



**Installation, Operation and Maintenance Manual
for
Dissolved Air Floatation (DAF) Range**

Covering:

**UF5, UF10, UF20, UF30, UF40, UF50,
UF60, UF70, UF80, UF90 & UF100**

**Operation and Maintenance Manual for
RAD Range**

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1. Terminology

Flotation – A process in which micro bubbles of air (30-50µm) dispersed in water adhere to dirt particles, creating the lifting effect required to carry the particles to the surface.

Flotation apparatus – A facility for waste water pre-treatment on the basis of flotation.

Dispersion – A mixture of substances, one of which is finely dispersed in the other one.

Emulsion – Two immiscible liquids one of which is finely dispersed in the other one.

2. Unit description

Main parts of flotation unit:

The DAF flotation tank (1), is designed to allow for optimisation of the following characteristics:

- Hydraulic retention time
- Surface/solids loading rates
- Volume loading

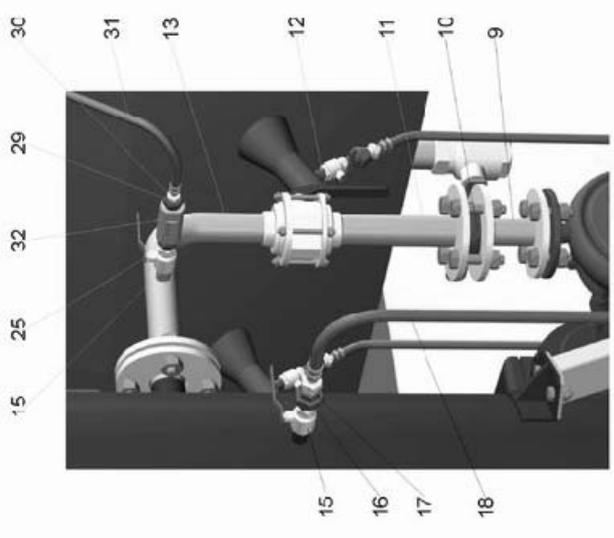
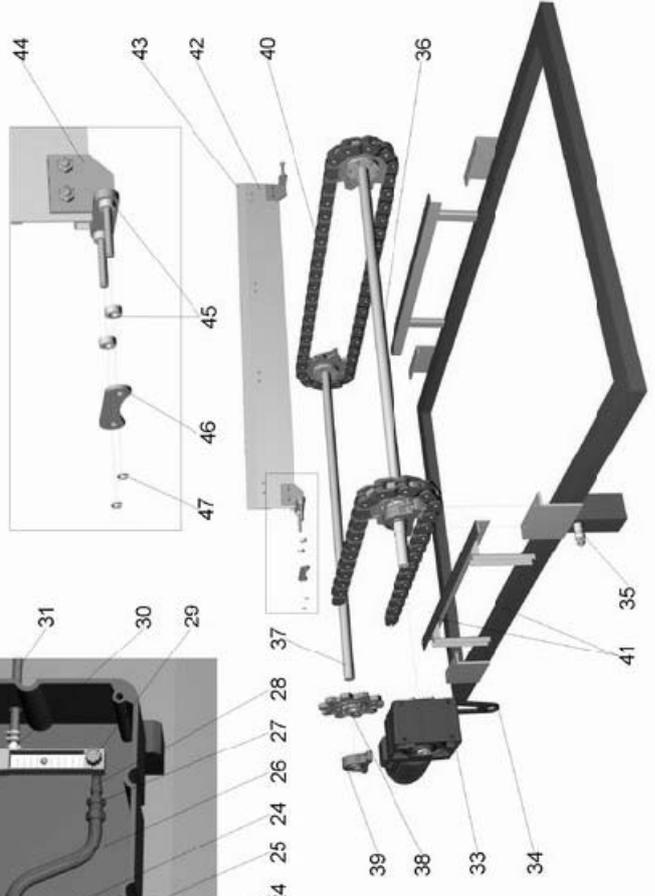
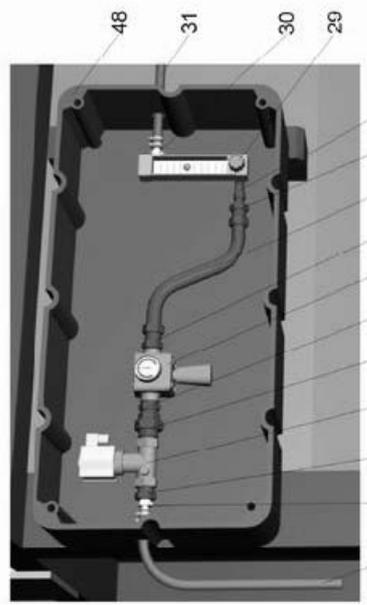
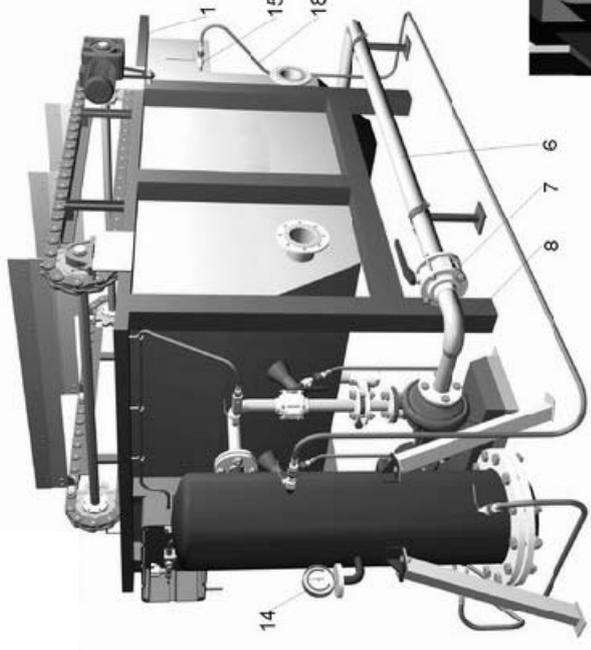
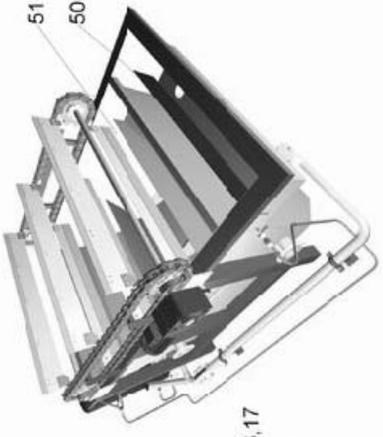
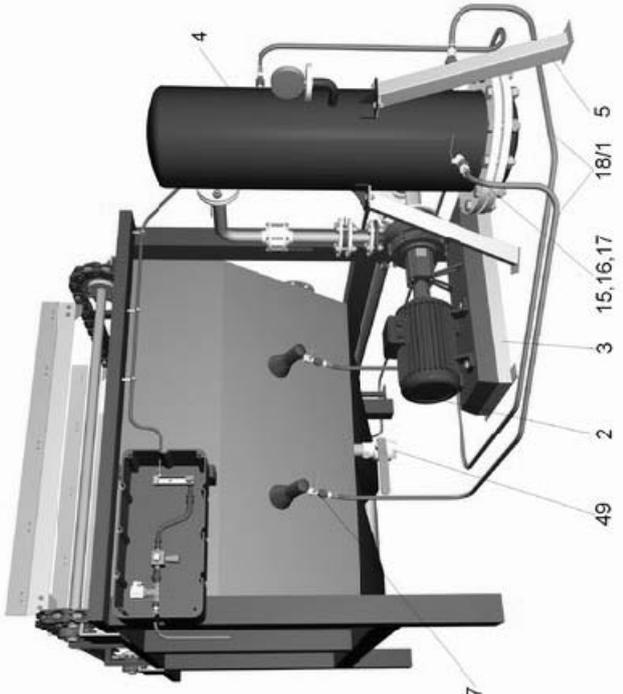
The DAF unit is divided into inlet section, flotation zone and sedimentation zone, including a trough for floated and scraped scum withdrawal and outlet part – for more details see Section 3, Fig. 1.

The following description relates to the image overleaf. The Scraper Mechanism wipes the floated scum from the flotation tank surface (1) into the offtake trough. The plastic skimmers (43) are screwed to the steel brackets (42, 44) and are fastened to plastic chains (40). The skimmer position against the chain is given by plastic rings (45) which are fixed by shaped washers (46) and stirrup rings (45). The chains are stretched between plastic chain-wheels (38) embedded into bearing bodies (39) through primary (36) and driven (37) shaft. To facilitate the chain movements they are led through removable plastic guides (41). The unit is driven by an electrical gearbox (33), with torque transmitted via lever (34) and rubber block (35).

The Recirculation Circuit recycles a proportion of the flotation tank contents thus returning effluent saturated with air back to the inlet section. The circuit consists of recirculation pump(s) (2), suction pipe (6) and discharge pipe. A check valve (10) and ball valve (12) are incorporated within the discharge pipe to provide unidirectional flow and isolation. The discharge pipe work also contains a pressure vessel (4) fitted with a pressure gauge (14) and a compressed air connection to a ball valve (15) allowing blow off, or purge of excess air via rubber hose (18/2). Distribution hoses (18/1) distribute recirculated and aerated water back to the front end of the flotation tank zone.

The Air Circuit supplies air at the required flow and pressure to the discharge side of the recirculation pump. It consists of an inlet rubber hose (19) connected to the pressurised air source (a compressor), solenoid valve (22), pressure regulator (25), rotameter (29) and an air check valve (32).

(Optional) built-in Laminated Blocks seated inside the flotation tank optimise the sedimentation process and separate the flotation and sedimentation zones.



Optional Accessories: (out of the scope of the flotation unit delivery unless specified on quotation)

- Compressor – The UNIVERSAL 500-50D type, output 360 l/min, max. discharge 10bar is recommended.
- Knife gate valve - (electrical or pneumatic actuation) to be located on the sediment removal pipe work.
- Coil pipe flocculator provides retention time for chemical reactions.
- Static Mixer – is inserted into the coil pipe flocculator. The mixer serves for mixing the incoming waste water with chemical agents.
- Chemical units – Dissolving and storage tanks for preparation of chemical agents.
- pH instrumentation and flow monitoring.
- Intermediate pump stations and balancing tanks.
- Pre-screening equipment.

3. Operation principle

See Fig. 1

Physical flotation:

Physical flotation can only be used for the effluent provided that it exhibits the following characteristics:

- Floated material occurs by means of air dispersion.
- Effluent is pre-treated to remove gross solids.
- Effluent will settle out and form a sediment.

The flotation process is not intensified by any chemical agent in this case. The flotation unit is in service condition, i.e. the flotation tank is filled with clean water, recirculation pump runs and the pump discharge is aerated. The saturation vessel pressure ranges between 4 and 6 bar. The air dispersion is visible on the surface of the DAF. The pre-treated waste water from the rotary drum screen passes forward to the DAF unit.

The recirculated aerated waste water stream is taken from the pressure vessel by hoses to the inlet sockets. The sockets lead into the inlet section (A) of the flotation area. The air saturated in the waste water is released in the inlet zone as a result of the pressure change in a form of micro-bubbles (size distribution approximately 30-50 μ m). A very fine air dispersion forms gradually over the whole inlet section and the process of physical flotation occurs, i.e. a mist of fine air bubbles (1) adhere to particulates (2) and the buoyant forces carry the particles up to the flotation tank surface.

A high volume of bubbles make the process extremely intensive and consequently a layer of floated sludge is created on the surface.

Effluent that is free of particulates flows through laminated blocks (if fitted) to facilitate the settlement process (3). Sediment settles out at the bottom of the flotation tank (D).

Pre-treated water (by flotation and sedimentation) overflows into the outlet trough (B) and flows out of the flotation unit through the discharge pipe.

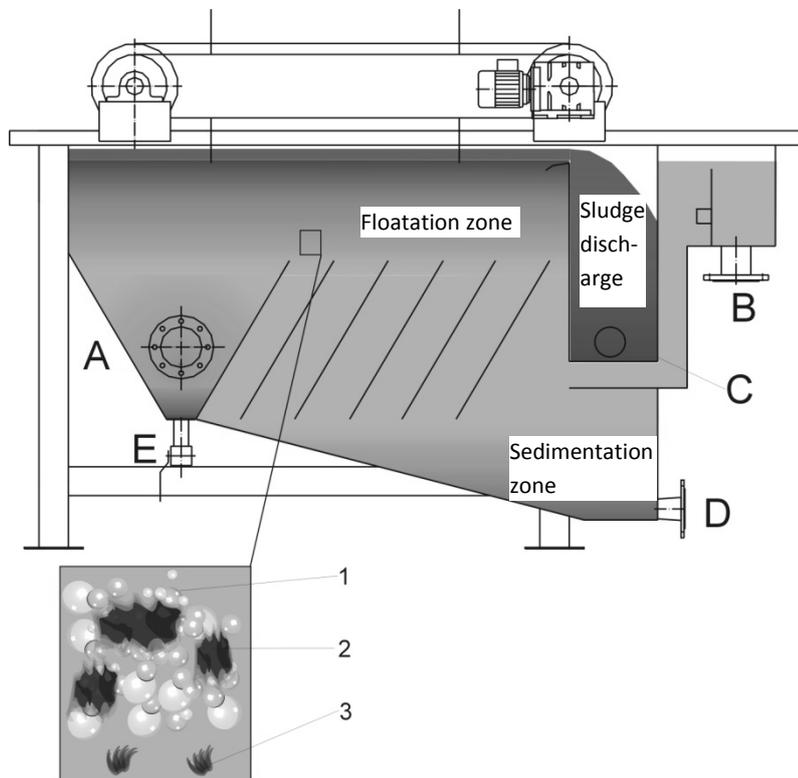
Floated scum is drawn from the surface of the flotation tank by a scraper towards the discharge trough (C) and the sludge handling facilities.

Sediment is emptied periodically (via pneumatic knife gate valve if fitted) via the discharge point by (D). The particles settled out in the inlet section (A) are withdrawn manually through the ball valve (E) as required.

Attention:

The DAF can be operated without any chemical addition only if the waste water is able to be treated by physical separation alone. That is, the pre-treatment within the DAF can guarantee a residual value of suspended solids below the point at which damage to the recirculation pump occurs.

Fig 1:



Chemical-physical flotation:

In this case the flotation process is intensified by dosing a suitable coagulant and/or flocculant. For this purpose chemical dosing equipment, storage tanks and make down units for chemical solution preparation, are included to improve the performance of the flotation unit. Metering pumps are mounted and draw chemical from the storage tanks and deliver at a controlled and known dose rate to a reaction vessel. In this case, the DAF unit is supplied with a coil pipe flocculator which precedes the flotation unit and is supplied to promote mixing of the incoming waste water with the chemical solutions. These chemicals induce precipitation of the emulsified waste yielding sludge flocs which are then easily separated by flotation.

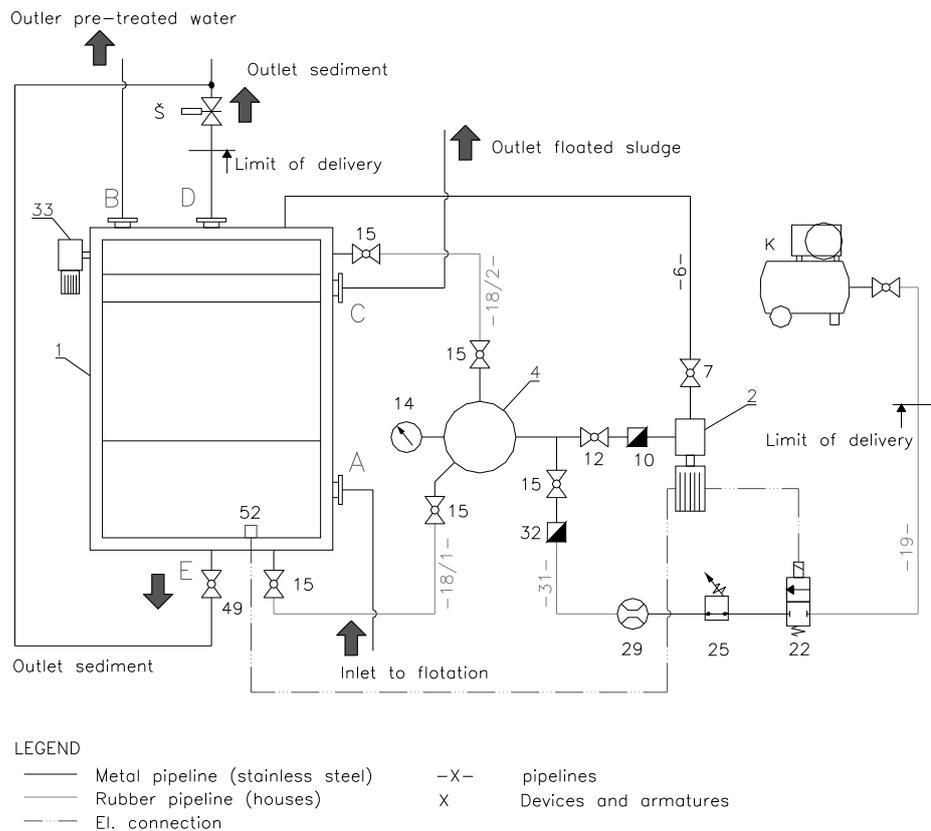
The optimum chemical agents and their dose rates are specified in each particular case on the basis of wastewater characteristics and raw effluent concentration.

Attention:The coagulant ferric chloride FeCl_3 should only be used if the DAF is constructed from 316L stainless steel.

4. DAF Piping & Instrumentation Diagram

The basic components and operation of the DAF unit connection are described earlier in Section 2. For correctly controlled operation the process requires for the wiring of the recirculation pump (2) with the solenoid valve (22) and float switch (52) in order for the pump to be inhibited and the solenoid valve closed in the event of the float switch disconnection – see Fig. 2. This prevents the recirculation pump operating below its suction head requirement thus mitigating against the risks of cavitation damage and as a conservative measure, the air circuit closes at the same time.

Fig 2



As discussed in previous sections, it is also recommended that automatic sediment removal (D) at certain time intervals is made available by making use of a gate valve (Š) with either electric or pneumatic actuation. Optimum time intervals may be determined under specific operating conditions after a period of normal operation has elapsed. The inlet section desludge point (E) can be discharged into the same line as (D) downstream of the gate valve (Š).

5. Application

DAF is a process designed for the pre-treatment of concentrated waste water often originating from food processing industries. Excellent results can be reached in meat processing plants, slaughter houses, poultry processing plants, fish processing plants, dairy works and other operations giving rise to oily or grease laden waste streams.

Flotation effectively reduces extractable contamination (fats and gross solids), however a significant reduction in organic pollution is also possible as measured by falls in BOD5 and COD across the process unit.

A general guide to possible removal efficiencies are given below:

Indicator	Physical flotation	Chemical-physical flotation
FoG	75%	90%
SS	75%	90%
BOD5	40%	65%
COD	40%	65%

The values shown are for general guidance only; they have been established on the basis of experience from previous installations of DAF units or from an evaluation of static laboratory tests.

Before any installation of a DAF system takes place, a complete understanding of technical ownership and responsibilities must be in place between the scheme designer, equipment supplier and civil and M&E engineering contractors in order to establish project roles and interfacing between parties. The structural and civil aspects should include but not be limited to the location where the process equipment is to be installed, levels and falls for sumps, sewer connections, chemical resources and management areas.

The technical specification should cover the installation of individual process units, i.e. pumps, mixers, waste water pre-treatment (rotary screens, screw screens etc), flotation unit, preparation and storage tanks for chemicals, containers for screenings and flotation sludge, presses, conveyors, etc.

Recommendation: Any atypical or difficult installations should always be consulted with the manufacturer.

6. Technical Specification

The DAF unit is manufactured and supplied in the basic model range (Fig. 3):

		UF-5	UF-10	UF-20	UF-30	UF-40	UF-50
Max. flow	m ³ /hr	5	10	20	30	40	50
Total capacity	m ³	2	2.5	4.5	6	11	11.5
Working volume	m ³	1.7	2	3.8	5.3	8	10
Surface area	m ²	1.8	2.7	5.4	4.7	4.7	8.5
Weight (dry)	kg	500	800	1000	1400	1600	1800
Weight (operating)	kg	2500	3300	5500	7400	11,100	13,300
Power	kW	4.37	4.37	5.87	7.87	11.37	11.37
Length (L)	m	2.7	2.7	3.9	3.4	4.4	4.4
Width (B)	m	1.5	2	2.3	2.5	2.5	2.9
Height (H)	m	2	2	2.2	2.6	2.6	2.6
Inlet (A)		DN100	DN100	DN100	DN200	DN200	DN200
Effluent outlet (B)		DN100	DN100	DN200	DN200	DN200	DN200
Floated sludge outlet (C)		DN100	DN100	DN200	DN200	DN200	DN200
Sediment outlet (D)		DN80	DN80	DN150	DN150	DN150	DN150

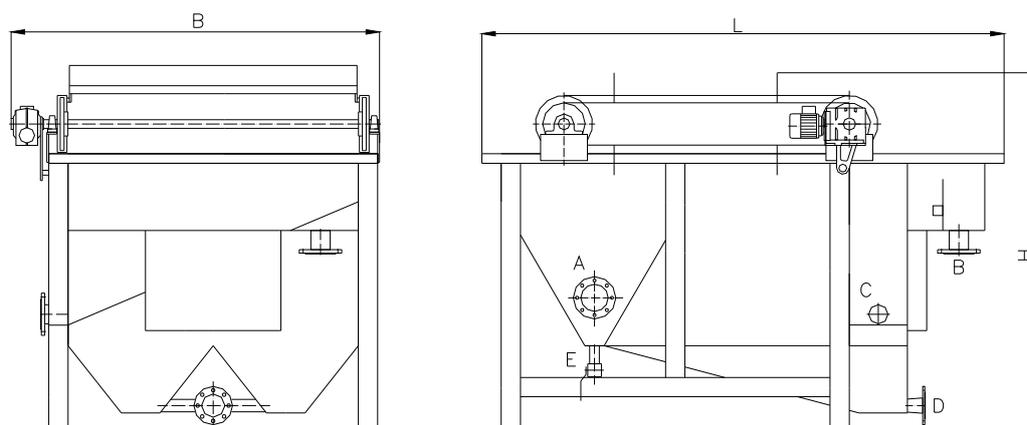
Please note: all diameters are European standard

		UF-60	UF-70	UF-80	UF-90	UF-100
Max. flow	m ³ /hr	60	70	80	90	100
Total capacity	m ³	12	15	17	19	24
Working volume	m ³	10.8	12.5	14.3	16.3	22
Surface area	M ²	9	10.3	11.7	10	13
Weight (dry)	kg	2000	2300	2600	2800	3000
Weight (operating)	kg	14,000	17,300	19,600	21,800	27,000
Power	kW	15.37	15.37	15.37	15.37	15.37
Length (L)	m	4.6	5.2	5.7	6.3	6.2
Width (B)	m	2.9	2.9	2.9	2.9	2.9
Height (H)	m	2.8	2.8	2.8	2.8	3.5
Inlet (A)		DN200	DN200	DN200	DN200	DN200
Effluent outlet (B)		DN200	DN200	DN250	DN250	DN250
Floated sludge outlet (C)		DN200	DN200	DN200	DN200	DN200
Sediment outlet (D)		DN150	DN150	DN150	DN150	DN150

Please note: all diameters are European standard

De-sludge point (E) in all cases through ball valve 2“.

DAF unit maximum flow is for guidance only as each specific case must be assessed individually according to effluent type and concentration.



7. Inspection and Testing

All parts are tested for build quality and accuracy before assembly of the flotation unit. After the unit is assembled, the quality inspection is carried out, followed by hydrostatic testing of all welds and joints.

Operation test:

- Quality and accuracy of scraper mechanism is verified;
- The recirculation circuit is tested with the unit loaded, i.e. tightness of all joints are tested at service pressure and under air dispersion operation.

8. Materials of Construction

The flotation tank is constructed out of 3mm stainless steel plate. The flotation unit legs and braces are typically of 100x100mm or 100x50mm forms. The recirculation circuit pipe work and other external pipe work used are of stainless steel (1.4301).

The internal and external surfaces of the DAF tank are impregnated and consequently inactivated. Both impregnation and inactivation agents are thoroughly washed down before shipping.

The skimming chains, chain wheels, cam chain guides, skimming blades and laminated blocks (if present) are made of plastic.

9. Acceptance and Delivery

The flotation unit recirculation circuit is always removed and disassembled prior to shipping and its parts are individually packed. The manufacturer is responsible for the unit quality and completeness but the customer is expected to check off the delivery items against the shipping manifest for quality and completeness.

Accompanying documentation:

- Certificate of conformity.
- O&M manual for flotation unit.
- O&M manual for recirculation pump.
- O&M manual for electric gearbox.
- O&M manual for compressor (if part of delivery).
- Quality certificate.
- Delivery and acceptance certificate for the flotation unit and accompanying documentation.

10. Transport and Storage

The flotation unit transportation is usually provided by the supplier at the cost of the customer. Offloading of the DAF unit must be determined by a trained and authorized banksman given the weight and dimension of the tank.

The customer must ensure protection from weather and mechanical damage during storage on site. Following delivery, the customer is responsible for the stored flotation unit.

11. Assembly

Mechanical and electrical assembly and installation is carried out by the supplier or his subcontractor following a purchase order and contract.

Should the customer decide to carry out assembly and installation on his own it is recommended that consultation with the supplier takes place to fully understand the requirements.

General rules for the flotation unit assembly:

- The unit may be reliably operated if it is protected from weather conditions and the ambient temperature never drops below 0°C.
- The unit must be installed in horizontal position.
- The recommended minimum space between the unit and wall is 600mm. There must be a space allowance for handling of the floated sludge from the side of the DAF unit and access must be made available to control elements on the scum outlet trough and to the air nozzle locations.
- The recommended height for the building is 1000 mm over the unit's maximum height.
- A valve must be inserted into the waste water inlet pipe to allow regulation of incoming effluent; a check valve should be included to prevent back flow in the event that the feed pump stops running.
- It is recommended that an access platform is installed beside the unit for operational adjustments and monitoring water level, scum removal and the overflow weir.
- The DAF unit must be installed in a well ventilated area as harmful gases may be generated by the process under normal operating conditions.
- The DAF unit should be installed in a well lit building.
- Necessary services for proper operation of the DAF unit include a mains water supply (3 bar minimum) and hot water source (3 bar @ 70°C).

12. Operating Instructions

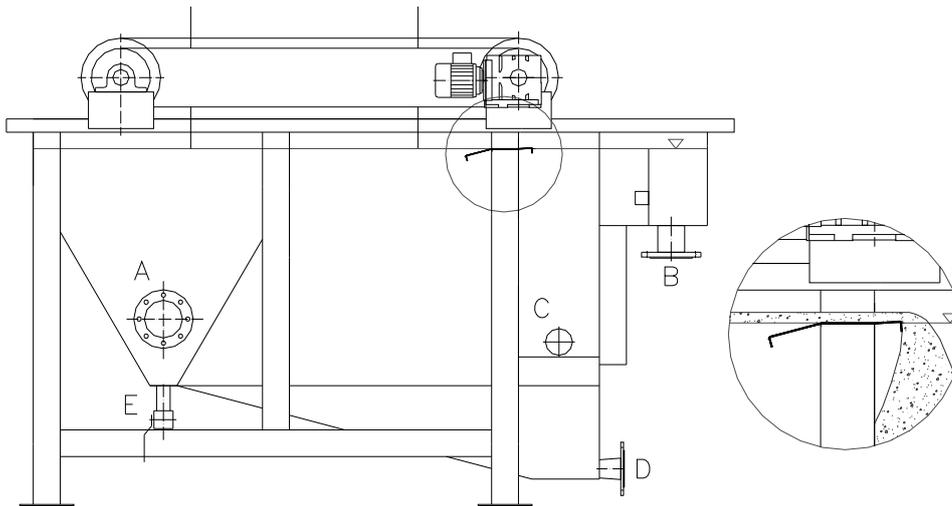
Commissioning:

- The flotation tank must be filled with clean water to a minimum level above the recirculation pump suction point. The recirculation pump must not be operated if the water level in the flotation tank drops below the suction point.

The recirculation pump is not designed for pumping effluent carrying gross solids therefore it is imperative to follow the start-up sequence of the DAF with clean water only.

- Before filling the tank the valves on the sediment removal pipe work (D and E) must be closed.
- The operating height of the flotation tank surface is given by the overflow weir which must be set so that the level reached is below the beaching area feeding the trough where floated sludge is removed from the process (see Fig. 4).

Fig 4:



- Following this, the pressure vessel valves must now be in a fully open position.
- Both the suction and discharge valves associated with the recirculation pump should now be fully open.
- It is then possible to start the recirculation pump and air compressor.
- The airflow must be regulated to the level shown by the flow indicator and the air pressure set at a level 1 bar higher than the pressure vessel.
- The pressure vessel should operate in the range between 4 and 6 bar, a fine air dispersion is formed in the inlet section of the DAF under these conditions –white water is generated. Eventually the white colour should be seen to spread across the entire surface of the tank.
- The DAF unit must be run for a minimum of 10 mins.
- The feed line butterfly valve on the inlet to the DAF may now be opened and the feed pump set to run.
- The flight and chain scraper mechanism should now begin operation (the gearbox configuration should allow periodic scraping operation, e.g. 5 mins idle, 1 min scraping).

Post service checks:

- Carry out daily checks on the pressure in the recirculation circuit and the amount and pressure air at the inlet to the saturator. In case of deviation from the optimal values make the necessary adjustments.
- Carry out periodic checks on the flotation tank level to observe whether the flotation scum has been formed and is being skimmed off. The level of the outlet weir should be properly set and pre-treated effluent should flow freely out the overflow.
- Every 2 hours the sedimentation zone at the base of the DAF must be de-sludged, the opening time for sludge removal should be set at the default value of 5 seconds minimum. The frequency and the time of the opening can be adjusted via the PLC if required.
- Check the sealing of any valves associated with de-sludge points on the DAF unit as loose valves or fittings can cause the DAF tank level to fall.

The recirculation pump is not designed for pumping of untreated effluent. It is very important when operating the DAF to avoid:

- Suction of any sediment should the frequency of sludge removal be set incorrectly.
- Suction of floated matter should the frequency of the scraper mechanism be set incorrectly.
- Suction of floated scum should the dose rates of chemical agents be set incorrectly.

Temporary shut down of DAF plant:

- Stop the feed pump.
- Stop the recirculation pump, compressor, de-sludging, scraper mechanism in this order.

Following shut down:

Carry out a visual check of the flotation tank level; in the event that the level in the tank falls, the de-sludge valve or the check valve in the feed line may not be fully tightened.

13. Maintenance

The DAF unit is a reliable and robust process which requires the standard form of maintenance and good housekeeping. Firstly, operators should carry out daily visual inspections of all hydraulic, pneumatic and chemical pipe work connections.

Other routine maintenance operations are as follows:

- On a biweekly basis, the operation of the recirculation circuit should be inspected. Effectively, the clarity of the liquid passing through all isolation valves in the pressure vessel, hoses and valves in the flotation tank must be observed. This check should be carried out during the normal operation of the DAF unit, consecutively for every single hose:
 - Close both valves associated with the hose being checked and release one of the hose ends.

- Open the valve and check it and the hose for water clarity (water should be drawn into a suitable container).
- Open the other valve and check the water for its clarity.
- Carry out the above operation with all the valves and hoses in the recirculation circuit. In case any of the valves and/or hoses get frequently blocked, the pressure vessel must be removed and cleaned out. The removal operation should be carried out by the manufacturer or representative agent.
- Three times a day or as required, open the inlet section de-sludge valve (for 30s).
- On a weekly basis, drain the flotation tank down to the inlet pipework level and rinse the sockets and nozzles by pressure washer (hot water is recommended if available).
- On a biweekly basis, before the DAF is shut down for more than three days, the whole flotation tank should be drained down (ensure slow drainage so as not to flood the sludge tank). Empty by tanker the sludge storage tank before this operation is carried out to ensure that sludge is not washed back to the balance tank. The flotation tank must be rinse cleaned and inflow socket interiors washed with warm water. It must be made sure that the water temperature does not damage the built-in laminated blocks (if fitted).

When servicing the recirculation pumps follow the manufacturer's instructions. Copies of service and maintenance instructions are included with the DAF unit documentation.

14. Service

WPL Limited provide both warranty and post warranty services. The post warranty service should be ordered in a written form if requested. Details can be sought from WPL.

All spare parts are delivered upon order.

15. Troubleshooting

Problem	Possible Cause	Action
Water overflows to the trough for floated sludge removal	The overflow weir, which regulates the level in the flotation tank is set too high	Lower the overflow weir
Scraping blades do not reach the floated sludge, the level is low in the flotation tank	The overflow weir is set too low	Set the overflow weir higher
	Waste water feeding pump is out of service - no increase in the level	1.Set the overflow weir higher 2. Switch on the waste water feeding pump
	There is a leak on the desludge valve	Check the sealing of the sludge removal valve
	Effluent feed pump is not running for extended period and the fall is caused by the overflow of the air purge volume	Switch on the waste water feed pump and fill the missing volume
On the surface in the flotation tank there is no floated sludge (foam)	No incoming air – the ball in the flowmeter is set at the zero value	1. Check the function of the solenoid valve 2. Check the pressure of the incoming air; it must be 1bar higher than the pressure on the manometer of the pressure vessel 3. Check the function of the compressor
On the surface in the flotation tank , at the inlet section large bubbles are appearing	The pressure vessel is full of air	Open the ball valve of the overflow of the purge air. After a period of deflation, turn down the valve, reducing the volume of incoming air on the flowmeter