SA Water

Advanced pre-treatment of trade waste

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Grease arrestors are the simplest devices for the removal of grease and oil, and fine suspended solids from trade wastewater. Their simple operating principle uses adequate retention time and differences in gravity to separate and retain contaminants. Under ideal conditions, this produces wastewater quality that is acceptable for small trade waste discharges.

However, their effectiveness decreases in many everyday circumstances despite regular maintenance pump-outs. For example:

- Sustained periods of high inflow rate reduce the retention time and the arrestor's ability to separate contaminants or reduce temperature.
- Short periods of excessive flow can flush some of the retained contaminants from the arrestor to sewer.
- Poor aeration of wastewater promotes anaerobic decay of retained contaminants, leading to foul odours and acidic (low pH) discharge to sewer.
- Arrestors cannot retain significant amounts of suspended solids or grease and oil before some of this carries over to sewer.
- Grease and oil that is emulsified by strong detergents or alkaline/caustic cleaning agents cannot be separated.

Typical trade waste activities where grease arrestors have proven to be an inadequate pre-treatment option include:

- Industrial activities such as food manufacturing
- Discharges with high grease and oil or suspended solids concentrations
- Food courts and other large food service activities
- Activities with periodic caustic discharges or other factors that inhibit simple gravity separation

When do I need an advanced pre-treatment system?

Retail activity

- For a **new site** with multiple trade waste activities (e.g. shopping centre, food court, large food service area) where the combined calculated grease arrestor capacity requirement for all activities exceeds 12,000L (using the indicative sizing methods and rules given in the trade waste Commercial Food Preparation and Service Fact Sheet). When calculating pre-treatment capacity, consider the following:
    - Divide the combined grease arrestor capacity by 1.5 for a better estimation of the DAF size. (See Appendix 1 below for sizing calculation example.)
    - For development projects use 1,500 litres for each unleased retail food tenancy with a trade waste connection.
    - Do not include tenancies where trade waste discharge risers are provided for future contingency, but are currently sealed below finished floor level. But appropriate design consideration should be given for future connection/development.

- For an **existing site** with multiple trade waste activities, if the scale, scope or number of activities has changed from the original, or it becomes evident that changes will occur, to the extent that the new combined calculated capacity exceeds 12,000L, and it is reasonably viable to group sufficient individual discharges to make an advanced pre-treatment system practical.
- For an **existing site** with multiple trade waste activities, if sewer chokes or other negative impacts on the downstream sewer are attributed to a site's discharge and compliance with acceptable discharge quality cannot be achieved by optimising the existing pre-treatment devices and an advanced pre-treatment system is a practical solution.

Industrial activity

Dissolved Air Flotation (DAF) units have had a demonstrated history and are widely used for treating industrial trade wastes high in solids, grease and insoluble biochemical oxygen demand. Most industrial processes (including food manufacturing) cannot maintain adequate trade waste discharge quality through a conventional grease arrestor or settling pit. This can be simply explained by the higher loads, higher flows and higher temperatures that result in poor separation in the arrestor/pit. A few examples are:

- For existing sites where chokes or other negative impacts on the downstream sewer are caused by a site's discharge, and DAF or similar pre-treatment is a practical solution.
- For existing sites where we have determined that discharge quality significantly exceeds one or more acceptance limits, and DAF or similar pre-treatment is a practical solution.
- For proposed new trade waste discharges, if DAF is proven in comparable situations to be a suitable, best practice trade waste treatment option.

There must be a demonstrated in-house ability to successfully operate the advanced pre-treatment system. If this requirement cannot be satisfied, a minimum 12 months maintenance program must be provided when lodging the trade waste application.

The following detailed information relates to the technical considerations when considering only DAF pre-treatment. There are other devices being trialled with our customers at the moment, with the intent to use them in both industrial and retail applications. Once these devices have had appropriate trials to validate performance is within specifications, we intend to incorporate them in this guideline.

Dissolved Air Flotation

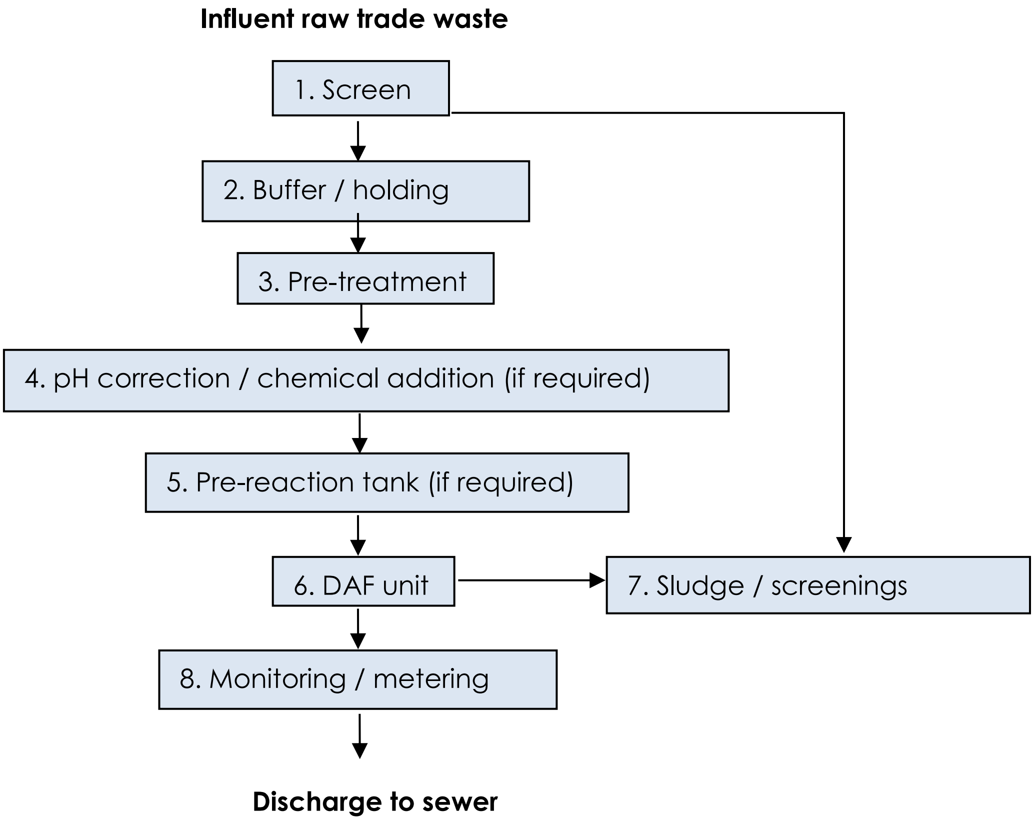
Pre-treatment of trade wastewater by DAF is a commonly used pre-treatment philosophy, where grease arrestors or other simple passive pre-treatment devices are inadequate.

At its heart, micro/fine bubbles of air are generated in the DAF vessel combine with insoluble contaminants in the wastewater, lifting them to the surface. Mechanical scrapers remove the floating sludge layer and the purified wastewater discharges to sewer. This achieves superior results at higher flow and contaminant loadings than can be achieved by conventional gravitational separation.

The DAF unit is only one element of a multi-component wastewater treatment system that controls and pre-conditions wastewater for optimum DAF operation. Selection and sizing of individual components from the range of possible alternatives requires technical expertise from a supplier or consultant to arrive at a DAF treatment package that delivers a reliable, cost-effective solution to each customer's specific wastewater treatment needs.

NOTE: this guideline is not professional technical advice. Our intent is to provide trade waste generators and system installers with some insights into the specific areas of system design and detail aspects we have found to be essential for effective operation.

A typical DAF system



1. Screening

Adequate screening to remove gross solids from trade waste influent, buffering and treatment steps is crucial because it:

- Prevents solids from blocking or damaging wastewater feed pumps, DAF recycle pumps and sludge pumps.
- Limits odours produced by anaerobic degradation of settled sludge that build up in the DAF unit and buffer tank. Reducing the build-up minimises the need for complete vessel clean out.
- Minimises sludge formation over the aeration bars in the DAF unit, which could otherwise upset micro-bubble formation.
- Reduces coagulant/flocculant consumption (if used at a later stage) by first removing as many solids as possible by simpler means.

A variety of screening mechanisms are available. Careful matching of the design and hole/mesh size with typical particle size and other wastewater characteristics is necessary. Rotating drum/sieve and bow shaped wedge-wire screens are commonly used.

In retail food preparation or service areas, silt trap baskets are useful for preventing localised drain blockages, but are not an acceptable mechanism for screening before a DAF. A centralised screening mechanism with maximum **2mm hole/mesh size** for processing all wastewater destined for DAF treatment is necessary. Alternatively, a decentralised or "at source" screening will require a maximum 3mm hole size.

2. Buffer / holding tank

Ensuring the influent is as consistent as possible over a production period or daily DAF operating cycle is crucial for optimum DAF performance. Collecting screened wastewater in a buffer tank for a sufficiently long period before further treatment moderates short-term variations in quality. The key parameters to be moderated are:

- **Temperature.** Elevated temperature or hot 'slugs' of material can emulsify grease and oil resulting in a higher percentage of carryover through the DAF unit, hinder the supply of dissolved air and promote undesirable biological breakdown of material in the DAF unit. Temperature in the DAF vessel should be maintained **below 40 degrees C**.
- **pH.** pH inconsistencies can result in potential damage to treatment equipment, odours, poor coagulant and flocculant chemical performance, and non-compliance with the trade waste discharge limit of **pH 6-10 (site specific limit may vary depending on conditions)**. Buffering of pH by mixing acidic and alkaline discharges might eliminate the need for chemical pH correction, or reduce alkali/acid dosing costs and their undesirable Total Dissolved Solids (TDS) impact.
- **Solids.** The recycle volume and air settings are set manually, to arrive at the desired air to solids ratio in the DAF vessel. Similarly, the dose rate of flocculant or coagulant is set to efficiently treat a certain concentration of contaminants. The DAF unit cannot automatically vary the settings to accommodate wide fluctuations in wastewater quality. Solids carryover to sewer is likely if higher than expected concentrations of solids enter the unit. Buffering moderates variations in wastewater solids concentrations and is a better alternative to adjusting the ongoing DAF settings, for effectively coping with short-term high contaminant concentration events.

  Careful investigation of wastewater quality and flow variations is needed to arrive at an effective buffer tank capacity. The minimum capacity varies significantly between individual applications, particularly industrial sites. However, a typical minimum buffering tank capacity of **3 hours** at design peak influent flow rate is required for centralised retail applications.
- **Other buffering considerations.** Appropriate mixing of tank contents ensures that solids and fats do not separate out, and tank contents remain aerated to minimise odours from biodegradation of waste before treatment.

  Extra contingency capacity in buffer tank storage is advisable for emergencies (e.g. DAF unit maintenance shutdown, sewer unavailability). It also allows for increasing the normal operating levels, if required to achieve the desired buffering of wastewater. However, holding wastewater for excessive periods due to overly generous buffering capacity or delays in processing wastewater can lead to degradation of influent, odours and lower wastewater pH.

  During low flow periods, the buffering volume should be adjusted accordingly. During prolonged shutdown periods or during commissioning with limited connected tenancies, it is advisable to process the buffer tank contents through the DAF unit and have the sludge from the buffer tank and DAF vessel hauled off site.

Pre-reaction and pre-treatment tank volumes can be included as volume toward the minimum buffering requirement.

3. Pre-treatment

Aside from screening, further pre-treatment is not generally required for retail food service applications.

In some industrial situations, it may be advantageous to install various forms of pre-treatment before DAF to minimise DAF operating costs, maintain consistent loadings to the DAF unit, or target removal of contaminants not primarily suited to air flotation. For example:

- An oil water separator can be used to remove free oil (and solids at low levels) for minimal cost before DAF treatment.
- A clarifier/settling tank can minimise solids loading to the DAF unit, by gravitational separation. This is especially useful for capturing grit and other rapidly settling solids that would cause settled sludge deposits in the DAF unit.

4. pH correction / chemical addition

pH correction systems must be installed on all DAF units, unless sufficient evidence verifies that this is not necessary.

In retail applications with adequate buffering, alkali dosing is usually necessary (to increase pH). This is primarily due to the natural tendency for highly biodegradable wastewater to decay before all on-site treatment steps are completed. Poor treatment system design and operation can compound on this tendency. Acid dosing to lower pH will not generally be required.

pH control of DAF treatment systems is essential for:

- ensuring pH complies with discharge limits.
- ensuring pH is within the ideal range for flocculant/coagulant effectiveness.
- minimising grease/oil emulsions.

Where the removal of targeted contaminants with DAF alone is poor, a flocculant and/or coagulant may be required. They assist in the separation of solids/fats from the water, and can greatly increase the removal efficiency of the DAF unit, or allow it to effectively cope with heavier contaminant loads than originally envisaged. A wide variety of chemicals are available, requiring specialist selection to arrive at the best balance between cost and effectiveness at each site.

Provision should be made at the outset on all DAF installations, for possible future inclusion of chemical addition (e.g. bunding, space for a pre-reaction chamber, flow meter and programmable logic controller PLC compatibility).

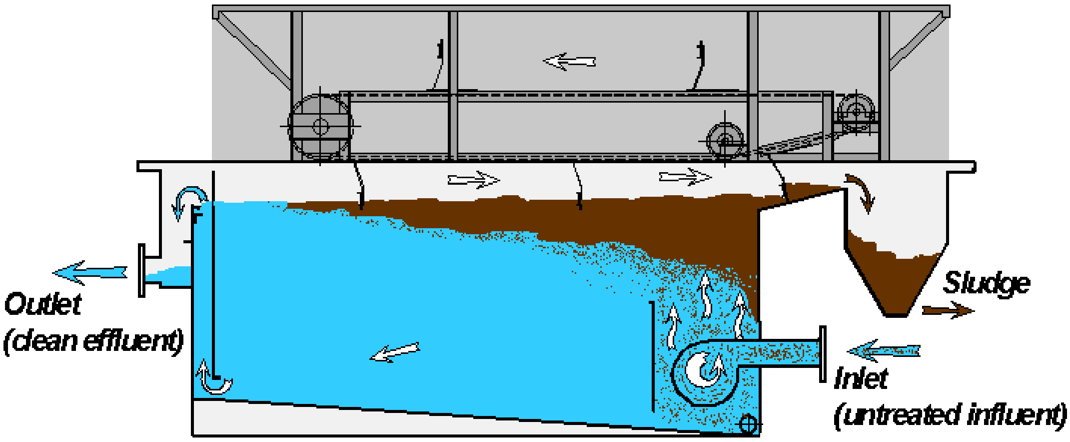
5. Pre-reaction tank

Pre-reaction tanks (well-mixed vessel on the influent side of the DAF unit) are not generally required for retail operations, but are common in treatment of industrial trade waste. Pre-reaction tanks help mix chemicals for pH correction and flocculant/coagulant addition. A pre-reaction tank provides adequate retention time to ensure optimum contact with chemicals before aeration. This is vital when using clay or bentonite-based additives that require increased reaction times to achieve the most effective separation. The use of pre-reaction tanks can minimise chemical costs and unwanted increases in final TDS concentrations.

Although an adequately sized buffer tank is preferable, a pre-reaction tank provides additional buffering before DAF treatment in circumstances where buffer tank sizing may be restricted.

6. DAF unit

Figure 1: Typical example showing DAF process flows



Influent enters a well-mixed zone where micro-bubbles from air previously dissolved into the water attach to the solid/grease particles, raising them to surface. Chain-driven blades scrape off the floating sludge for de-watering and disposal. The treated wastewater exiting the outlet has a greatly reduced solids/grease loading. Those rapidly settling solids that cannot be floated will settle in the DAF vessel and must be removed periodically before they build up to an unacceptable level.

Although the counter-current rectangular DAF shown in Figure 1 is not the only type available to achieve our discharge quality standards, its design has greater flexibility than others for accommodating changes in source flow, loading, etc.

DAF units with 'hopper' or conical bottom sections on the main DAF vessel are advisable when there is likely to be significant loadings of grit, clays, silt and any other solids likely to sink rather than float in the DAF vessel. This design simplifies removal of settled sludge.

Plumbing into and out of the DAF unit should prevent any syphoning, or any significant changes to DAF operating water level. Otherwise, higher level surges could cause water carryover in the scraped sludge, and floating solids removal would not occur with a drop in level below the scraper blade and sludge 'beach' positions.

It is vital to maintain flow and consistent contaminant levels into the DAF unit, within its practical operating limits.

All feed pumps must be of the non-emulsifying type (e.g. diaphragm or progressive cavity "mono").

Relief of dissolved air into the DAF unit should be through an appropriate self-flushing valve with broad seat clearance. Manual valves (i.e. ball valves) must not be used in an attempt to maintain constant dissolved air feed to the DAF unit, as they are likely to partially block and result in turbulent large air bubbles. This decreases the performance and reliability of the DAF unit.

7. Sludge/screenings disposal

DAF units, screening and pre-treatment mechanisms are likely to produce a significant quantity of sludge for off-site disposal. The quantity can be predicted with reasonable accuracy if the untreated wastewater quality and quantity is known. These calculations will determine final sludge tank sizing.

A de-watering device is a practical necessity for almost all DAF systems, to reduce the quantity of solids to be hauled off site.

Appropriate organic flocculant and coagulant additives are desirable, due to disposal options such as composting or our co-digestion facilities, instead of landfill.

8. Monitoring/metering requirements

Process control

pH correction probes used to ensure compliant discharge and optimum DAF performance must be placed upstream of main DAF unit in a location exposed to representative wastewater flows. Suggested locations include pre-reaction tank or a well-mixed buffer tank. pH control probes should **not** be located in main DAF vessel, unless careful consideration has been given to their ability to accurately maintain compliant discharge **at all times**. Probes should be of suitable quality and design appropriate for the particular wastewater type.

Final effluent monitoring

Effluent flow meters and flow data loggers are required on all DAF installations. Refer to the trade waste Discharge Flow Meters Fact Sheet for details.

Electronic monitoring of final discharge quality

Monitoring of final pH, TDS, etc. may also be required. Electronic probes must be in a location exposed to representative final treated trade waste discharge. Recommended locations are:

- a flooded section of pipe work immediately downstream of the DAF unit,
- the effluent weir overflow (if flows are uninterrupted), or
- in the main DAF cell against the effluent weir near its overflow.

Data collection and alarms

These may also be required. Refer to the trade waste Electronic Monitoring and Data Collection Fact Sheet for details.

Venting and Odour control

Wastewater containing food or other biodegradable substances is often prone to odours generated by natural microbiological activity. With good management, they can be minimised and controlled. Some of the DAF system elements where odours can occur are:

- ***The DAF cell*** – The main body of the DAF cell on conventional DAF units is not enclosed or covered. The aeration process can drive odours into the surrounding area. For installations within buildings or other enclosures, an extraction fan located directly above the main DAF cell and/or adequate venting should be installed (i.e. 'whirly bird' or some form of forced extraction device).
- ***Sludge handling*** – The sludge tank often has significant volumes of concentrated organic effluent which is the source for the majority of odour issues surrounding DAF treatment systems. This tank should be
- adequately enclosed (i.e. cannot vent to atmosphere), or
- where sludge is routinely pumped and odour is minimal, connected to an adequate (air forced) venting system.

- ***Screenings*** – A full volume screen often removes a large quantity of organic solids into a bin/container. This should be regularly emptied and cleaned to prevent significant odour generation.

Other odour/venting considerations should include:

- Use materials appropriate for the design application, which can withstand lower pH and higher Hydrogen Sulphide (H_2S) levels. Copper or low grade stainless pipe/tank lining materials can rapidly corrode.
- Buffer tank levels and consequent holding time of effluent should be constantly optimised to minimise odour levels. High temperatures (such as during summer) and significant changes in volume (such as progressive addition or deletion of trade waste activities) should promote these alterations.
- Adequate pH correction system will minimise H_2S and odour generation.

Regular house-keeping in general treatment area can greatly reduce odours.

Maintenance

Maintenance of all elements in the DAF system should be conducted in accordance with the manufacturer's recommendations, or more frequently where actual experience shows it to be necessary. The following requirements are a mandatory:

- The DAF unit is periodically drained and cleaned to prevent sludge build-up and poor micro bubble formation.
- pH probes are calibrated monthly and cleaned weekly as a minimum.
- Screens are periodically cleaned to prevent carry-over of large solids or sharps into the DAF unit.

An inventory of critical spare parts, prior arrangements for rapidly obtaining specialised assistance in the event of an equipment failure and other contingency measures to minimise down-time are necessary.

Appendix 1

Example DAF sizing method

A new development includes a food court with 10 food tenancies. The calculated grease arrestor minimum capacity, based on fixtures hourly volumes was found to be 12,400L so a DAF system is required as pre-treatment.

To better estimate the actual hourly volume for a DAF system, a factor of 1.5 has to apply as per following:

- The calculated grease arrestor minimum capacity (12,400L) is divided by 1.5 (12,400L /1.5 = 8267L)

Therefore an 8KL hourly volume has to be considered when designing the DAF system.