

## Dissolved Air Flotation (DAF)

### Trade Waste Fact Sheet

Effective from 1<sup>st</sup> January 2012

#### INTRODUCTION

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

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

- Sustained periods of high inflow rate that compromise the arrestor's critical retention time for contaminant separation or temperature reduction
- Short periods of excessive flow, which flushes some of the accumulated material from the arrestor to sewer
- Poor aeration of wastewater promotes anaerobic decay of accumulated contaminants, leading to foul odours and acidic (low pH) discharge to sewer
- Cannot retain significant amount of SS or FOG before some of this carries over to sewer
- FOG that is emulsified by strong detergents or alkaline/caustic cleaning agents cannot be separated.

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 FOG or SS concentrations
- Food courts and other large food service activities
- Activities with periodic caustic discharges or other factors that inhibit simple gravity separation

Pre-treatment of trade wastewater by a system based on the Dissolved Air Flotation (DAF) principle is a commonly used best practice option, where grease arrestors or other simple passive pre-treatment devices are inadequate. At its heart, micro fine bubbles of air 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 gravity separation technologies.

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The DAF unit is but one part 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.

**This Fact Sheet is not professional technical advice.** Our intent is to provide trade waste generators with some insights into the specific areas of system design and set out a number of aspects that we have found to be mandatory for effective operation.

## WHEN DO I NEED A DAF 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 capacity (using the indicative sizing methods and rules given in the Trade Waste Grease Arrestor Guideline) exceeds the volume that can be treated by grease arrestor/s with a combined capacity of 12,000L.
  - For development projects where tenancies use 2400 litres for each unleased retail food tenancy with a trade waste connection, when calculating pre-treatment capacity.
  - Do not include tenancies where trade waste discharge risers are provided for future contingency, but are currently sealed below finished floor level. However, appropriate design consideration should be given for future hook-up/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 DAF or similar pre-treatment 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 DAF or similar pre-treatment is a practical solution.

### Industrial activity

DAF units are widely used for treating industrial trade wastes high in solids, grease and insoluble BOD. 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.

- For existing sites where chokes or other negative impacts on the downstream sewer are attributed to 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 a proven in comparable situations as a suitable, best practice trade waste treatment option.

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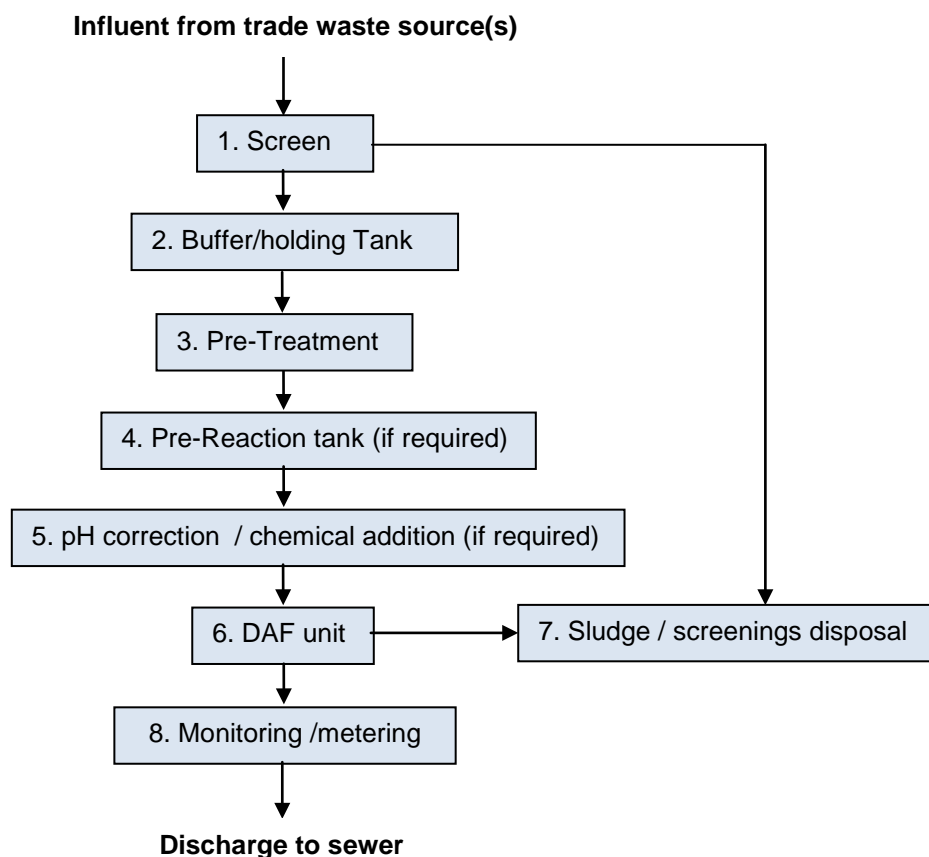
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## A TYPICAL DAF SYSTEM



### 1. Screening

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

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

A variety of screening mechanisms is 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 wedge-wire screens are commonly used.

In retail food preparation / service areas, silt trap baskets are useful for preventing localised drain blockages, but are not an acceptable mechanism for screening prior to a DAF. A centralised screening mechanism with maximum 1mm hole/mesh size for processing all wastewater destined for DAF treatment is necessary.

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## 2. Buffering / 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 buffering/holding 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 fat/oil/grease resulting in a higher percentage of carry-over 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<sup>0</sup> C.

### *pH*

pH inconsistencies can result in potential damage to treatment infrastructure, odours and non-compliance with the trade waste discharge limit of pH 6-10 at all times. 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 (floc) or coagulant (coag) 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, to effectively deal with occasional peak concentrations of contaminants.

Careful investigation of wastewater quality and flow variations is needed to arrive at an effective buffering/holding tank capacity. The minimum capacity varies significantly between individual applications, particularly industrial sites. **However, a typical minimum buffering tank capacity of 4 hours at design peak influent flow rate is required for centralised retail applications.**

### *Other Buffering Considerations*

Appropriate mixing is necessary to ensure tank contents are well mixed, solids and fats do not separate out and tank contents remain aerated to minimise biodegradation of waste prior to treatment.

Additional contingency capacity in buffer tank storage is advisable for emergencies (e.g. DAF unit maintenance shutdown, sewer unavailability). Additional capacity 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, it is advisable to process the buffer tank contents through the DAF unit and have the sludge from the buffer tank and DAF cell hauled off site.

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

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### 3. Pre-treatment

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

In certain situations, it may be advantageous to install various forms of pre-treatment prior to 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:

- A Coalescing Plate Separator can be used to remove free oil (and solids at low levels) for minimal cost prior to 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 effluent to decay prior to 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 (generally pH 6-10)
- Ensuring pH resides within the ideal range for floc / coag effectiveness
- Controlling pH to minimise grease / oil emulsions

Where the removal of targeted contaminants with dissolved air floatation 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.

Chemical addition is generally not required in retail applications provided influent is consistent, low in temperature and emulsified grease/oil.

**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 & PLC compatibility).** Should this prove necessary, Augmentations can be made relatively cheaply and easily.

### 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 assist in mixing chemicals for pH correction, floc/coag addition. A pre-reaction tank provides adequate retention time to ensure optimum contact with chemicals prior to aeration. This is vital when using clay or bentonite-based floc/coag 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 prior to DAF treatment in circumstances where buffer tank sizing may be restricted.

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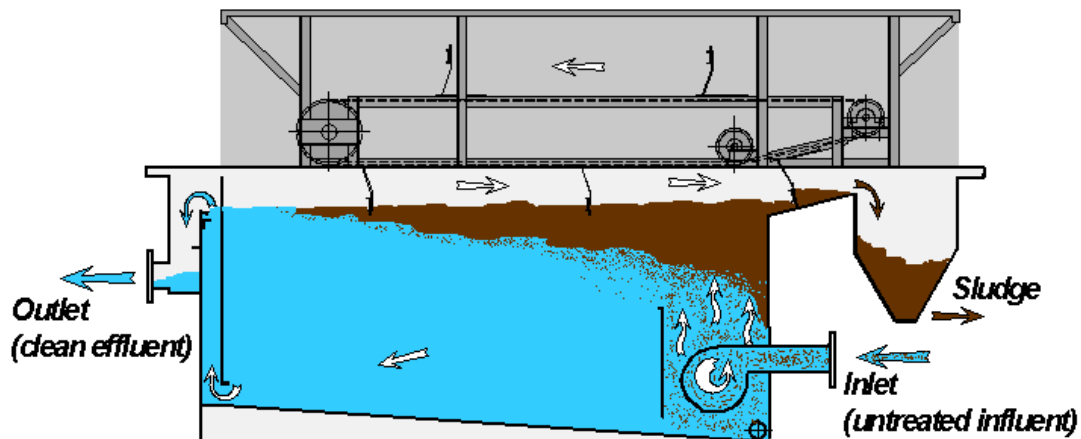
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## 6. DAF unit

Figure 1: TYPICAL EXAMPLE SHOWING PROCESS FLOWS



*Influent enters a well-mixed zone where micro-bubbles from air previously dissolved into the water attach to the solid/grease particulates, causing them to rise to surface. Chain-driven blades scrape the floating sludge off for dewatering 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 are not the only type available to achieve SA Water's discharge quality standards, their 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 clays, silt, sediment and any other contaminant with likelihood of sinking shortly after aeration. 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.

Maintaining flow and consistent contaminant levels into DAF unit, within its practical operating limits, is vital.

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 (ie- ball valves) must not be used in an attempt to maintain constant dissolved air feed to 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 to reduce the quantity of solids to be hauled off site for almost all DAF systems.

Appropriate organic floc / coag additives are desirable, due to increased scope of disposal options, such as composting instead of landfill.

## 8. Monitoring/metering requirements

### *Process control*

pH correction probes used to ensure compliant discharge and optimum DAF performance must be placed in a representative location upstream of main DAF unit. Suggested locations include; pre-reaction tank or well-agitated 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 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 should be positioned in areas containing representative final treated trade waste discharge. Recommended positions 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.

## 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 recommendations can be used as a guide:

- The DAF unit should be periodically drained and cleaned to prevent sludge build-up and poor micro bubbles formation.
- pH probes should be calibrated monthly and cleaned weekly as a minimum.
- Screens should be periodically kept clean to prevent carry-over of gross 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.

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