

FLOTTWEG DISC STACK CENTRIFUGES

Innovative liquid-solid separation

Separation principles

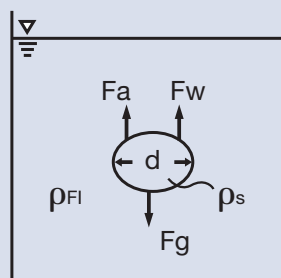
Mixtures of immiscible liquids, such as water, oil and solids, can be separated by gravity if the components have different densities. Solid or “spherical” particles (such as oil droplets in water or water droplets in oil) are influenced by three different forces (Fig.1). The gravity F_g interacts with the buoyant force F_a and the frictional force

F_w . In a viscous fluid, the particles reach a terminal velocity also known as the settling or buoyant velocity depending on the density of the particle – larger or smaller than the viscous fluid. With assumed laminar flow the resulting terminal velocity is given with the Stokes Law (Fig. 2).

This equation shows the significant parameters which influence the terminal velocity:

Particle diameter d :

The terminal velocity increases with the square of the particle diameter. Large particle diameters result in higher terminal velocity.



$$\Rightarrow V_g = \frac{d^2 \cdot (\Delta\rho) \cdot g}{18 \cdot \eta}$$

Particle influenced by three different forces (Fig.1)

Terminal velocity V_g (Fig.2)

Difference in density $\Delta\rho$:

Increasing difference in the density of particle and solid results in higher terminal velocity.

Dynamic viscosity η :

Decreasing dynamic viscosity in the fluid results in higher terminal velocity.

It is important to regard the distance between the particle and the bottom/surface to estimate the time of the sedimentation/flotation. The separation is finished when all of the particles have sedimented (trub residues in juice production) or floated (oil droplets in water).

The separation process in the disc stack centrifuge

Imagine a continuous system for solid/liquid separation at a high flow rate. If the feeding speed is high, some particles will not reach the bottom and will flow away with the liquid. The separation process is incomplete (Fig.3)

This can be avoided by inserting plates to reduce the distance to the bottom ($h \rightarrow h_1$). More clarification area is provided (Fig. 4). This will work until the system clogs.

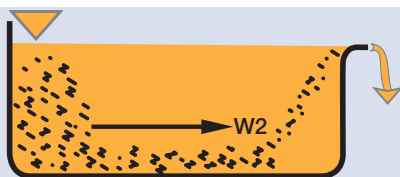
By using inclined plates the solids will slide to the tank bottom (Fig. 5).

Liquid/liquid separation such as the separation of water and oil, works on the same principles (Fig. 6).

The disc stack of the separator divides the product stream into thin layers. The separation itself happens in the space between two discs. A high number of discs result in a large clarifying

area. The centrifugal force of a centrifuge (up to 16000xg) strongly increases the effect of this clarifying area.

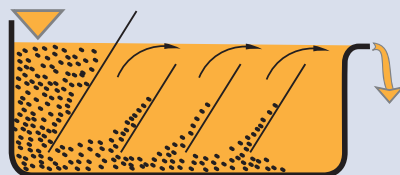
The geometric surface of the discs (clarifying area) and the centrifugal force result in the "equivalent clarifying area". This factor shows the capability of a separator.



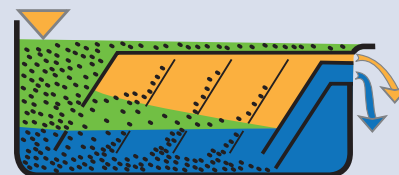
(Fig.3)



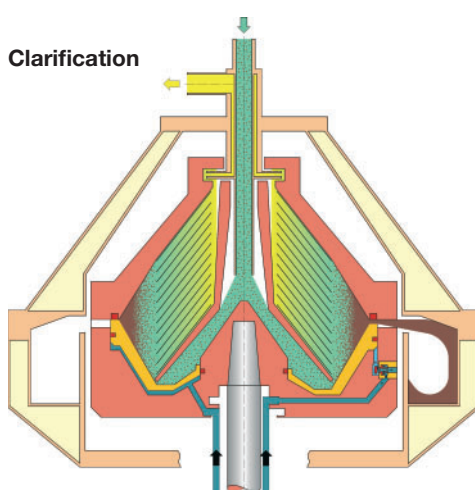
(Fig.4)



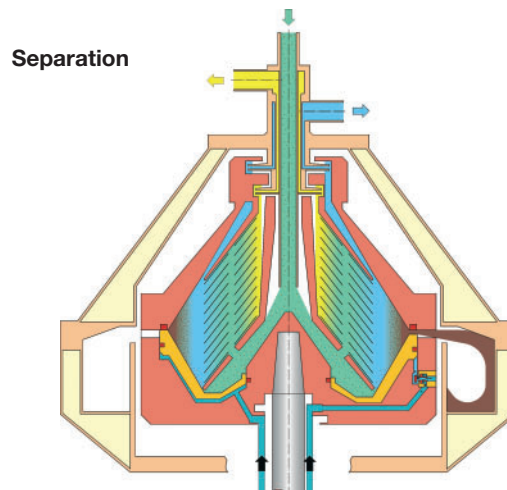
(Fig.5)



(Fig.6)



(Fig.7)



(Fig.8)

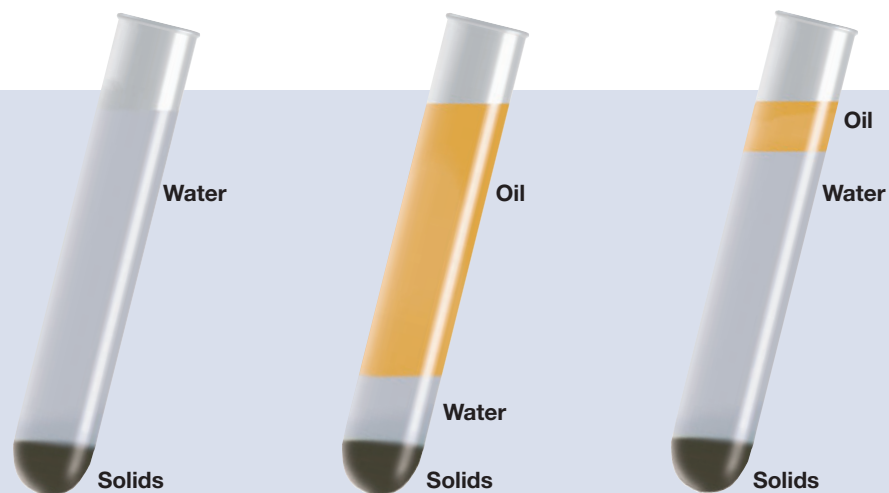
$$V_g = \frac{d^2 \cdot (\Delta\rho)}{18 \cdot \eta} \cdot (r\omega^2)$$

Disc stack centrifuges in process technology

Self-cleaning disc stack centrifuges for liquid/solid separation are essential in many technical processes. The rotation speed of disc stack centrifuges is much higher than most other centrifuges in industry. The centrifugal force in a disc stack bowl is apparently stronger

than for e.g. in a decanter. Hence disc stack centrifuges are predestined for processes which require high separation efficiency or the separation of micro particles. Even mixtures of liquid phases with very small difference in density can be separated.

There is a wide range for the application of disc stack centrifuges. You find them in every branch of industry – like the food and beverage, animal and vegetable fats and oils, chemistry, pharmacy and biotechnology, mineral oil products, energy production, and environmental protection.



Sedimentation in a test-tube – clarification, purification, concentration

Separators are essentially designed for three basic process operations:

- **Clarification**

Finely dispersed particles are separated from a fluid (e.g. trub solids in juice)

- **Purification**

Separation of a liquid with higher density from a continuous

liquid phase with lower density, (e.g. water droplets from mineral oil). The separation of solids at the same time is possible.

- **Concentration**

Separation of a liquid with lower density from a continuous liquid phase with high density, (e.g. essential oil from water). The separation of solids at the same time is possible.

Hence to these basic process operations **FLOTTWEG SEPARATORS** are designed as **Clarifiers**, **Purifiers** and **Concentrator** variants.

Advantages of self cleaning disc stack centrifuges

Compared to other centrifuges and filter systems, self cleaning disc stack centrifuges offer several advantages:

- Compact design, small footprint, yet high flow rates
- Separation of finely dispersed particles
- Liquid-liquid separation of fluids with minor difference in density
- Closed design that prevents odor emission or contamination of product and environment (optional)
- Easy to operate and control through continuous and automatic operation
- No filter cloth, additives, or flocculants necessary



FLOTTWEG SEPARATORS in the field



Typical applications*

• Beverage/food

Fruit juice, vegetable juice, essential oil, wine/must, pectin, tea, coffee

• Chemical/pharmaceutical/ biotechnical

Whey clarification, process water in the starch industry, algae (food additives), industrial biotechnology/fermenta-

tion broth, solvents, chemical waste water

• Oils and fats

Land animal fat and fish oil, vegetable oil, algae (biofuels), olive oil, biodiesel

• Industry/mineral oil

Slop oil/waste oil treatment in combination with the FLOTTWEG TRICANTER®

* more applications available upon request



Functional principle of a self cleaning disc stack centrifuge

The product to be separated enters the inside of the bowl through a stationary inlet pipe (1) into the distributor (2). The separation takes place in the disc stack (3). The product flow is divided into multiple thin layers by the disk stack and a large surface area is created. From the disk stack, the clarified liquid flows to the

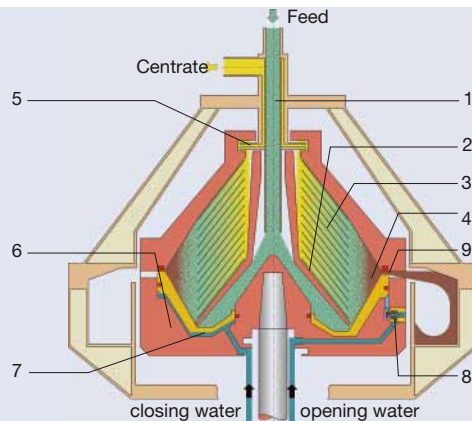
impeller (5) to be discharged.

Depending on the process, the liquid can be discharged under pressure or unpressurized.

A distinction is drawn between a clarifier and a purifier version with a single or double impeller. Separated solids are packed in the solids chamber (4) and discharged periodically.

• Bowl

The bowl of a self-cleaning disc stack centrifuge consists of a bowl bottom (6) including the hydraulic discharge system and the bowl top. The solid discharge (9) is opened and closed by vertical sliding of the piston (7) and controlled by the bowl valves (8). Using a hydraulic system in the bowl



Cross section of a FLOTTWEG SEPARATOR (clarifier version)



FLOTTWEG SEPARATOR bowl

bottom, the separated solids are discharged at full speed.

The hydraulic system of the FLOTTWEG AC centrifuges enables exactly reproducible partial discharges as well as total discharges in any combination.

• Disc stack

The disc stack (3) consists of the discs and the distributor. The purifier and concentrator versions are equipped with additional separation discs (10). The product is introduced to the center of the distribu-

tor through the inlet pipe (1). A specially-designed distributor ensures the smooth acceleration of the product. The impact of shear forces on the particles has to be avoided. This would lead to emulsification and therefore be counterproductive



for the separation process.

Passing the distributor through holes at the bottom, the product enters the disc stack.

Through the rising channels, the product is fed into the space between the discs. An additional separation disc on top of the disc stack (purifier and concentrator) ensures the separated or concentrated liquid to flow into the corresponding collection chamber.

● Liquid discharge

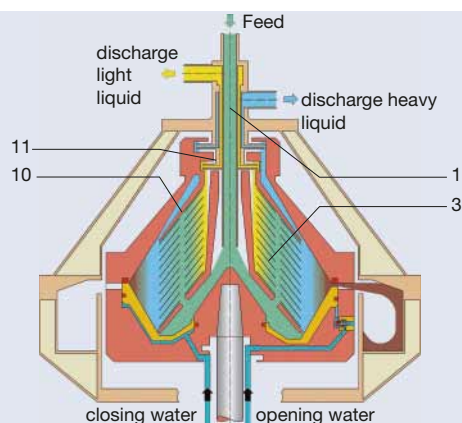
The separated liquids leave the disc stack centrifuge through the liquid discharge. The design varies depending on whether it is a clarifier, purifier or concentrator version.

Using a clarifier version, the liquid is discharged under pressure via a stationary impeller.

There are three options for the purifier and concentrator version:

- Both separated liquids are discharged by means of a double impeller (11).
- The light phase is discharged by a single impeller. The heavy phase is discharged unpressurized and leaves through a stationary regulating ring.

- The heavy phase is discharged by a single impeller (5). The light phase is discharged unpressurized and leaves through a stationary regulating ring.



Cross section of a FLOTTWEG SEPARATOR (concentrator version)



Disc stack



Tri-clamp connection with screw joint

● Drive

The required drive power is transmitted directly to the bowl shaft using a standard three-phase AC motor with frequency drive control via a V-rippled or flat belt. The motor is controlled by a frequency drive

enabling a smooth acceleration and limiting the inrush current. Furthermore, there is the possibility to vary the bowl speed. Compared with other drive systems, the FLOTTWEG drive offers lower maintenance and increased efficiency.

● Materials of construction

All product-wetted parts are made of stainless Cr-Ni-Steel. Depending on the requirements, the components of the bowl are made of stainless

steel or duplex alloys. The sealing materials are made of perbunan (NBR) and polyamide. Other materials such as PEEK, Viton (FKM) and EPDM are available.

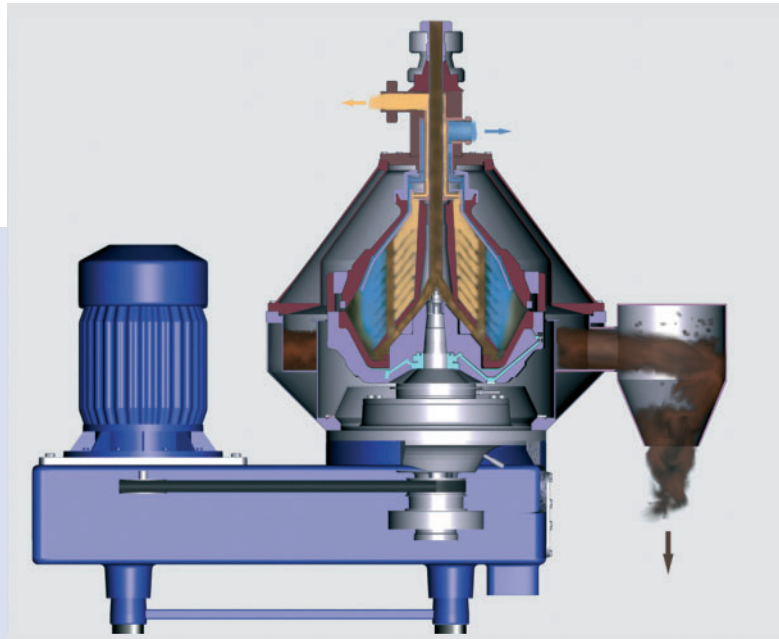
- **Lubrication**

The bearings are lubricated using an internal oil lubrication system. Oil level and flow are controlled by the control system (AC1500, 2000, 2500). An oil pump provides appropriate proportioning of the lubricating oil.

- **Hydrohermetic**

The hydrohermetic seal option enables hermetic feed of the product (clarifier version). Oxygen pick-up, foaming, or gas leakage is avoided. The hydro-

hermetic seal consists of a stationary disc above the impeller. The disc is dipped into the fluid sealing the product from the environment. The system is quite similar to a siphon.



Cross section FLOTTWEG SEPARATOR

- **CIP**

FLOTTWEG SEPARATORS are designed according to requirements of “hygienic design”. They can easily be integrated into an automatic CIP-system.

- **Explosion proof**

All FLOTTWEG SEPARATORS are in compliance with the regulations of 94/9/EG (ATEX95). They are suitable for use in explosion hazardous areas.



● Inert gas purge unit

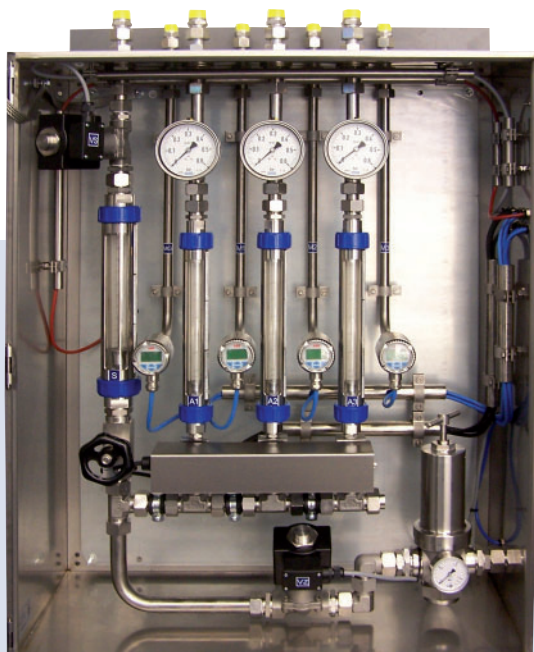
Inert gas purge units are necessary for the production of products whose vapors may contaminate the atmosphere or to prevent contact of the product with the atmosphere (oxidation). If centrifuges are used to process media whose

vapors mixed with aerial oxygen generate an explosive mixture, the risk of explosion has to be eliminated by replacing air with an inert gas. Usually this operation is done using pure nitrogen. Centrifuges and system parts used for the processing of such materials have

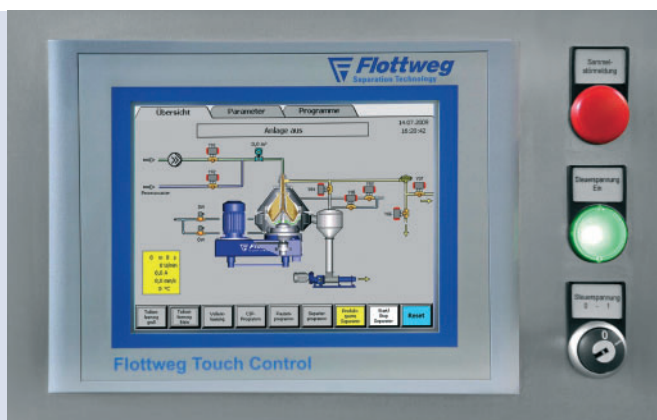
to be gastight to prevent the exit of vapors into the atmosphere as well as to avoid the entry of air into the system. Inert gas is injected into several parts of the centrifuge in order to provide optimal purging and inert gas blanketing inside the centrifuge.

Inert gas purge units are typi-

cally used in the chemical, pharmaceutical, or the mineral oil industry. It is used for all systems which process highly flammable organic solvents or hazardous volatile components. Inert gas units prevent the oxidation of products in the food and beverage industry as well as in the edible oil industry.



FLOTTWEG purge gas control unit



FLOTTWEG touch control

● Centrifuge controls

All centrifuge functions and components are monitored and operated by a programmable logic controller (PLC). The control cabinet includes:

- Motor protectors and ramp-up control system using frequency drive
- Timer for automatic solid discharge
- Solid discharge controlled by turbidimeter (option)
- Control of all components of the disc stack centrifuge and (optional) secondary systems
- All necessary touch and operating controls

Technical data*

Type	AC1000	AC1500	AC2000	AC2500
Volume	4 liter (1.1 US gallon)	14 liter (3.7 US gallon)	25 liter (6.6 US gallon)	58 liter (15.3 US gallon)
Solids chamber	1,5 liter (0.4 US gallon)	7 liter (1.8 US gallon)	11,5 liter (3.0 US gallon)	22,5 liter (5.9 US gallon)
Separator motor	5,5 kW (7.4 hp)	18,5 kW (24.8 hp)	37 kW (49.6 hp)	55 kW (73.8 hp)
Dimensions (Length x Width x Height)	1100 x 600 x 1000 (mm) 43 x 24 x 39 (inch)	1500 x 1000 x 1700 (mm) 59 x 39 x 67 (inch)	2000 x 1100 x 2000 (mm) 79 x 43 x 79 (inch)	2.100 x 1300 x 2100 (mm) 83 x 51 x 83 (inch)
Gross weight	390 kg (860 lbs)	1600 kg (3527 lbs)	2900 kg (6393 lbs)	3750 kg (8267 lbs)
Hydraulic capacity	10.000 l/h (44 US gpm)	20.000 l/h (88 US gpm)	45.000 l/h (198 US gpm)	85.000 l/h (374 US gpm)

* The listed figures are guidelines only



FLOTTWEG SEPARATOR AC2000 gas-tight version in explosion-proof design



Customer Service is our strength – worldwide



Application-based project planning, high-quality manufacturing and professional after-sales service are prerequisites for customer satisfaction.

Experienced and reliable service engineers from our customer service department are ready to respond quickly to reduce down time. The FLOTTWEG service group is also available to perform preventive maintenance.

FLOTTWEG products are designed and manufactured in GERMANY!

ISO certification

FLOTTWEG is ISO 9001 certified and manufactures its products in compliance with all current technical standards.



FLOTTWEG services include:

- Competent advice on separation processes
- Tests at the Flottweg laboratory and test center
- Pilot tests on-site
- Selection and specification of equipment
- Customer-tailored automation/control systems and process integration
- Design and construction of complete process systems
- Installation, commissioning, maintenance, repair, and spare parts service worldwide.
- Preventive maintenance
- Customer training

FLOTTWEG international



FLOTTWEG – headquartered in Vilsbiburg, Germany, near Munich – has subsidiaries and branch offices in Australia, Brazil, China, Germany (Cologne/Leipzig), France, Italy, Mexico, Poland, Romania, Russia, Ukraine, U.K., and the USA, as well as representations in nearly all countries worldwide.

On our homepage www.flottweg.com under contact/service you will find your competent contact person.

**We will support you
any way we can!**



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