond surface. If over-inflation occurs, ensure the emergency release valves are not blocked.
- ☐ Inspect for leaks from the cover, for example due to animal damage
- ☐ Inspect for the build-up of crust under the cover – this can be observed through inspection ports and/or felt under the cover
- ☐ Check the operation of the stormwater removal pumps to ensure control of excess stormwater on the cover.

Vegetation

- ☐ Control vegetation around the inner walls of a pond. Some vegetation helps limit erosion of pond walls, but excessive amounts can hinder access and encourage vermin.
- ☐ In the case of CALs, ensure around the pond are free of vegetation to prevent fires from reaching the large biogas store under the CAL cover.
- ☐ In the case of Naturally Crusted Ponds, remove trees and shrubs from pond crusts (reeds and grass should be acceptable in deep ponds). Do not burn vegetation off anaerobic ponds due to the presence of methane.

Monitoring

- ☐ Inlet composition monitoring is generally not required except during replacement of the pond or for trouble shooting
- ☐ Sample and test outlet composition on a regular basis:
  - as often as weekly for intensive treatment systems follow the anaerobic pond downstream (e.g. activated sludge systems or discharge to sewer)
  - once each month or quarterly where the anaerobic pond has facultative ponds downstream and/or waste water is disposed to land
- ☐ Monitoring parameters (outlet) include:
  - On-site – measure temperature, pH and electrical conductivity (EC)
  - Off-site – sample anaerobic pond effluent (5 litres minimum) and test for COD and preferably Volatile Fatty Acids (VFA) (mg/L as acetic acid) and terephthalic acid (TA) (mg/L as $CaCO_3$). Other parameters that may be useful include TSS, total kjeldahl nitrogen (TKN), ammonia-N, oil and grease.

Table 2: Recommended operating ranges for anaerobic ponds

Parameter	Preferred range	You're in trouble
Temperature	20 – 37°C	More than 40°C Less than 10°C
pH	6.7 – 8.0	Less than 6.5
EC	Less than 3,000 µS/cm	More than 10,000 µS/cm
COD	70 – 90% removal	< 50% COD removal A rise in outlet COD of more than about 30% on two consecutive occasions.
VFA/TA ratio	≤ 0.25	> 0.5

Supplements

- ☐ It is rare for promoted biological products to significantly improve a well-designed and operated anaerobic pond. It is not scientifically possible for an anaerobic pond to operate without some offensive odour unless it is very underloaded.
  Products that remove the crust off naturally-crusted anaerobic ponds are very risky. In these ponds, the crust is important for minimising odour release and keeping heat in the pond, especially during winter. Remove it at your own peril!

Shutdowns

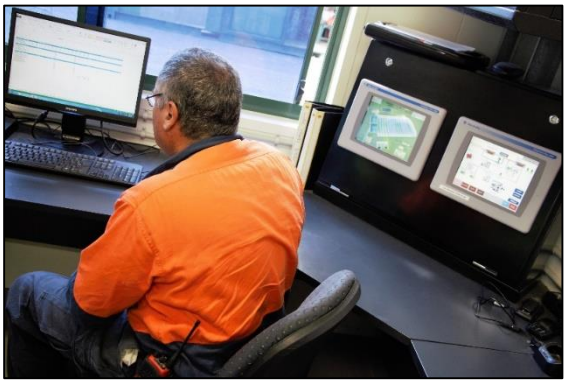
- ☐ Ensure careful monitoring of the system during start-up when there has been shut down for extended periods such as two to three months.

Supervisor/management responsibilities

Recommended supervisor/management responsibilities include:

Supervisors should:

- ☐ Review the monitoring data to observe trends with time. Problems with anaerobic ponds emerge gradually over months. The best means of catching problems before they cause non-compliance with final effluent is to watch trends for COD removal, pH, temperature and VFA/TA ratio with time.
- ☐ Anticipate impacts of sustained increases or decreases in production on the operation of anaerobic ponds. Where needed, obtain specialist advice on these impacts.
- ☐ Promote maintenance expenditure as required.



Review monitoring data
Image: Teys, Beenleigh

These fact sheets have been prepared by The Ecoefficiency Group Pty Ltd in association with Johns Environmental in 2017.