Upstream wastewater treatment

Upstream treatment is the first set of wastewater treatment processes. Its task is to prepare the wastewater for discharge to sewer or further treatment using biological treatment processes. Meat processing wastewater can be difficult to treat properly compared to other industrial wastewaters due to its:

- High levels of total suspended solids;
- High oil and grease concentrations ; and
- High temperatures.

The upstream, or primary, treatment processes used in the meat processing industry typically seek to reduce suspended solids, oil and grease and flow variations.

Reducing suspended solids

Key technologies used in Australian meat plants for reducing suspended solids levels are shown below.

Static screens are usually a vertical bow shaped wedge-wire screen. Most of the liquid drains through the screen while the solids collect at the base before discharge.
Image: Meramist, Caboolture

Baleen screens are a fine, flat static screen that slopes slightly and uses a mechanical water spray to move the solids.
Image: JBS, Dinmore

Rotary screens use a rotating horizontal cylindrical screen. The solids move to the opposite end of the rotating cylinder, where it discharges.
Image: ACC, Cannon Hill

Screw presses comprise of a rotating screw in a compression barrel, fitted at the inlet end, with a slotted screen for initial dewatering. Compressed solids form a 'plug' at the discharge end, against which the incoming solids are compressed by the action of the screw and dewatered.
Image: Hydroflux Huber

Degritting hydrocyclones pump wastewater into a conical hydrocyclone where denser particles are 'flung' to the inner wall and slide down to the bottom discharge. The water and finer or lighter solids remain centred in the unit and are discharged near the top. Image: Teys, Wagga Wagga (courtesy Johns Environmental)

Table 1: Features of the most common upstream technologies used in meat processing plants for reducing solids concentrations

Issue	Static screen	Rotary screen	Screw press	Degritting hydrocyclone
Capital cost	Low ($15 - $20K)	Low ($15 - $20K)	Moderate ($50 - $80K)	Moderate ($50 - $80K)
Life expectancy	Long life	Long life	Component replacement(s) after 10 years. Screens after 2-3 years.	Moderate life
Operating cost	Low	Low	Moderate	Low
Best for removing	Gross and paunch solids	All solids	Paunch and manure solids	Stockyard grit
Nature of solid discharge	Wet	Wet	Dry (up to 30% TS)	Wet
Effect of fat on operation of equipment	Blinds screen	Blinds screen	Little effect where sufficient paunch solid is present	Severe blockages

Reducing oil and grease

Key technologies used in Australian meat plants for reducing oil and grease are shown below.

Savealls are large settling tanks. Fats separate and float to the top and heavier solids sink. Surface scrapers tease the floating fat off the liquid surface. Sometimes base scrapers remove solids in a similar manner.
Image: JBS, Dinmore

Deoiling hydrocyclones expel less dense oil and grease through the top of the unit while water flows out the base. This hydrocyclone requires very effective screening of the wastewater to minimise blockages and are generally most effective on non-render red streams.
Image: Courtesy Johns Environmental

Dissolved Air Flotation units (DAF) inject a high-pressure stream of liquid, into the raw wastewater stream which forms a mass of very fine air bubbles that attach to particles and fat globules and lift them to the surface. The floating material is scraped off for disposal or reprocessing and the clean water underneath is discharged.
Images: NB Foods, Oakey

DAFs can be undosed or dosed. **Dosed DAFs** are more commonly applied in meat plants. The process is exactly the same except that chemical coagulants and polymer are mixed into the wastewater feed, increasing the removal of oil and grease, suspended solids and Chemical Oxygen Demand (COD).
Images: NB Foods, Oakey

Table 2: Common upstream technologies used in meat processing plants for reducing oil and grease concentrations

Issue	Saveall	Undosed DAF	Dosed DAF	Deoiling hydrocyclone
Capital cost	Low	High	High	Moderate
Operating cost	Low	Low	High	Low
Applicable to	Non-render plants	Fat reduction when biological treatment follows	Sewer discharge where space is tight	Fat recovery from red streams
Nature of solid discharge	Sloppy and wet	Sloppy and wet	Firmer and wet	Sloppy

Reducing flow variation

A major challenge for most meat plants is the wide variation in wastewater flow during a 24-hour day. Typically, the largest flows occur during the processing shifts when ancillary processes, such as rendering, stockyard sprays, gut room activities and boning, are operating. During cleaning, flows tend to reduce to about 60 – 80% of process flows, before falling away to almost nothing once cleaning is completed.

There is little need for balancing or 'equalising' the wastewater flow in meat plants with downstream anaerobic ponds as they act as a very large balancing pond. In these cases, the saveall or a waste water pump pit is the only form of flow balancing required. Where wastewater is discharged to sewer via a chemically dosed DAF, more care is needed to provide a more consistent flow to the DAF.

For these plants, a large balancing tank is required to accommodate the peak flows and discharge the wastewater to the DAF at a more constant rate. The main challenges for balancing tanks are:

- minimising odours;
- ensuring mixing to minimise solids settling; and
- minimising corrosion especially if the tank is inside a building structure.

Legislative and regulatory requirements

There are significant health and safety concerns with upstream processes, mainly related to the risk of confined spaces such as pits, savealls etc. Raw wastewater which remains stagnant for long periods may generate potentially toxic levels of hydrogen sulphide (H_2S) due to protein decomposition. Extreme caution must be exercised in entering such places (refer to confined space regulations).

Extreme caution must be exercised when entering confined spaces
Image: ACC, Cannon Hill

Operator Responsibilities

Upstream treatment systems usually require the bulk of the operator's time due to:

- the need for regular removal and disposal of solids discharges from the various processes;
- the need to continuously ensure blockages and other issues related to the variability in the various raw wastewater streams entering the treatment system are dealt with; and
- cleaning of plant to minimise vermin and blockages.

Recommended day-to-day operator responsibilities include:

Solid discharge control

- ☐ Handle solids carefully to ensure no spills (as often spilled material is returned to the wastewater treatment system and/or sewer which is undesirable).

Inspections

- ☐ Inspect the upstream treatment process several times a day to ensure everything is operating properly.
- ☐ Watch out for overflows caused by plant incidents, blockages or equipment failures (pumps, etc).
- ☐ Check that monitoring equipment is functioning (flowmeters, etc).
- ☐ Notify maintenance when breakdowns or malfunctions occur.
- ☐ Notify management when excessive quantities of fat, blood or manure are observed entering the wastewater system. This represents a significant loss of product and they may be completely unaware of the problem.

Monitoring

- ☐ Undertake biannual sampling of the wastewater exiting the upstream process for analysis in an external laboratory.
- ☐ For DAF plants using chemical dosing discharged to sewer, conduct water sampling and testing daily (at least). Operators may conduct some testing on-site to help control the process.

Shutdowns

- ☐ Check upstream treatment processes are functioning properly (within 30 minutes or less) of restart.

Recommended plant specific responsibilities include:

Screens

- ☐ Ensure inlet weirs are not partially blocked by gross solids (intestines, gloves, etc.).
- ☐ Ensure regular cleaning of screens to minimise fat accumulation which causes wet discharge solids.
- ☐ Control solid discharge disposal.

Screw press

- ☐ Ensure solids discharge is not too wet (adjust pressure plate).
- ☐ Ensure any pre-screen for bulk solids is kept clear.
- ☐ Control solid discharge disposal.

Hydrocyclone

- ☐ Check regularly for blockages of the inlet and outlet apertures.
- ☐ Control solid discharge disposal.

Saveall

- ☐ Ensure inlet weirs are not partially blocked by gross solids (intestines, gloves, etc) and flow into saveall over the inlet weir is even.
- ☐ Ensure scraper sets are running correctly (not too fast to cause water disturbance; not too slow so float build-up is too thick).
- ☐ Control solid discharge disposal.
- ☐ Check at least weekly for solids build-up in the saveall if bottom scrapers are not fitted.
- ☐ Service and rotate pumps or ensuring servicing has been done.

Undosed DAF

- ☐ Ensure inlet weirs are not partially blocked by gross solids (intestines, gloves, etc.) and flow into DAF over the inlet weir is even.
- ☐ Check that DAF aeration is running correctly, e.g. air volume to the saturator, saturator pressures. The emerging float should look like a fine milky froth. There should be no big air bubbles (larger than 1 mm diameter) erupting on the surface.
- ☐ Ensure scraper sets are running correctly (not too fast to cause water disturbance; not too slow so float build-up is too thick).
- ☐ Control solid discharge disposal.
- ☐ Check for solids formation in cold weather.
- ☐ Check at least weekly for solids build-up in the DAF if bottom scrapers are not fitted.

Dosed DAF

- ☐ As for DAFs above.
- ☐ Monitor coagulant and polymer inventory and dosing.

Recommended supervisor/management responsibilities include:

Supervisors should:

- ☐ Ensure operation is in compliance with the environmental conditions in the facility's licence.
- ☐ Ensure that appropriate investment and maintenance support is provided to the upstream treatment area.
- ☐ Monitor the upstream treatment area for evidence of large amounts of blood or tallow. This may indicate that valuable product is being lost down the drain.
- ☐ Oversee proper disposal of waste solids from the upstream process area.
- ☐ Conduct regular (approximately six monthly) representative sampling of the wastewater exiting the upstream process. This provides a valuable benchmark of waste water strength and is useful when upgrading downstream processes
- ☐ Regularly monitor the discharge to sewer to ensure Council charges are accurate and to assess the benefit of improved treatment.

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