Odour

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Environmental Objectives

Environmental best practice for odour and air quality requires:

- Operation in compliance with statutory and licence conditions applicable to the plant
- Operation to minimise impact on surrounding community air quality
- Achievement of air quality objectives through plant design, operating procedures, waste minimisation, air emissions and odour collection and treatment system design and operation.

Potential Environmental Impacts

Odour Emissions – from operations within the meat processor:

- Animal receival and holding (lairage/pens)
- Rendering and blood drying
- By-product storage and handling
- Waste water treatment
- Waste material disposal and handling

Kill floor and meat processing emissions do not generally cause adverse impacts.

Smoke (particulate emissions)

- Solid fuel combustion
- Plant dust control
- Rendering processes.

Low Level Dust

- Animal movements.

Gaseous Emissions

- Fuel burning equipment
- SOx and NOx
- Greenhouse gases.

Key Performance Indicators

- Odour levels at the nearest receptors
- Contaminant emission concentrations and opacity
- Greenhouse gas emissions (kg CO_2-e/tHSCW)
- Community complaints (complaints/ktHSCW)

Current Legislation and Regulation

Compliance legislation varies from State to State but generally specifies no offensive odour at the nearest receptor or boundary.

Odour guidelines used for *consent and/or planning applications* are based on a dispersion modelling-based criterion. The criterion specifies a maximum odour concentration at a particular exceedence level and averaging time period.

Modelling-based regulation is not generally used for compliance purposes. For this reason odour emission levels for individual odour sources are rarely prescribed in licenses.

Particulate and gaseous emission levels are normally specified as source concentrations.

FURTHER INFORMATION

- *Odour guidelines for each Australian state are available from MLA* [1]
- *A more recent summary is available in the Odour Intensity Report* [2]

Key Legislation by State	
Queensland	*Environmental Protection Act 1994* *Environmental Protection Regulation 1998* *Environmental Protection (Air) Policy 1997*
New South Wales	*Protection of the Environment Operations Act 1997* *Authorised Officers Manual: Abattoirs* *Draft Policy: Assessment and Management of Odour from Stationary Sources 2001*
Victoria	*Environment Protection Act 1970*
South Australia	*Environment Protection Act 1993*
Western Australia	*Environment Protection Act 1986* *Environmental Code of Practice for Abattoirs* *Environmental Code of Practice for Rendering Plants 1991*
Tasmania	*Environmental Management and Pollution Control Act 1994* *Environmental Code of Practice for Meat Premises (Slaughtering) 1995*
Northern Territory	*Environmental Assessment Act 1982* *Environmental Offences and Penalties Act 1996* *Waste Management and Pollution Control Act 1998*
Australian Capital Territory	*Environment Protection Act 1997* *Environment Protection Regulations 1997* *Code of Practice – Livestock and Poultry at Slaughtering Establishments*

Environmental Best Practice Overview	
Processing Plant Location and Site	• Understand site topography and meteorology, and possible katabatic drainage of odours • Site plant to minimise air quality impacts on surrounding community by having regard to dominant and problematical wind directions
Identify all Odour and Air Emission Sources	• Quantify and rank all sources • Apply emission minimisation principles to eliminate/minimise air emissions • Provide air emission treatment to remaining sources as required to meet licence conditions and community obligations
Management Focus on Air Quality	• Training and culture to understand air quality issues • Operating procedures to minimise air emissions • Comprehensive data base on weather conditions and plant operation abnormalities • Reporting systems to retain focus on air quality and maximise the value in the feedback from residents (time, duration, odour character etc.)
Performance Monitoring	• Air quality as a key performance indicator • Include community feedback along with quantitative emission monitoring • Retain staff focus
Community Relations	• Develop a communications strategy which addresses community feedback • Implement a formal complaint handling procedure

1.0 BEST PRACTICE INFORMATION

Achieving best practice in odour and air quality takes account of the following:

1.1 Processing Plant Location

The size and shape of the property on which a plant is to be built will affect the potential for odour and air emissions to impact on surrounding residents. The judicious siting of odorous plant and wastewater treatment facilities on a site is as critical as the selection of the site itself. These criteria apply to new plants and may be difficult to apply to existing plants on well-established sites. Some points for consideration in site selection are:

- City or country location
- Site size and shape
- Avoid obvious katabatic (air drainage) problems
- Larger, rural locations are more tolerant to on-site disposal of waste materials
- Allow for the possibility of including a rendering plant even if the processing plant does not initially intend to process by-products.

1.2 Processing Plant Scale and Scope

- Larger meat processing plants incorporate greater integration of secondary processes – rendering and blood drying for example, which may increase odour emission risks
- Smaller and regional meat processing plants may export secondary processing off-site. In this case, they need only consider animal holding pens, wastewater treatment and possibly thermal plant as odour and air emission sources, although future plans may dictate the inclusion of secondary processing
- Processing plant age
- Equipment and technology upgrades
- Building design and ventilation
- Integration of odour and air emissions controls.

1.3 Raw Materials

- Condition of raw material stored and processed through the by-products (rendering and blood drying) systems.

FURTHER INFORMATION

- *Refer to the MLA Advisory Package on Rendering for specific recommendations* [3]

1.4 Fuel Sources

Fossil fuel sources for thermal plants determine gaseous and greenhouse gas emissions.

Coal used for fuel at a processing plant

2.0 TYPES OF AIR EMISSIONS

Air emissions fall into three categories, defined below:

2.1 Gaseous Emissions

Gaseous emissions refer to the release of specific chemical compounds into the air from meat processing operations. The National Pollutant Inventory Handbook for Meat and Meat Product Manufacturing lists the following as major gaseous pollutants to atmosphere:

- Ammonia
- Carbon monoxide
- Hydrochloric acid
- Nitrogen oxides
- Particulate matter
- Sulphur dioxide and sulphuric acid
- Total VOCs.

The industry is also a producer of greenhouse gas – particularly carbon dioxide and methane – and many other gaseous pollutants in lesser quantities.

FURTHER INFORMATION

- *National Pollutant Inventory Handbook for Meat and Meat Product Manufacturing* [4]
- *The full pollutant inventory is available on the NPI website at: www.npi.gov.au*

2.2 Particulate Emissions

Particulate emissions refer to the release of discrete particles of material, generally from:

- fuel combustion
- drying processes
- dust from vehicles or livestock movement, or wind action.

2.3 Plant Odour

Although both gaseous and particulate emissions can be odorous, odour emissions represent complex mixtures of components with an associated odour. Meat processing can generate a variety of odorous emissions each with its own complex character, some unpleasant.

FURTHER INFORMATION

- *Investigations of odorous gas emissions from meat and rendering plants* [5]

A typical odour inventory for an integrated meat processing plant demonstrates the contributions of source and treated odours to overall plant odour emissions is presented in Table 1. Odours may be from area or point sources.

2.4 Point and Area Sources

Any of the above categories of emission can be further classified according to whether they are:

- Point sources - comprise a concentrated stream of air or process gas exhausted to the atmosphere through a stack or similar defined outlet. These are the major sources of particulate (solids fired boilers) and gaseous emissions and include some odorous streams.
- Area sources - are generated over large areas rather than a defined point. Examples include compost heaps, wastewater ponds or animal holding yards. They can be more challenging to control.

These boiler stacks are one example of a point source

Holding yards are an area source for emissions

Table 1 – Ranking of odour sources from an integrated meat processing plant

ODOUR SOURCE	ODOUR EMISSION RATE	ODOUR CONCENTRATION
Abattoir Sources		
Kill Floor Vents	x	x
Holding Pens/Yards	xx	x
Wastewater/Waste Sources		
Save All	xxx	xx
Wastewater Screening	xx	xx
Anaerobic Lagoon (crusted)	x	xxx
Aerated Lagoon	x	x
Settling/Holding Ponds	x	x
Effluent Irrigation	x	x
Paunch Storage Piles (static)	xx	xx
Paunch Storage Piles (during turning)	xxxxx	xxxxx
Rendering Sources		
Raw Materials Receival (fresh)	x	x
Raw Materials Receival (imported/aged)	xxx	xxxx
Blood Tank Vent	x	xxx
Cooker Non-condensable Gas (untreated)	xxxxx	xxxxx
Rendering Process Air (effective collection)	xxxx	xxxx
Rendering Room Ambient Air (effective collection)	xx	x
Blood Dryer Stack (scrubbed)	xx	x
Meal Process and Storage Area	xx	xxx
Tallow Loading	x	xx
Odour Control System Sources		
Thermal Oxidiser Stack	x	x
Biofilter Exhaust	x	x

3.0 BEST PRACTICE AIR EMISSIONS MANAGEMENT

Best practice in odour and air quality is strongly influenced by plant location and the proximity of a potentially affected neighbourhood.

For the purposes of this guide, the following definitions are used:

- **Isolated** - the processing plant and all of its ancillary equipment is located and sited so that there is adequate opportunity for the dispersal of low level odours and settling of low level dust, thus causing negligible impact on neighbours.
- **Sensitised** – the processing plant location and siting is such that low level odour and/or dust may be detectable beyond the plant boundaries under at least some wind conditions and there is a significant sensitivity to air quality from plant neighbours

3.1 General Principles

Graphic modelling of likely odour impacts

Minimisation of air emissions – odour, gaseous and particulate – requires the integration of air quality into all aspects of plant layout, design and operation. Dispersion modelling and knowledge of the dominant and most problematical wind directions should be used to locate odorous plant and wastewater treatment facilities such that dispersion to nearest receptors is maximised.

Where rendering is carried out it is important to maintain by-product material in a fresh condition prior to rendering. While this is not generally a problem for integrated plants, the condition of imported by-product material and blood from off-site can greatly increase odour emissions if this material is in a deteriorated condition. The unloading and handling of this imported material must be carried out without major exposure to atmosphere.

FURTHER INFORMATION

- *An audit of NSW processing plants is reported in a Compliance Performance Report* [6]

3.2 Emission Minimisation

Air emission minimisation optimises process plant design and operating procedures to reduce the load on air emissions control equipment.

Best practice:

- Regular cleaning of holding yards – particularly for processing plants in sensitised areas
- Regular and frequent removal of waste material from the processing plant – either off-site or for further treatment on-site
- Prompt processing of material for rendering
- Avoid receiving aged material for rendering unless appropriate receival and processing systems are in place
- Waste and processed material (meal etc) to be transported around the site in enclosed systems wherever possible
- Non enclosed systems to be accessible for regular clean down
- Proper operation of water treatment systems to avoid odour generation in treatment and holding ponds and during irrigation.

FURTHER INFORMATION

- *WA Rendering Code of Practice* [7]
- *Odour Minimisation Manual* [8]

3.3 Management Culture

Management attitudes will determine the success achieved in emission minimisation and air emission plant operation.

Best practice:

- Air quality as a key management goal in plant operations
- Air quality reporting integrated into overall operations reporting to ensure appropriate attention at all management and operational levels
- The culture of air quality achievement as part of staff training
- Air quality as a goal in it's own right, as well as a result of good housekeeping and other operational procedures
- Formalised contingency plans for the failure of air emissions control plant and other plant and processes which can cause increase air emissions.

3.4 Training

Air quality management should be included as a key operating objective in site inductions and specific training for all employees and staff.

Best practice: Specific training relating to equipment and systems that can effect air emissions should cover:

- Housekeeping and operating procedures which can lead to increased air emissions (particularly odour)
- Operation and maintenance of air emission control equipment under normal and abnormal conditions
- Procedures which can effect (particularly odour) emissions – eg ventilation ducting not reconnected, covers not replaced.

3.5 Plant Design

Processing plant design can minimise air quality and odour impacts by incorporating the following factors in designing new plant or plant upgrades:

Best practice:

- Identification of the major air pollutant and odour emission sources
- Appropriate technology choices to minimise air emissions
- Modelling of the sources on the site to achieve permit limits (or better) at the site boundaries
- Equipment or processes likely to create odour or air emissions should not be located in unfavourable dispersion locations or near site boundaries.

FURTHER INFORMATION

- *Rendering Systems, MLA Advisory Package* [9]
- *Novel Rendering Technology, MLA Advisory Package*[10]

4.0 AIR & ODOUR EMISSION SOURCES & CONTROL

4.1 Rendering

This is the major source of odour emissions from an integrated meat processing plant.

- Primary emission sources should be captured and treated – where odours will be a nuisance to the community. These may include non-condensable vapours from the cooker(s), and possibly press emissions, screw conveyor emissions, meal screening emissions and raw material bins (if imported material is being processed).

Ducting for odour control

- Depending upon the proximity of odour receptors secondary emission sources may also need to be directed to the odour control system. These include raw material bins, meal storage bins and conveyors, tallow storage tanks and blood tanks.

FURTHER INFORMATION

- *Environmental Control in the Rendering Industry, MLA Advisory Package* [11]
- *Cleaning a Rendering Plant, MLA Advisory Package* [12]

Best practise for the effective control of rendering odour in sensitised locations:

- Equipment enclosure - all material transported within the rendering facility is capable of high odour emissions. On the hot material side, this is further aided by the odour sources being within a highly buoyant, elevated temperature, steam environment which leads to rapid dispersal within the building

- Source capture – a hood and ducting system designed to capture and transport the odour sources from the point of generation or release, through a ducting system for treatment
- Efficient source capture permits the exhaust of building ventilation air direct to atmosphere without further treatment
- In the absence of efficient source capture of odours, the rendering building ventilation air should be treated in an odour removal system
- Heat recovery – energy recovery from high temperature rendering vapours to produce hot water for plant use and reduce condensate temperatures to ~50oC
- Odour removal – various technologies are available for the treatment of odorous gas streams – key characteristics are summarised in Table 2. Detailed descriptions of these technologies are included in Appendix 1
- Raw material receival ventilation – not identified as a problem if only fresh material generated on site is processed through the rendering plant. A potential source of odour emissions if aged, outside material is processed through the plant
    - Receival for fresh, site generated, material should be located within the rendering building (or adjacent enclosed space) and be ventilated as part of the building ventilation system
    - Receival for imported and aged material will be external to the rendering building. The receivals area should be designed to meet normal industrial ventilation criteria. Receival bins should be vented to the rendering odour capture and treatment system.

Biofilter

FURTHER INFORMATION

- *Refer to the set of MLA Advisory Package – Rendering information, reference numbers: 8 - 11*

4.2 Blood Handling and Drying

Blood processing is a potential source of particulate and odour emissions from blood storage, drying and dried product handling. Burnt blood can produce a particularly offensive odour.

4.2.1 Blood Receival

Best practice:

- Blood to be received as fresh as possible and processed as soon as practicable
- Aged blood storage should be vented to an odour control system.

4.2.2 Blood Drying

Best practice incorporates the use of indirect contact or low emission direct dryers which minimise the release of odours and particulates in the off gas streams.

Dryer exhaust gas from indirect contact dryers should be treated through a condensor for removal of vapours. Non-condensables should be handled through the odour treatment system.

In applications using direct contact dryers, air quality is usually seen as a particulate control rather than an odour control issue.

Best practice includes:

- Blood as fresh as practical to minimise odour emissions
- Control and monitor dryer operation to eliminate the creation of offensive odours by burning blood
- Dryer exhaust equipped with wet scrubber using water as scrubbing liquor

Where raw materials or the process are likely to cause odour problems, or where site sensitivity could be an issue, non-condensable emissions should be directed to the plant odour collection and treatment system.

4.3 Thermal Plant

- Steam is a requirement in larger, integrated meat processing plants
- Hot water is usually sufficient in smaller plants without rendering facilities.

Fuel options for thermal plant to generate steam and/or hot water include:

Oil fired burner

- Natural gas – reduces Greenhouse emissions; no particulate emissions
- Oil – potential SOx emissions; no particulate emissions
- Coal – its use is favoured by cost and availability; but requires particulate controls and coal specifications to limit SOx emissions
- Wood waste – greenhouse-beneficial through economical re-use of a waste otherwise destined for landfill or incineration
- All – combustion control to limit NOx emissions

Thermal plant is a principal source of:

- Particulate emissions (coal firing)
- NOx and SOx emissions
- Process related Greenhouse gas (CO_2)

4.3.1 Particulate Control

Coal fired boilers are the major point source of particulate emissions to atmosphere. The particles (fly ash) come from the ash content in the coal. The particles are readily removed from the gas stream by the most appropriate of several technologies, selected to suit the permitted emission levels and the type of boiler.

A comparison of available technologies is presented in Table 3.

Fabric dust filter

Best practice:

- Coal specification to suit the boiler plant and minimise particulate and gaseous emissions
- High efficiency cyclone collectors for stoker and grate fired boilers where the emission – 200 - 250 mg/Nm^3 – is permitted under regulations
- Fabric filters for pulverised fuel fired boilers and other plants where a lower emission - <25 mg/Nm^3 – or non-visible stack emission is mandated

Boiler ash and fly ash may be disposed of dry, mixed with other waste material or processed through the plant waste water system.

4.3.2 Sulphur Oxides

Sulphur Oxide (SOx) emissions only arise when sulphur-containing fuel is burnt – coal or fuel oil. Emissions levels can therefore be controlled by limiting the sulphur content in the fuel – often covered in processing plant operating licences. Natural gas is essentially sulphur free.

Low sulphur or sulphur free fuels have an additional benefit of reducing or avoiding acidic corrosion in boiler plant.

Best practice:

- Use natural gas as an energy source where this fuel is economically available
- Where coal or fuel oil are used, the sulphur content is to be monitored and limited
- Wood waste is a low sulphur, renewable resource which can provide beneficial energy recovery from an otherwise waste product.

4.3.3 Nitrogen Oxides

All combustion processes generate nitrogen oxide (NOx) emissions in one form or another. Nitrous oxide (N_2O) is classified as a major greenhouse gas; nitrogen dioxide (NO_2) is scheduled in the Ambient Air Quality NEPM and the National Pollutant Inventory.

In Australia NOx emission levels are universally maintained by control of the combustion process in the boiler.

Best practice:

- Specification of required NOx emission levels for thermal plant
- Regular review of combustion conditions to ensure that the NOx emissions are maintained below permissible levels.

4.4 Building Ventilation

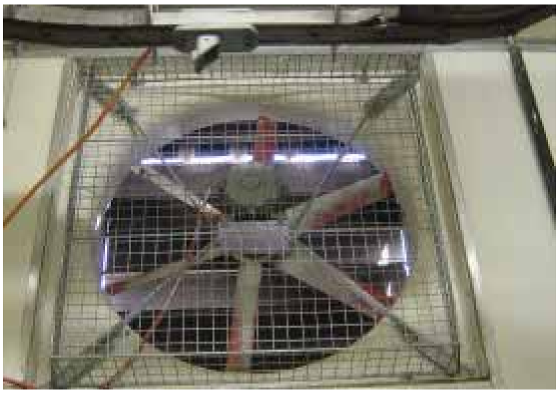
4.4.1 Rendering Building

The extent to which the rendering building ventilation will be an odour source will depend upon efficiency of capturing the primary odour emissions. Effective capture at primary odour emission sources should eliminate the requirement for any treatment of rendering building air emissions.

Pneumatic conveying, storage and handling of meatmeal is a potential source of particulate emissions.

Best practice for rendering facilities located in sensitised sites:

- Building ventilation – rendering building to be fully enclosed, all doorways normally closed, air inlets to building via purpose designed louvres, appropriate air change rate to achieve both satisfactory working conditions and removal of remnant steam and odour. Environmental regulators will require dispersion modelling evidence that the ventilation air will not adversely impact on local receptors. Buildings may be ventilated by:
    - Natural draft through ridge vents
    - Induced draft through roof fans direct to atmosphere
    - Induced draft fan discharging to atmosphere through a stack
    - An induced draft system is preferred for the control over ventilation rate and improved dispersion



Air changes are determined both by environmental and OH&S considerations. For rendering rooms where odour problems occur, 25 – 30 changes/hr have been used. Air exchange rates greater than 40 per hour may be necessary in very hot areas.

FURTHER INFORMATION

- *Environmental Control in the Rendering Industry, MLA Advisory Package* [11]
- *Odour Minimisation Manual for the Meat Processing Industry* [8]

4.4.2 Slaughter Floor, Boning Rooms, Chillers, Freezers

These areas are mechanically ventilated to provide a controlled working environment and are a low to nil odour source.

There are possible odour emissions from paunch and offal handling in the areas between the slaughter floor and rendering.

4.5 Waste Water Management

Solids removal, anaerobic, aerobic and storage lagoons can all emit varying amounts of odours related to the waste water system treatment design and operation.

Wastewater management practices are considered, in this module, only in the context of minimising air emissions.

FURTHER INFORMATION

- *Refer to the Industry Best Practice Guidelines – Wastewater Treatment*

4.5.1 Primary Treatment

Generally, all wastewater streams receive primary treatment to reduce coarse and suspended solids and fat concentrations prior to further treatment. Equipment commonly found in this area will include:

- Collection pits and pumping
- Static screens
- Rotary screens and/or screw presses
- DAF or CAF units

This area of the wastewater treatment process is potentially the most odorous under *normal* plant operating conditions, particularly when rendering stick water is processed. The handling of solids removed in this part of the plant can also have a major effect on local odour generation.

The need to treat the odours from this source will depend on plant location and is more likely to be an issue for plants in highly sensitised locations. The principal of treatment is to locate the plant within the site to minimise odour at the boundary.

Best practice: Where odours are likely to impact on the community and considering the specific technologies likely to be used in this part of the plant, odour control options should focus on:

- Minimise generation of hot vapours and odours. In most cases, effluent cooling is not practicable due to the high volume of hot water
- Remove all solids and fats recovered from the area, frequently.

Where processing plants are located in highly sensitised locations, additional best practice includes:

- Adopt enclosed technologies (screw press, etc);
- Enclose static or rotary screens
- Pits – minimise openings to atmosphere.

4.5.2 Secondary Treatment

The dominant wastewater treatment process for the industry is anaerobic followed by aerated ponds and settlement/storage ponds. The wastewater at that stage is disposed on site (irrigation) or further treated for off site disposal. Wastewater, after aerobic treatment, may also be recycled onto the site for yard wash down and similar applications.

Anaerobic Ponds

Emissions to atmosphere from the anaerobic ponds are potential high intensity odours. The prevailing and successful method of odour control is the establishment of a strong and stable crust on the pond with the only penetration being a relatively small area around the wastewater inlet.

Best practice - natural crust:

- Regular monitoring of the pond condition and rapid attention to any areas of crust breakdown
- Ensure discharge from pond into downstream unit is submerged on entry.

Well-designed anaerobic lagoons with an effective crust will not emit odours detectable beyond the plant boundary. For this reason the selection of a covered anaerobic lagoon process for odour control reasons is rarely required. Energy recovery can be achieved by fitting a synthetic cover to collect the offgas, but may create a point source, high strength odour discharge if not properly treated. The collected gas has a significant energy value. Plants recovering the energy also require standby capability for use when the boiler, water heater or other thermal device is off line.

Best practice - synthetic cover:

- Cover remains sound and intact
- The integrity of the cover seal to the pond border remains intact
- Back up system for off gas oxidation may be required, particularly in sensitised locations
- Ensure discharge from pond into downstream unit is submerged on entry.

Aerobic Treatment Systems

Odour emissions from facultative, or aerated ponds or activated sludge systems, which are well aerated, are not considered to be of concern, providing the pond is not located on any of the plant boundaries. The odour has a typical 'earthy' smell, not usually associated with the meat processing industry.

Best practice:

- Maintain adequate redox (reduction-oxidation potential) in the system (generally more positive than – 75 mV)
- Desludge ponds when accumulated solids rise to within approximately 30 cm of the water surface.

Settlement and storage ponds are not considered to be an air emission problem providing all of the upstream water treatment systems are properly operated and a positive dissolved oxygen level is maintained at the pond surface.

Best practice:

- Best practice operation of the wastewater treatment system will minimise air emissions.

4.5.3 Tertiary Treatment

Tertiary treatment is not common in the industry, but may be used in specific situations where the wastewater is to be returned to waterways and is required to meet more stringent water quality criteria. Odour or other air emissions are not expected from tertiary treatment systems.

4.6 Irrigation

Potential exists for low-level odour to be released from irrigation with inadequately treated wastewater or wastewater containing insufficient dissolved oxygen.

Irrigation as a means of wastewater disposal normally occurs on meat processing plants with adequate pasture or crop area to manage the water and nutrient load to be disposed of, or has agreements with adjoining landholders for the same purpose. Providing secondary wastewater treatment provides a non-odorous final effluent, irrigation will not create an air quality issue.

FURTHER INFORMATION

- *Industry Best Practice Guideline on Effluent Irrigation also addresses odour issues*

4.7 Yards

Sheep pens

Cattle lairage

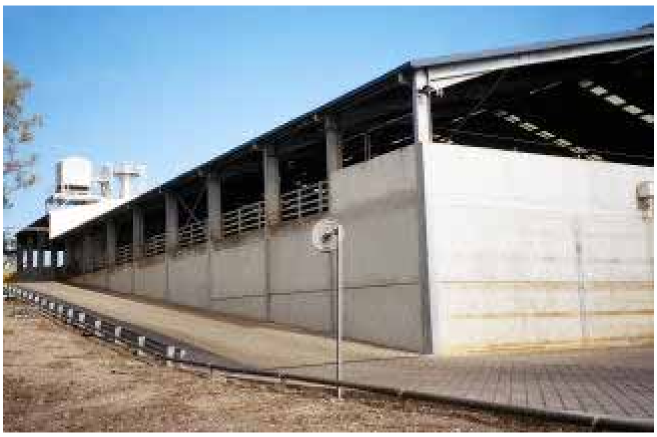
Yards, pens, lairage, ante mortem all refer to the facilities for holding animals prior to processing. These are regarded as area sources of emission.

- Odour sources arise from the production and subsequent handling of manure and urine
- Dust may arise from yards that are open to wind effects and dry enough to permit dust to arise

Design and operation of holding yards can greatly influence the incidence and contribution of low level odour and dust from the processing plant.

Best practice:

- Minimise manure and urine accretion by 'drop through' design (for sheep) or hardstand, regularly cleaned (cattle)
- Minimise wind effects by roofing and sheeting
- Water sprays on cattle races for dust control
- Minimise animal movements to minimise dust generation.



4.8 Waste Solids Disposal

4.8.1 Paunch and Waste Solids

A potential odour source arises from the receipt, storage, handling and disposal of a range of putrescible waste materials during meat processing. Paunch storage and composting is highly odorous when the windrows/piles are turned.

Best practice:

- Paunch and similar waste solids should be either treated on site or removed off site daily
- On-site disposal is to be avoided in sensitised areas.

4.8.2 Carcase Disposal

Carcase disposal procedures vary across meat processing plants, based on scope of plant operations and the market requirements for meatmeal.

Best practice:

- Dispose of carcases promptly
- Where the meal is not intended for human consumption, or where export rules permit, carcases are preferably processed through rendering
- Where the meal is intended for human consumption and/or export, or inedible rendering is not possible, composting (wet or dry) achieves good carcase disposal when performed appropriately. NCV skins are also suitable for composting [Ref 13].

Dead stock composting heap

4.8.3 Inert Solids

Inert solids will principally include boiler ash and fly ash. Off site disposal can be included with other waste solids or the material can be handled separately and in such a way that a dust nuisance is not caused.

4.9 Transport

4.9.1 Livestock Transport

Transport of livestock to the meat processing plant can involve air quality and waste issues well outside the plant boundaries with the deposit of urine and manure on public roads. Most transport is conducted by operations independent of meat processing companies and it is the responsibility of these operations and their drivers to comply with their duty of care to the environment. However, the processing plant should encourage drivers to maintain their vehicles in clean condition on leaving the plant.

Best practice:

- Provision of facilities for the washing of transport vehicles, both inside and out, prior to leaving site
- Facilities supported by plant rules requiring a minimum standard of cleanliness prior to leaving the plant
- Agreed routes for all livestock transport

4.9.2 By-products, Waste and Hide Transport

Transport of these materials off-site may be performed by processor company vehicles or contractors. The processor should require contractors to follow best practice.

- By-products - material such as face pieces, dried blood and bone meal
- Hides - untreated cattle hides from the processing plant
- Waste solids - may include paunch contents, solids from waste water treatment, manure (if collected separately) and boiler ash. The resulting product is generally quite wet.

Best practice:

- Prompt removal of waste solids to avoid the generation of odours through aging

- Avoid drips and leaks from trucks
- Cover loads for odour containment and visual reasons
- Wash trucks externally before leaving the processing site (wheels, bodies).

FURTHER INFORMATION

- *Refer also to the Industry Best Practice Guidelines on Waste Solids*

4.10 General Site Dust

General site dust comes from the movement of equipment and animals (particularly cattle) on the site. The effect beyond the site boundaries is visual and inconvenience (dust settling on houses and washing).

Best practice:

- Preferably sealed roads for all main vehicle movements
- Regular watering of unsealed roads and areas
- Removal of dried material from livestock trucks prior to leaving site
- Regular cleaning of cattle lairage
- Dust suppression sprays in cattle races
- Design of lairage to minimise wind effects
- Minimise dust generation by limiting movement of animals.

4.11 Greenhouse Gas

Greenhouse gas is produced *directly* in the meat processing plant through:

- Thermal combustion processes
- Organic gas emissions from the waste water treatment system
- Ancillary plant associated with transport.

Greenhouse gas is produced *indirectly* through electrical energy consumption as, in most cases, power is supplied from fossil fuel fired generation plant.

Best practice:

- Proper operation of wastewater treatment systems (odour minimisation)
- Overall efficient energy utilisation.

Greenhouse gas produced by animals in the meat processing industry is beyond the scope of this document.

FURTHER INFORMATION

- *The Australian Greenhouse Office supports greenhouse gas reduction projects as part of the greenhouse Friendly TM and other programs – www.greenhouse.gov.au*

5.0 CONTINGENCY

Contingency plans for the failure of production equipment are either formalised or understood. Actions to overcome the air emissions consequences of equipment failure should be incorporated into the overall contingency plan. Contingent situations that can effect air emissions – particularly odour – include:

- Malfunction of the plant odour control system
- Equipment failures – fans, motors etc.
- Rendering failure – need to avoid ageing raw material
- Blood drying failure.

Wastewater treatment system malfunction – particularly due to organic overloading of biological system or loss of crust from anaerobic ponds.

Best practice:

- Formalisation of contingency plans
- Integration into the training program
- Extension of those plans to include odour and air emissions minimisation.

6.0 MONITORING AND REPORTING

Monitoring and reporting of air emissions and air quality incidents is mandated under various government and licence requirements and is an important tool in handling community relations.

Statutory reporting can include:

- Regular emission reports for point sources and at processing plant boundaries
- National Pollutant Inventory (NPI) reports
- Other regulatory and licence requirements.

Internal reporting of air quality performance can either be a formal or informal process.

- Formal reporting tends to monitor air quality performance as a management tool and to raise cultural awareness of air quality performance at all levels throughout the plant
- Informal reporting focuses more on reporting by exception – equipment malfunction or incident reports

Monitoring programs are often a licence requirement on some point sources (particulate emissions from boiler plant). Particularly in sensitised situations, plant monitoring should be supplemented with local weather monitoring (wind speed and direction) as a critical tool in handling community and EPA complaints.

Best practice:

- Maintaining licence and statutory reporting requirements
- Formal reporting of air quality performance as well as malfunctions or incidents
- Air quality as a key performance indicator
- Weather monitoring, particularly in sensitive and sensitised locations.

FURTHER INFORMATION

- *Environmental performance for the industry is reported* [14]

7.0 COMMUNITY RELATIONS

Effective handling of community relations is demonstrated in a number of meat processing plants. Many processing plants operating in sensitised areas have established a mutually beneficial relationship with the local community.

Best practice:

- Complaint handling and abnormal events –
    - Formal complaints register and protocol
    - Fast and co-operative response for complaint handling
    - Meat processing plant as the first point for complaints (not EPA)
- Community relations and interaction -
    - Open, two way communications through consultation
    - Maintain communication and feed back in both normal and abnormal times
- Pro-active role in advising of potential problems during shutdowns, process upsets and other abnormal situations.

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Table 2 – Odour Removal Technologies

Technology	Water Scrubbing	Chemical Scrubbing	Biofiltration	Oxidation/Ozone	Thermal Oxidation
Process	Off gases pass through wet scrubber for removal of condensable and soluble gas components	Chemical treatment of off gases in a multi stage wet scrubber. Normally require acid, alkali and oxidation (chlorine) stages	Saturated air treated through biologically active packing at low velocity	Oxidation of odorous gases in a reaction chamber using ozone or 'activated' oxygen	High temperature destruction of organic gas components
Consumables	Water	Acid (sulphuric), alkali (caustic soda), oxidant (eg. sodium hypochlorite, hydrogen peroxide, chlorine dioxide)	Water for cooling and condensation	Power to produce ozone or 'activated oxygen'	Thermal energy – usually natural gas
Odour Outcome	Selective removal of odour compounds; limited effectiveness	Three stage scrubbing normally produces satisfactory odour removal	Can remove to non-detectable levels. Residual odour will resemble biofilter medium character.	Low odour emissions	Non-detectable
Application	Possible low strength odour applications or where high removal efficiency is not required	Normally high strength odour streams because of consumable cost	Both high and low strength odour streams	Both high and low strength odour streams	Operating costs limit use to high strength odours Boilers can be used to oxidise small, high strength flows
Operational/ Maintenance	Occasional scrubber clean out for removal of fats, build ups etc.	Occasional scrubber clean out for removal of fats, build ups etc. Chemical handling	Minimal – maintain biofilter bed moisture; occasional packing replacement (>3 years)	Reaction chamber clean out	Potential build up of fats on oxidiser packing (if used)
Waste Products	Odorous waste water stream	Low-odour waste water stream and chemical wastes	Low odour water stream from condenser/cooler; minor leachate flow from biofilter	Some condensate	Nil

Table 3 – Particulate Removal Technologies

Technology	Cyclones	Fabric Filters	Electrostatic Precipitators	Wet Scrubbers
Process	Centrifugal force removes the dust particles from the gas stream	Particulates removed by passing gas through fabric filter elements – bags. Programmed cleaning regenerates filter capacity	Particulates are electrostatically charged and collected on earthed electrodes	Dust particles are wetted to form agglomerates for removal from the gas stream
Consumables	Nil	Nil	Nil	Water
Emission	Multi cyclones (small diameter) can achieve emissions below 250 mg/Nm^3 on coarse particulates from grate type boilers	Capable of achieving emission below 20 mg/Nm^3 (clear stack) on all forms of coal fired boilers and other dust generating processes	Capable of 30 – 100 mg/Nm^3 on coal fired boilers. May be sensitive to coal quality No application in other areas	Capable of 30 – 150 mg/Nm^3 depending on particle size and scrubber energy consumption
Application	Grate and stoker fired type boilers	All forms of coal fired boilers, meal and other solids handling, storage and bagging applications	All types of boilers. Only applicable to large gas flows – large boilers – and out of the usual range for meat processing industry	All types of boilers, blood dryers and processes where collected material can be returned to the process in wet form
Operational/ Maintenance	Low	Regular bag replacement – 1 – 3 years	Minimal	Occasional scrubber clean out for removal of scale, build ups etc.
Waste Products	Collected ash for dry disposal	Collected ash for dry disposal; other collected product may be returned to process or end product	Collected ash for dry disposal	Collected and discharged as a slurry

APPENDIX 1 – TECHNOLOGY DESCRIPTIONS

A. WET SCRUBBERS

Process and Description

Wet scrubbers can be used for removal of both particulate and gaseous (odorous) contaminants from process and ventilation air streams. Scrubbing liquor is used to agglomerate and increase the mass of particulates or react chemically with gas phase contaminants.

Scrubbing liquor may be any combination of:

- Water – particulate removal and soluble gaseous contaminants
- Oxidising –- for VOC oxidation
- Acidic –for alkaline gases such as ammonia, amines
- Alkaline –for acidic gases such as hydrogen sulphide, mercaptans

Application

Wet scrubbers – water based – are commonly used in treating the exhaust gas from blood dryers and remove any particulate carry over very efficiently

Scrubbers using chemical reagents can be used – usually in a multi stage form – for scrubbing odours. Rendering will usually require oxidation, acid and alkali scrubbing.

Scrubbers can be used for both process gas or ventilation airflows. Typically, separate scrubbing systems would be used due to different scrubbing reagent requirements.

Inputs

Inputs are either water – for particulate removal – or chemical reagents for gaseous scrubbing. Common reagents are:

- Oxidising - sodium hypochlorite, hydrogen peroxide, potassium permanganate - as liquid reagents; chlorine, chlorine dioxide, ozone directly injected in gaseous form
- Acidic – most commonly weak sulphuric acid

- Alkali – most commonly sodium hydroxide

Chemical scrubbers require careful monitoring to maintain reagent concentrations, scrubber performance and minimise reagent waste.

Discharge

Scrubber discharge will be a contaminated liquid stream, which can be returned to the process – as in blood dryers – or sent to the water treatment system. The waste stream may be highly contaminated, but is small in volume in comparison to other wastewater streams and is readily diluted and treated.

The air discharged from a scrubber will be fully saturated with water vapour, leading to a visible emission in colder weather.

B. BIOFILTRATION

Process and Description

Biofiltration is now the most commonly used technology for odour removal in the meat processing industry. The process occurs in two stages:

- Absorption of odorous gases onto an organic packing medium
- Biological destruction of the odorous gases by aerobic bacteria (micro organisms) within the packing medium

The simplest, and most common, biofilters are shallow concrete brick structures with an effective air distribution system in the base and a bed of about 1 – 1.5m of biologically active medium – pine bark, compost etc – through which the air stream passes. Such a simple biofilter requires a large ground area – readily available on most sites.

Other designs are highly engineered – and thus more expensive - to provide multiple layers of organic or inorganic packing and thus occupy a smaller footprint.

Effective operation of the biofilter requires:

- Moisture control of the biofilter bed
- Even air distribution across the total bed area
- Cooling to below 40^{o}C

The most effective means of maintaining moisture control is pre-humidification of the foul airstream and surface sprays on the bed itself

Applications

Biofilters are commonly used in the meat processing industry for all odour control applications from rendering, blood drying, materials handling and all building ventilation.

Inputs

Once bed activity is established, the only input requirements are:

- Water for air stream humidification
- Water to maintain filter bed moisture levels

From time to time (usually 3 or more years) the filter bed may require replacement and topping up in the intervening period.

Discharge

The only discharge from the filter bed is a small quantity of leachate comprising condensation in the incoming ducting and any excess water in the filter bed. The water quantity is very low - measured in litres/hour – but may be very odorous.

C. ADSORPTION

Process and Description

Organic gases (VOC) can be adsorbed into the pores of a material – most commonly activated carbon. The process is most effective at low temperatures – up to 40^{o}C – and humidity below 80%. Such systems are less effective with reduced sulphur compounds and ineffective with sulphur oxides.

Eventually, the activated carbon pores will become saturated. This is remedied in smaller adsorbers by replacing the carbon. In larger units, some form of stripping and VOC recovery may be employed (regeneration). Steam stripping is the most common process.

Applications

Carbon adsorption is very effective on VOC gas streams and is commonly used as back up for other mainstream odour removal equipment. There are obvious limitations in process applications (airstream temperature) and contaminant gas composition.

Inputs

Carbon bed replacement is the major input for smaller units with replaceable beds.

Steam for bed regeneration is the major input for larger, regenerable units.

Discharge

The discharge from replaceable bed units is the contaminated bed itself.

Regenerable units will discharge a mix of water, soluble and non-soluble VOC condensates for further treatment or disposal.

D. OZONE AND OXIDATION

Process and Description

Gas phase oxidation using direct UV radiation or systems producing ozone or oxygen radicals which subsequently oxidise air contaminants forms the basis of this technology.

The direct radiation system may consist of an array of equipment including:

- Fine dust filters
- Ammonia scrubbing – water based
- Grease and fat removal
- UV radiation and VOC oxidation
- Further oxidation from ozone generated in the process
- Adsorption of remaining gas in an activated carbon bed

While appearing complex, the system can be made very compact and be housed within, or adjacent to, the rendering building.

The oxygen radical system requires a clean air supply through the generators. This active air supply is mixed in with the contaminated air stream for odour destruction and a very significant dilution effect.

Applications

Both systems have been supplied in Australia.

Capital and operating costs limit applications to major, highly odorous process streams rather than treating high volume, ventilation air streams.

Inputs

The major input is power for the generation of UV/ozone/oxygen radicals.

Discharge

Oxidation in the gas stream produces no significant discharge as all products exit through the exhaust system.

E. THERMAL OXIDATION

Process and Description

VOCs and most other gases are destroyed by raising the gas temperature to between 700 and 1000°C through some form of incineration. The energy cost is such that:

- Heat recovery is an essential part of the process – either to preheat the incoming gas stream or to produce a useable energy source (steam, hot water) on the plant
- Use is restricted to low flow, high concentration gas/odour sources

Incineration is the most effective technology, ensuring over 99% odour destruction.

The incinerator/combustor design must take account of possible contamination from fats and any solids on heat exchange surfaces.

Flaring is a technology well suited to the combustion of methane and off gas from covered anaerobic ponds, either as the main or back up system.

Boiler/heating plant existing on all meat processing plants can be a very effective incinerator for high intensity odours.

Application

Limited to high strength odours in situations where extremely high destruction efficiency is required; to situations where existing thermal plant can be used as the incinerator or where captured off gas from covered anaerobic ponds is available.

Flaring is suited to highly flammable gas streams without a strong odour or non-combustible component, due to the short residence time for gas destruction in the flare.

Inputs

The major input is thermal energy, usually in the form of natural gas or fuel oil.

Discharge

There is no discharge other than the dissociated gas leaving the incinerator as part of the exiting gas flow.

F. CYCLONES

Process and Description

Cyclones generate centrifugal force as a means of separating particulates from the gas stream. They are used in two forms – separate (large diameter) cyclones in groups of 1 to 4 units or multiple cyclone units installed in parallel in a steel casing (multi-cyclones). The smaller diameter multi-cyclones are more efficient than the large diameter cyclones.

The ash removed from the gas stream is discharged from the bottom of the cyclones for removal.

Application

Cyclones will be used in the following applications:

- Disengagement of pneumatically conveyed material at the point of destination
- Fly ash removal from grate type boilers – where the particulate emission limit is below 200 mg/Nm^3

Inputs

There are no external inputs, other than the system pressure loss.

Discharge

Material removed from the process gas stream.

G. FABRIC FILTERS

Process and Description

The process gas or airflow passes through a set of fabric filter bags. The filter media removes all but the finest of particles, allowing a cleaned gas flow to exit to the stack. The collected dust is removed from the filter bags on a regular basis – normally with an air pulse – and collected in a hopper beneath the filter bags.

Filter media can be selected to handle gas and air streams at temperatures from ambient to 250^{o}C.

Application

Filters will be used in the following areas:

- Particulate control from dry materials handling and storage, such as meal and dried blood
- Fly ash removal from pulverised fuel fired boilers or in situations where an invisible stack – less than 25 mg/Nm^3 – is required

Inputs

Compressed air is required as part of the filter bag cleaning system on most modern filters.

Discharge

Material removed from the process gas stream.