



Safety and efficiency – the strongest compound

GEA centrifuges in chemical production



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ONE GEA – ALL COMPETENCIES

From boosting oil wells or biochemical cell treatment to the finished chemical product, from product development to global production – GEA expertise and solutions cover the entire range of chemical applications.

The strongest compound

The GEA mission is to ensure uniquely efficient and safety-protected production for the benefit of the manufacturer.

Full efficiency

GEA offers pioneering concepts in chemical engineering to increase the feasibility and reliability of processes, the reproducibility of results and the sustainability of each process step. As modern life continues to depend on plastics, synthetic fabrics, paints, fuels, and many other chemical products, GEA gives customers an edge in competitive markets.

Full safety

Plant operators turn to GEA to ensure the highest level of safety in industrial chemical processing to protect the plant's personnel, operations and the environment as well as the manufacturer's investment and brand reputation.

Strong partnership

GEA has been supporting the chemical and petrochemical industries for decades in a variety of separation tasks. The technology leader supplies disk stack and decanter centrifuges for such process lines. The systems convince our partners worldwide by the high quality of the end products, cost effectiveness and a conservative approach to resource handling.

Separation in the chemical industry

GEA has been supporting the chemical and petrochemical industry in separating duties for decades.

A recurring task in chemical processes, often in multiple cycles, is the mechanical separation or clarification of substances and phases or the extraction of substances. Centrifugation offers not only high yields from the employed raw materials but also ensures reliable process management which makes efficient use of resources.

State-of-the-art centrifuge technology

Outstanding GEA innovations that have become industry-leading standards include state-of-the-art feed and discharge systems on disk stack, nozzle and solid-wall bowl centrifuges. GEA also offers decanter centrifuges with optimized machine geometry and both high and low speeds for varying solid contents.

Modular customization options to fit any task

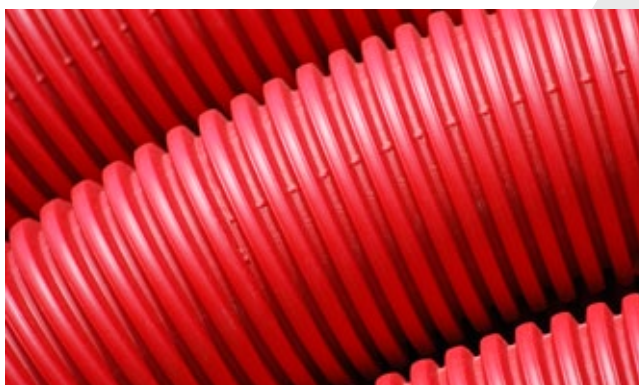
GEA provides centrifuges optimized for the task to meet the specific conditions present on every customer's premises. Current machines are available in suitable design variants to fit specific processes and processed product. Different design executions are available with ideally suited special materials for a given purpose or hardfacing.

On the other hand, many GEA centrifuge models are equipped to accommodate multiple process applications, saving efforts for plant management and maintenance.



Important products:

- Agar-agar
- Aluminum hydroxide
- Amines
- Aniline dyes
- Ash leaching
- Barium sulfate
- Black liquor
- Cellulose and derivatives
- Catalyst recovery
- Dyes
- Ethyl amines
- Filter backflush liquid
- Fungicides, etc.
- Gum arabic
- Herbicides
- Ink
- Insecticides
- Lignocellulose
- Lyes
- Nitro compounds
- Petrochemical additives
- Paints
- Peroxides
- Phosphoric acid
- Polyacetates
- Polybutadiene, etc.
- Polycarbonate
- Polymer
- PTA (purified terephthalic acid)
- Salts (various)
- Sodium borohydride
- Suspensions with metals, oxides, hydroxides, catalysts
- Tall oil
- Viscose, cellulose acetate, etc.



Full safety

Chemical production involves hazards hardly experienced in any other industry – complex reactions, inflammable materials, concentrated acids, heat, high pressure, risks of decomposing and explosion.

GEA centrifuges are optimally protected, using six strategies to fulfill your specific process needs:

1. Corrosion resistance

Strong, non-corrosive stainless steel alloys and nickel-based alloys are selected for each centrifuge depending on the unique application.

2. Wear protection

Hard-facing from durable materials, applied with sophisticated processes, prevents mechanical failure and unnecessary wear on machine parts.

3. ATEX 2014/34/EC compliance

GEA machines for use in explosive environments are monitored and certified according to ATEX regulations.

4. Inert gas blanketing

For numerous processes, units for blanketing the centrifuge bowl with inert gas are available, reducing the oxygen content inside the centrifuge below the critical level.

5. Temperature control

For products that can decompose at low temperatures, state-of-the-art monitoring at the critical points is available.

6. High process temperature

Special design features are in place for centrifuges used in high temperature applications.



Typical hazards

- Nitrated organics such as MNT and DNT can explode after exceeding a certain temperature, independent of the presence of oxygen.
- Peroxides can decompose in the absence of oxygen even at comparatively low process temperatures, enhancing the explosion risk.
- Elevated temperatures are characteristic of processes in the production of petrochemical additives or catalyst recovery.
- Critical concentrations of solvent vapors and oxygen inside the centrifuge can cause explosions or fires.
- Vapor leakages must also be prevented so as not to pose a risk to the health of the operators.





Full efficiency

Chemical products such as polymers and peroxides are often mass produced, which means that manufacturers need to achieve both high-quality results and maximum production to be profitable. This is where the industry experience of GEA pays off to provide the ideally selected and customized solution.

Higher yield

All chemicals are different and require different properties from centrifuges for maximum-efficiency clarification, polishing or extraction. The GEA high-performance centrifuges and decanters can be fine-tuned in each different case to achieve exactly the right parameters and to obtain exact and pure separation results with fewer processing cycles and higher yield from the same raw materials.

Adjustable parameters include bowl types and dimensions, disk stack and nozzle sizes, bowl angles, integrated feed and discharge systems, automated control options, rotation speed, and numerous other parameters. Decanter centrifuges are equally optimized to achieve highest yields.

Reproducible results

Exact mechanical operation is one reason for ensured reproducible results with GEA machines. The other reason for this are extensive monitoring and control options – either between batches or even during operation.

Reliable operation

Robust operation and plannable service intervals for maximum availability throughout the entire life cycle is a key characteristic of all GEA centrifuges and decanters.



Global test center network

Innovate, partner and prosper with GEA

Driving your future	Driving solutions	Driving technologies
By combining advanced in-house technology with a thorough understanding of the processing industries, we help our customers to maximize their development results, gain more know-how and discover additional opportunities for their applications.	From new product and feasibility trials to scale-up studies, training programs and process support, we believe that our services greatly benefit anyone involved in industrial R&D, equipment selection, process optimization and product development.	Overcoming technical barriers throughout the entire process chain, there's no limit to where the GEA global network of test centers can take your research.

The GEA global network of test facilities offers teams of experts who work closely with their customers to optimize procedures and evaluate their products, enabling them to achieve their process and production goals.

GEA test center Separation

At the GEA test center of competence, customers can test both new and established products in a wide range of separation operations or perform comparative process studies with our skilled operators. Other test programs in GEA test centers around the world can be involved to test entire manufacturing lines.

On-site trials and test centers

Centrifuges are available for process trials at the operator's site to assess the feasibility and profitability of individual process steps and combined operations.

In co-operation with the customer, GEA also develops and tests completely new processes. In this way, the GEA test centers also underline the innovation strength of GEA as a leading international technology group.

Prosper with GEA

Book your ticket to success at [gea.com/contact](https://www.gea.com/contact)



GEA Global Test Center



Petrochemical additives

Reliable removal of solids without clogging

Petrochemical additives increase the fluidity of lubricants, reducing wear and energy consumption in mechanical operations. The preparation of safely applicable additives demands that inorganic salts and other contaminants are removed from the product, typically by processing with decanter and disk stack centrifuges. For this, GEA offers a specialized machine portfolio characterized by particularly reliable functionality.

Faster discharge for continuous operation

Unwanted solids, such as calcium salts or other inorganic salts, are typically present at varying concentrations in the organic carrier solvent of petrochemical additives. GEA decanter centrifuges are able to effectively remove these solids due to the optimal design of their bowl geometries and discharge systems.

A flat angle of the conical bowl section ensures that the separated salts are discharged quickly, before they can clog the machine. This prevents unplanned shutdowns.

GEA TSE SKID

Perfect for effective polishing:

The complete disk stack centrifuge with integrated controls and ports works alongside the GEA CF decanter centrifuge to ensure the most efficient removal of high and low solids concentrations.



Maximum safety and efficiency

GEA optimizes each centrifuge for the treatment of petrochemical additives to meet the specific conditions of the customer's process. Test runs at the production facility as well as the experience of GEA experts ensure efficient operation of the centrifuge in the process line.

With gas-tight, explosion-proof centrifuges according to ATEX standards, GEA guarantees maximum safety.

Efficient polishing in a second step

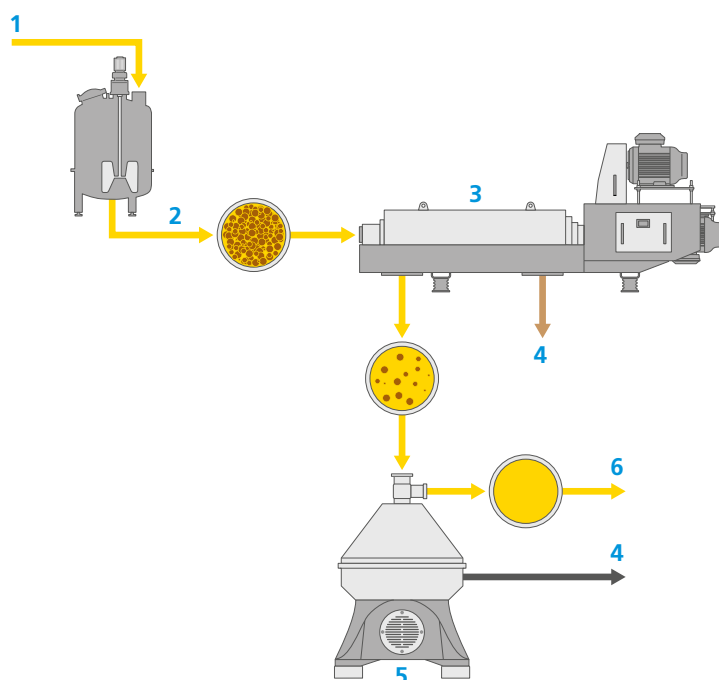
Depending on the pre-concentration of the product, the separation process uses decanter and disk stack centrifuges. Very frequently, both machines are used in a 2-step process. If the additive solution has a high solid content, a decanter centrifuge is the ideal machine. These machines are best equipped to handle great concentrations of solids and can typically remove the solids content by 80 to 90 %.



For a higher solids removal rate, the product can be polished in a disk stack centrifuge. This second process step is marked by a less frequent discharge of solids, reducing both the consumption of process liquid and the loss of valuable product during discharge.

Both the initial separation in the decanter centrifuge and the polishing step with a disk stack centrifuge thus improve the overall efficiency of the production process.

PETROCHEMICAL ADDITIVES



- 1 Contaminated oil additive, obtained from a reaction process
- 2 Oil additive solution + salts
- 3 Decanter CF series
- 4 Salts (disposal)
- 5 Self-cleaning centrifuge, DSE or TSE series
- 6 Oil additive solution to further treatment

Chemical catalysts

Safe recovery at any required temperature and pressure

Catalysts are chemical substances that accelerate the reaction rate and do not change themselves. Typically, the catalysts must subsequently be removed from the reaction product, as they are often valuable recyclables, such as platinum, cobalt, and manganese, or in some cases materials that could be hazardous to the environment. For efficient recycling of the catalysts, GEA offers highly suitable nozzle-type centrifuges that are not only reliable but also particularly safe in operation and able to handle high temperatures and pressures.

Explosion- and pressure-proof operation

GEA nozzle centrifuges for recovering catalysts are marked by a fully sealed, explosion-proof centrifuge bowl. This is important because a number of recovery processes demand temperatures of up to 180°C to reduce the viscosity of the carrier fluid, which in turn may require increasing the pressure to up to 10 bar to prevent the fluid from evaporating. Thanks to their closed-bowl concept, GEA nozzle centrifuges operate safely and without problems under these conditions.

The pressure-stressed components hood, solids catcher and protective hood meet the requirements of the European Pressure Equipment Directive and the American ASME code. A double mechanical seal provides the necessary segregation of the product space from the environment.

Product-wetted parts are made of Duplex stainless steel. Depending on centrifuge size, Super-Duplex and Super-Austenitic steel can be selected as well. Special materials such as Inconel 625 and suitable gasket elastomers such as FKM and FFKM are also available.



GEA TDC NOZZLE CENTRIFUGE

Plug and play: The explosion- and pressure-protected centrifuges are suitable for operation at up to 180°C and resistant against wear and tear. Each model can be supplied as a complete package unit.



Protection against wear and tear

Catalysts are mainly inorganic material that cause wear on centrifuge parts. This is why GEA machines for this process are equipped with state-of-the-art hardfacing.

The innovative nozzle design devised for GEA TDC centrifuges further decreases the abrasive effect, significantly increasing the lifetime of the centrifuge.

Simplified maintenance, long service life

GEA nozzle-type centrifuges feature special inspection covers for simple inspection and replacement of the nozzles, making it unnecessary to open the centrifuge bowl for maintenance exchanging the nozzles.

Dependable performance

Nozzle-type centrifuges from GEA reliably provide highest clarifying results with a defined solid concentration in the nozzle discharge.

To adjust the solids content in the concentrate, the nozzle output can be recycled to the centrifuge by means of an external recycle pump. Compared to other recycle systems, this method is independent from the centrifuge's bowl speed.

If high solid contents need to be processed or catalyst solids must be dewatered to a high degree, decanter centrifuges of different sizes from GEA offer an alternative technology solution to ensure maximum efficiency.

Viscose

Recovery from filter reject with maximum service life

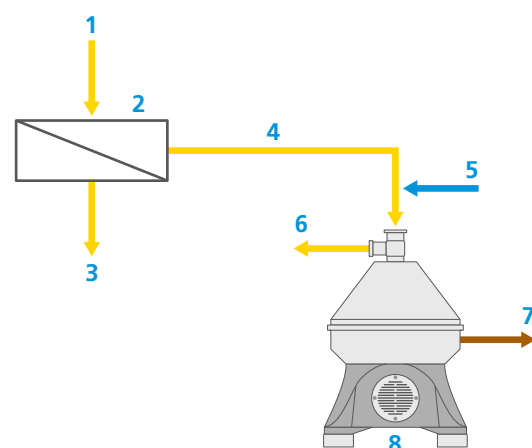


Viscose manufacturers advance their productivity by recycling the reject from the filter cleaning process to achieve a higher yield of the in-demand product. Smart GEA centrifuges are equipped to achieve this with minimal machine wear, optimizing the efficiency of the system and the operational costs.

Faster discharge for less wear and fewer stops

The filters for the main process of viscose filtration are back-flushed regularly for cleaning. Following that, the reject liquid is centrifugally clarified to be subsequently recycled to the process, removing sludge, sand and other suspended solids that have not been discarded upstream with hydrocyclones. However, these abrasive solids require careful attention to minimize wear, particularly on the ejection system. Here, the ingenious GEA **hydrostop** system on all GEA machines for viscose recovery offers a crucial advantage: The large stroke of the sliding piston ensures a very fast ejection and shortens the contact time between ejected solids and machine parts by the factor 10 compared to other ejection systems. The result is prolonged

VISCOSE RECOVERY



- | | |
|-------------------|---|
| 1 Viscose | 6 Reject viscose, recycle to process |
| 2 Filtration | 7 Waste |
| 3 Refined viscose | 8 Self-cleaning centrifuge, DSE or TSE series |
| 4 Reject viscose | |
| 5 Water | |

stand times of the centrifuge due to less maintenance and fewer cleansing intervals.

Balanced abrasion patterns for increased lifetime

The sliding piston on these DSE machines, always a critical part when handling abrasive solids, is designed to continuously change its radial position relative to all other bowl parts. This design feature leads to uniformly smooth abrasion patterns.

It reduces the typical formation of wear channels and thus increases the service life of the wear parts.

Robust series concept

GEA centrifuges for viscose recovery are available in particularly robust executions with only few necessary additions for maximum service life. Vulnerable parts of the machine are protected by exchangeable wear plates and/or hard facing.

As viscose continues to rank among the most used fabrics in the world, GEA DSE centrifuges add efficiency and yield to the manufacturer's profit.

GEA DSE SERIES

The equally smart and robust machines offer long operating times and a long service life, meeting all requirements of efficient viscose recovery.



Polymers

Extreme purity and minimum residual water



Polymers are among the most sought-after plastics, used in countless industries and areas of life. In particular, polycarbonates are a popular choice for many modern applications, from construction to optical products, because of their superior transparency and impact resistance.

The typical manufacturing process uses centrifuges in the multi-stage wash cycle designed to separate the pure organic polymer solution from the acidic wash liquid. Among the most suitable GEA models are the TTC series of solid wall bowl centrifuges for liquid-liquid separation and the TSE series of self-cleaning disk stack centrifuges for liquid-liquid-solid separation.



GEA TTC 300

Optimized for purity of the product and safe operation: Solid-wall bowl centrifuges with corrosion-resistant materials and effective customization options.

Optimized separation efficiency

These GEA centrifuges provide outstanding separation performance for maximum product purity. One major reason for this is that each machine can be tailored precisely to the operator's specifications and process requirements in terms of flow rates and phase ratios, as well as the densities and viscosities to be processed.

The separation process not only aims for extreme purity, but also for minimal residual water content in the organic phase. These market demands are met by GEA technology that is specially designed for high centrifugal speeds.

Risk-free, long-life operation

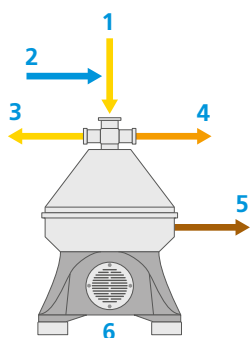
All GEA centrifuges for polymer washing are optimized for continuous operation. To avoid corrosion risks from increased chlorines contents all GEA centrifuges are made of duplex or super-duplex. GEA solid-wall bowl centrifuges can be clad with special material such as Hastelloy.

For the safe processing of solvents, all centrifuges are available in explosion-proof closed design, sealed from the atmosphere and blanketed with inert gas.

Equipment for other polymer process steps

GEA disk stack and decanter centrifuges can also be used for the clarification, classification and dewatering steps in polymer production.

POLYMER WASHING



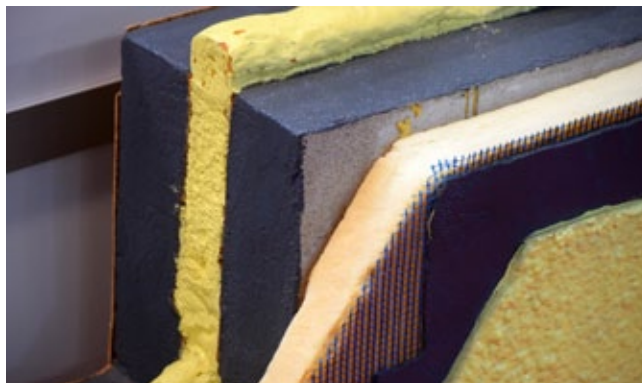
- 1 Polymer solution with impurities
- 2 Fresh wash water
- 3 Purified polymer solution
- 4 Used wash water
- 5 Suspended impurities
- 6 Centrifuge TTC (manual solids discharge) or TSE

Nitroaromatic compounds

Safe and efficient separation at just the right temperature

Important industrial products such as polyurethane (PU) and other plastics, but also explosives or pharmaceuticals, derive from nitrated aromatics, e.g. aniline or nitro toluene. The nitration reaction to obtain these nitroaromatics involves aggressive basic materials as well as explosive reaction products, the hazards of which must be vigilantly controlled. GEA centrifuges offer superior concepts to protect the safety of process, plant and operators.

Nitroaromatic compounds are obtained in a multistage, large-scale process. After repeated nitration in the reaction tanks, the product is separated from the spent nitric acid, then undergoes a multistage washing process to achieve a high degree of purity. Solid-wall disk centrifuges from GEA can be applied to all of these steps. In the final separation step, the nitroaromatic is separated from the water after washing.



Crucial temperature control

Solid-wall bowl centrifuges from GEA are an excellent choice for the main separation processes because of the excellent purity of the nitroaromatic compounds obtained with a disk stack centrifuge. The level of control secured through this bowl design and numerous functional options enables the plant operator to safely adhere to the tight temperature limits that ensure a steady process, but prevent the treated medium from decomposing. This eliminates the risk of explosion.

The purity and yield of the nitroaromatics obtained with these solutions is excellent. Separation takes place in a very small space, significantly increasing the safety of the installation. Centripetal pumps ensure the safe discharge of both the acid and the organic phase.



GEA TTC 150

Safe, efficient and highly durable: These proven solid-wall bowl centrifuges are now available with robust and space-saving direct drive for challenging separation tasks.

Unique anti-corrosion armor

A particularly critical factor in the aversion of safety risks and process errors is corrosion protection, made especially difficult by the presence of strongly acidic media. To keep these hazards at bay, all parts that come into contact with the product must, in principle, consist of Incoloy 825. GEA uses cladding with Incoloy 825 for the loading part of the bowl to maintain the advantage of maximum bowl speed with a Duplex or Super Duplex bowl while providing the corrosion resistance of the Incoloy 825. The problem is particularly acute when processing nitrated toluene (MNT, DNT), thus Incoloy 825 is typically used for all components in contact with those media.

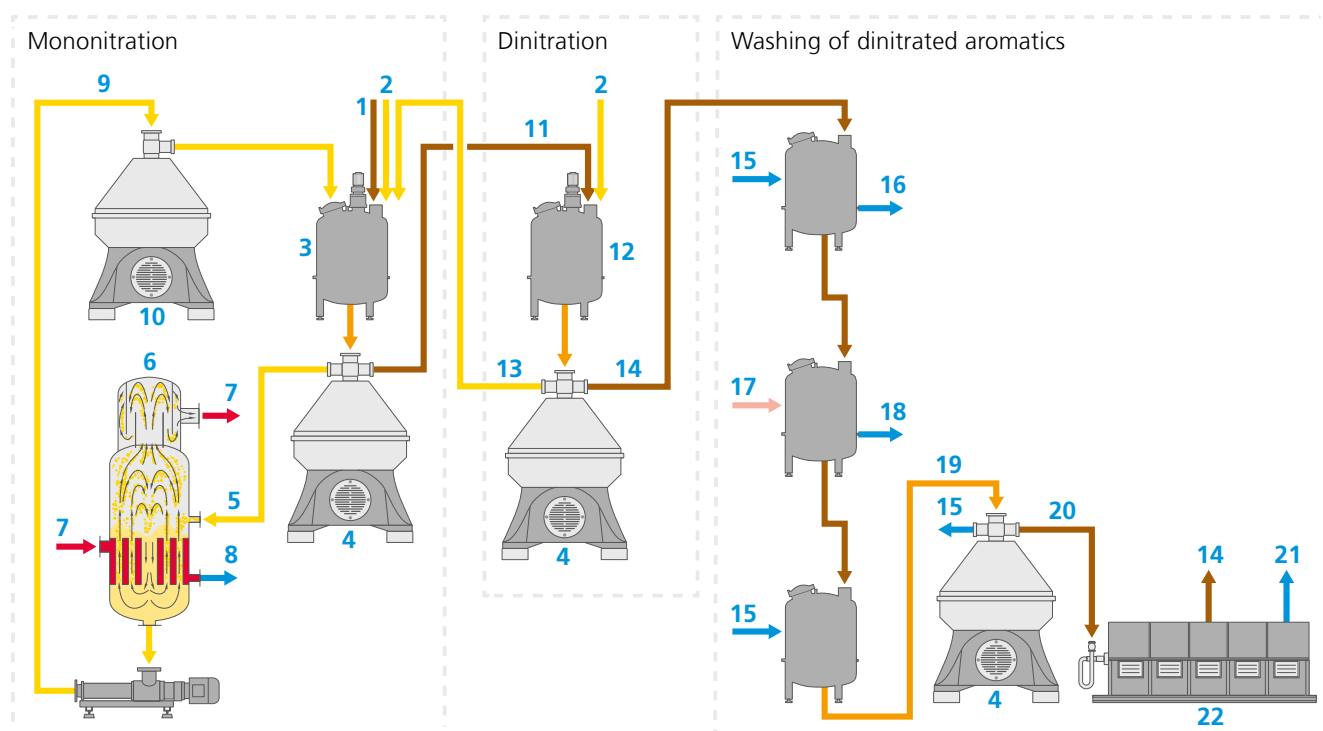
Small, low-footprint machine solutions

GEA nitroaromatic compounds are characterized by a wide bowl head, suitable for a sufficient overflow to accommodate the typically high density difference (1.3-1.6). This also applies to small, space-saving solutions such as the GEA TTC 150, the use of which saves valuable space in the production facility.

Cost-saving acid recycling

In addition, chamber-type centrifuges are successfully used to clean the spent acids for recycling. This increases the operation uptime of the centrifuges in the nitration stages by up to 100 percent as sulfuric acid cleaned in this way significantly extends the intervals between the cleaning cycles of the solid-wall bowl machines.

NITROAROMATIC COMPOUNDS



Mononitration

- 1 Aromatic
- 2 Mixture of nitric acid and sulfuric acid
- 3 Reactor for mononitration
- 4 TTC / TTI series centrifuge
- 5 Exhausted acid to recovery station (H₂SO₄ + H₂O + organics)
- 6 Recovery station
- 7 H₂O steam

8 Condensate

- 9 Clarification of Fe-sulfate from sulfuric acid
 - 10 Centrifuge TKC / TKI 100
- #### Dinitration
- 11 Mononitrated aromatic
 - 12 Reactor for dinitration
 - 13 Acid for recirculation
 - 14 Dinitrated aromatic

Washing of dinitrated aromatics

- 15 Wash water
- 16 1st washing step: sour water
- 17 Caustic soda solution
- 18 2nd washing step: alkaline water
- 19 3rd washing step
- 20 Washed dinitrated aromatic
- 21 Condensate
- 22 Dryer

Peroxides

Customized solutions for safe maximum-purity processing

Hydrogen peroxide is used as a disinfectant and bleach in many industries, while organic peroxides are used as chemical reactants. Nowadays, peroxide is also used for processes such as HPPO converting HP (peroxide) into PO (propylene oxide). Since the peroxide production process requires particularly accurate separation results and reliable explosion control, GEA TTC centrifuges are effectively customized to individual process conditions and production parameters.

Maximum accuracy of separation

Peroxides are most commonly obtained using the anthraquinone process, which puts an organic working solution through a cycle of hydration, oxidation, washing and concentration. To extract impurities, an aqueous phase is added to the working solution or directly to the organic peroxides, then both phases are separated with centrifuges. Since further processing requires a very pure organic phase, the GEA TTC solid-wall bowl centrifuges are specially customized for separation with maximum accuracy.

Highest yield and efficiency

The extensive customization options for GEA TTC models also make sure to achieving highest yields and flow rates with any given process setup and volume.

Special design modifications are available to optimize separation efficiency, particularly with regard to the peroxide process: Since the light phase accounts for more than 90 percent of the total flow, most of the centrifuge capacity should be used to purify the light phase. Only GEA TTC can be configured to ensure this without sacrificing other performance benefits.

Safe operation and temperature control

The peroxide process is always critical in that peroxides can decompose even in the absence of oxygen at temperatures above certain limits. Hydrogen peroxide is even used as space rocket



GEA TTC 300

All TTC centrifuges from GEA can be customized to ensure maximum safety, efficiency and durability for any peroxide process. Starting with small GEA TTC 10 models, the right size can be chosen from a broad range.



fuel. In order to minimize the risk of explosion in the separation process, GEA centrifuges are explosion-proofed and the temperatures at the critical points are permanently monitored.

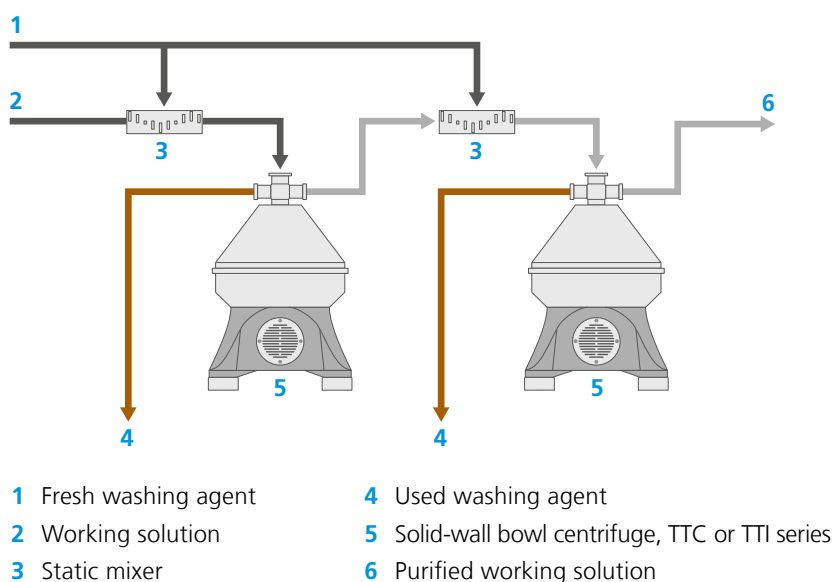
Where flammable liquids are handled, the GEA centrifuges are explosion protected according to European ATEX regulation.

The closed bowl is completely sealed off from the atmosphere, blanketed with inert nitrogen and connected to the plant's vent system. The bowl design is also optimized for low-friction operation to prevent heating.

Continuous, long-life operation

GEA TTC machines are designed and equipped for continuous operation in peroxide processes.

PEROXIDES



Paints, dyes, inks

Classifying with exactitude and style

Almost every industrial product requires some form of coating and/or coloring, and most are made of or accompanied by printed materials. These facts clearly show the great economic importance of paints, dyes and inks. GEA disk stack and decanter centrifuges for classification tasks ensure optimum quality and visually appealing results.

Great centrifugal force for small particle classification

Technically, paints, dyes and inks consist of a liquid phase containing colorant particles. What seems uncomplicated at first glance turns out to be a real challenge on closer inspection: particles of just the right size have to be processed in order to achieve the desired color or protective function.

Thanks to their design and extensive customization options, GEA machines ensure that all process and production parameters are taken into account so that only the desired particle size class is retained in the end product. The small particles, often no more

GEA DSE 120

Exact and safe classification is the domain of this disk stack centrifuge, available in sizes from DSE 10. For classifying solutions with higher solid content, GEA CF decanter centrifuges are available.





than a few micrometers, typically require high speeds and large clarification areas in the centrifuge. In these applications, GEA chamber bowl centrifuges and continuous disk stack centrifuges have proven their benefit.

Effective, speedy discharge

To ensure maximum quality, the discharge system on GEA disk stack centrifuges is controlled by the GEA **hydrostop** mechanism with operating water that does not come into contact with the end product. The discharge system creates a large discharge port for a particularly rapid discharge so that sticky colors, dyes and inks will not clog the system.

Safe operation

When flammable organic solvents are used in a production process, it is necessary to use explosion-protected centrifuges. Machines from GEA are equipped with certified components

and the product chamber is gas-tight. The product chamber and drive chamber are blanketed with inert gas that reduces the concentration of oxygen in the centrifuge to a non-critical level and keeps it within safe parameters.

Decanter centrifuges are used for inks and paints with a high solid content. For classification of inks the decanter centrifuges are equipped with special control features to keep product temperatures below hazardous level. Explosion-proof design of these machines is provided if needed for the specific process conditions.

In most cases, identical GEA models can be dedicated to most or all color variants of a given paint, dye or ink product in a plant.

Zero Liquid Discharge

Zero Liquid Discharge (ZLD) at reproducible quality

Water consumption and water conservation are a major concern in many areas of industrial operation. As a result, Zero Liquid Discharge (ZLD) solutions have become a key factor in successful processing. Manufacturers under pressure to achieve exactly reproducible results can rely on advanced decanter centrifuge technology from GEA to achieve their goals.

Reproducible results

In ZLD processes, decanter centrifuges are used to clarify the spent process water and remove salts and other substances so the liquid phase can be recycled as high-purity water to the main process. GEA decanter centrifuges are designed particularly for efficient and reliable treatment of high-solid suspensions. All GEA machines for ZLD processes feature a flat pond design with 25 percent higher g-force at solid outlet than conventional centrifuges.

Both the clarified phase and the removed solids are discharged by gravity. In a typical continuous application, the solid content in the liquid phase can be reduced to 0.1 percent or less.



Customized for the task at hand

The extensive experience of GEA in developing and customizing advanced centrifugal solutions gives every user an important edge in terms of reproducible results at minimum energy consumption. All critical technical parameters, from centrifugal velocity to cone angle and pond depth, are tailored to the task at hand by GEA experts so that each customer achieves impeccable results over a long service life.



GEA dryMaster – DECANTER CENTRIFUGES FOR HIGH-SOLID LIQUIDS

Extensive adjustment options in this industrial centrifuge range ensure reproducible ZLD results and advanced water savings.

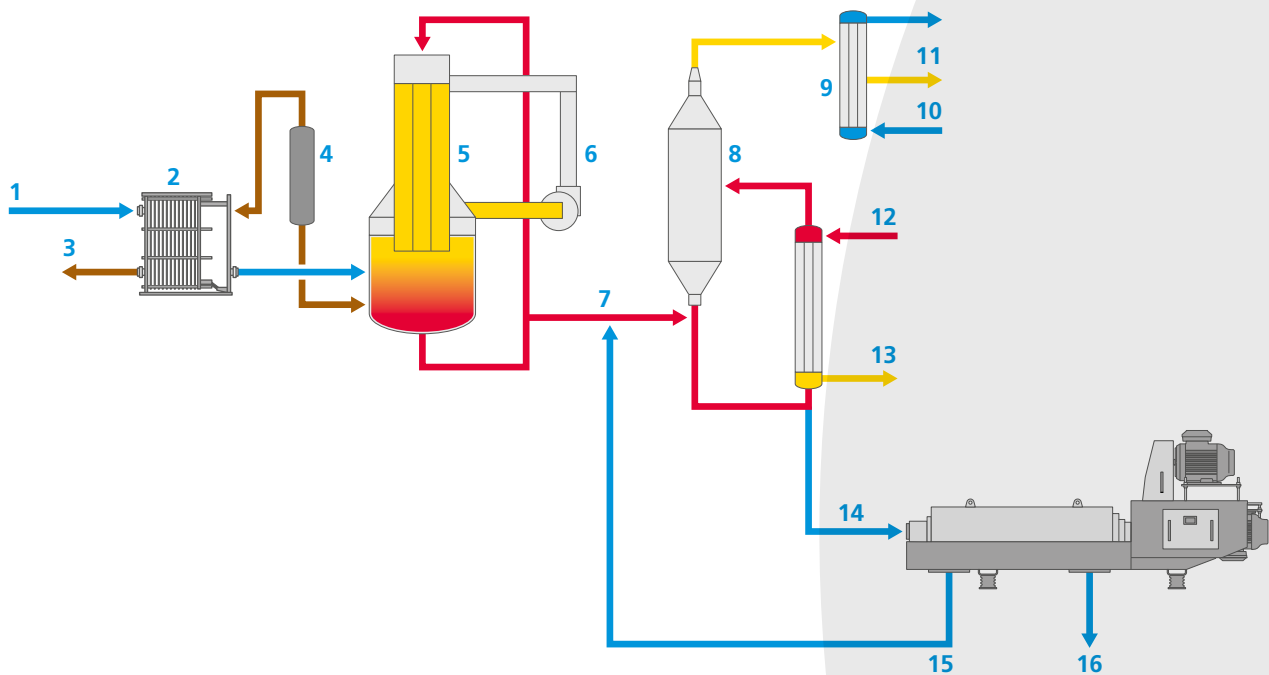
Protected from aggressive salts

In order to protect the machine and the operation from risks due to corrosion, all wetted components that cannot be manufactured from non-corroding materials can be protected by coating with suitable materials such as Hastelloy C, Duplex or Super Duplex stainless steel.

Economic and environmental advantage

Clarification results of reliable and reproducible quality allow the plant operator to protect their main process from inadequately clean water. Ensuring effective water management improves overall plant efficiency, saves operating costs and eliminates liquid waste streams, thereby protecting the environment.

ZERO LIQUID DISCHARGE



- 1 RO reject to brine concentrator
- 2 Heat exchanger
- 3 Distillate recycle to cooling tower
- 4 Distillate pump
- 5 Brine concentrator

- 6 Compressor
- 7 Brine concentrator blowdown
- 8 Crystallizer
- 9 Surface condenser
- 10 Cooling water

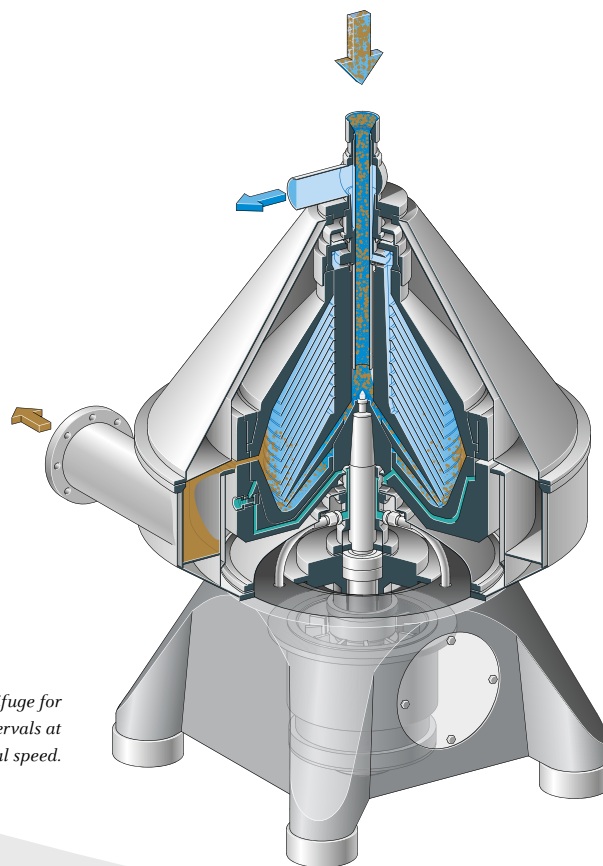
- 11 Process condensate
- 12 Plant steam
- 13 Prime condensate
- 14 Crystallized solids
- 15 Clarified decanter liquid to process
- 16 Suspended crystallized solids

Centrifuge technology

Self-cleaning disk stack centrifuges

Self-cleaning centrifuges are used in many applications in the chemical and petrochemical industry, meeting all demands for continuous operation.

The centrifuges are equipped with a disk-type bowl and movable sliding piston. The liquid is clarified fast and gently whereas the solids are spun out into solids chamber. When the optimum ejection point is reached, the movable sliding piston is opened hydraulically. The solids are ejected in a fraction of a second under operational speed allowing for maximum yield and optimum energy consumption. The clarified liquid is discharged foam-free and under pressure by means of a centripetal pump. To prevent oxygen pick-up, these centrifuges can be delivered in hydrohermetic (liquid seal) design.



Self-cleaning centrifuge for optimum ejection intervals at operational speed.

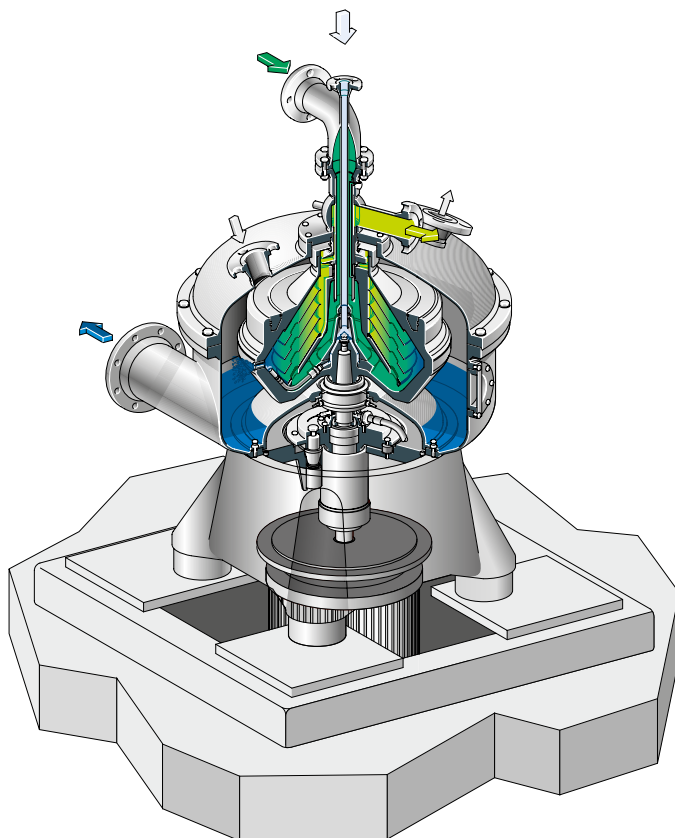
Centrifugal working principle

The product to be separated enters the rotating centrifuge bowl – with a combined surface equivalent to 80 soccer fields. The higher density of the solids means they are forced towards the bottoms and the outer solids discharge chamber. The remaining liquid in the disk stack is caught by a centripetal pump and moved to the outlet pipe at the top end of the centrifuge.

Nozzle centrifuges

Nozzle bowl centrifuges are the optimum solution for products with a high solids content, e.g. polymers and plastics. They are available with a washing system or concentrate recycling system and direct drive in explosion-proof design.

The separated solids (concentrate) are continuously discharged through nozzles into the concentrate catcher. The solids concentration depends on the throughput capacity, the feed concentration, the nozzle diameter and the bowl speed. The desired concentration can be adjusted by exchanging the nozzles and regulating the throughput capacity. The concentrate flows off under gravity from the concentrate catcher.



- Innovative direct drive concept
- No limitation of motor capacity
- Motor control via frequency converter
- Stress-optimized bowl design
- Reduced weight, therefore reduced floor load
- Easy top to bottom disassembly and bottom to top assembly
- Bayonet type nozzles for optimized flow pattern and reduced service costs
- Continuous bowl speed and vibration monitoring
- External lubrication system for longer oil change intervals, better oil quality and simpler oil change
- Monitoring and cooling of the lube oil feed
- Depending on size, available for high pressure applications of up to 10 bar (g) overpressure and a temperature of up to 190 °C
- Process-wetted parts made of stainless steel alloys
- Special design available made of nickel-based alloy (depending on model)
- Erosion protection

To ensure that maximum performance is permanently achieved, the nozzle-type separators are also equipped with a special wear protection against abrasion. This solution comprises coated wear plates as well as a coating on the distributor bottom and the bowl bottom.

- Upstream rotary brush strainers prevent clogging of the nozzles
- Reliable protection against abrasion

Nozzle centrifuges are equipped with a disk-type bowl with nozzles at the periphery to discharge the concentrate continuously.

Solid-wall bowl centrifuges

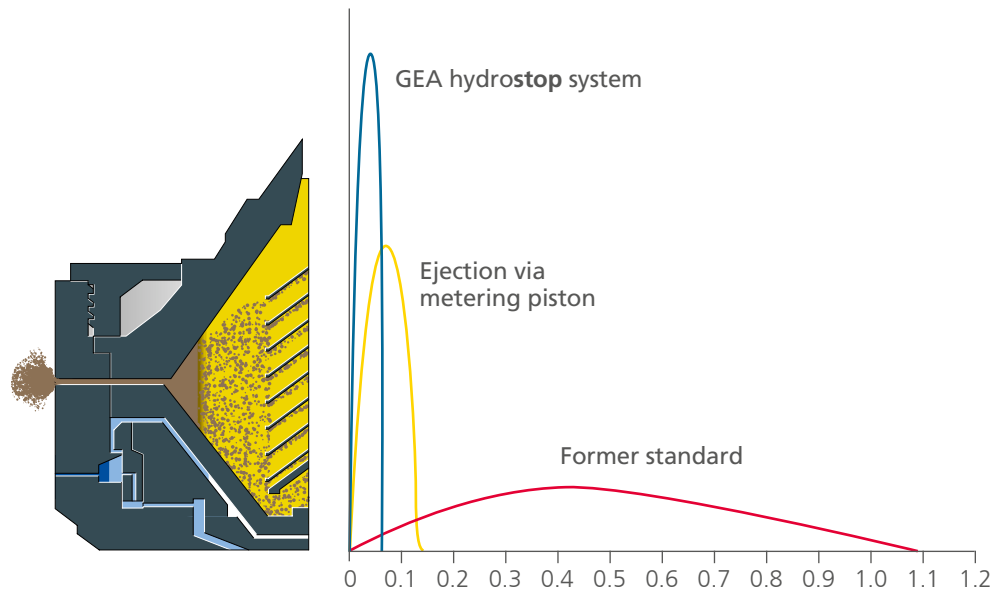
Solid-wall bowl centrifuges from GEA are used to achieve highest separation of two liquid phases with a very low or negligible solids content. Although the manual removal of solids cannot always be avoided, protective clothing is no longer needed, as GEA provides the only solid-wall bowl centrifuges in the world where the bowls are completely drained by gravity. Only small quantities of medium (often very toxic) remain in the bowl to be cleaned manually. Proper washing cycles after stopping the bowl can reduce that quantity even further.

The trick is extremely effective: Special drain holes keep “dry” during machine operation because of the centrifugal forces.

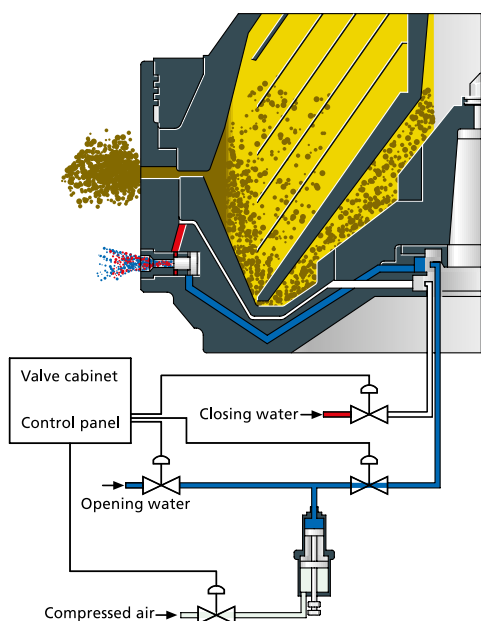
Only when the centrifuge slows down the liquid enters this discharge area. The liquid discharges completely from the bowl and is collected in downstream tanks via the frame drain. CIP is facilitated as the product drains out without the need to open the bowl, for a significant increase of production time and decrease of downtime (also see next page).

GEA hydrostop discharge system

The GEA hydrostop discharge system can be adjusted precisely and reproducibly to specific solids concentration requirements. This patented system discharges extremely quickly, reducing the actual discharge time to less than one tenth of a second, and permits partial discharge starting from one-minute-intervals.



With GEA hydrostop even small volumes can be discharged reproducibly for much higher yields and better quality.



Metering piston ejection system for precisely metered discharge quantities.

Metering piston discharge technology

The metering piston ejection system on GEA centrifuges offers advantages:

- When very precise partial ejections are not required
- When only a low operating water pressure is available (2 bar)
- When minimal operating liquid consumption is desired

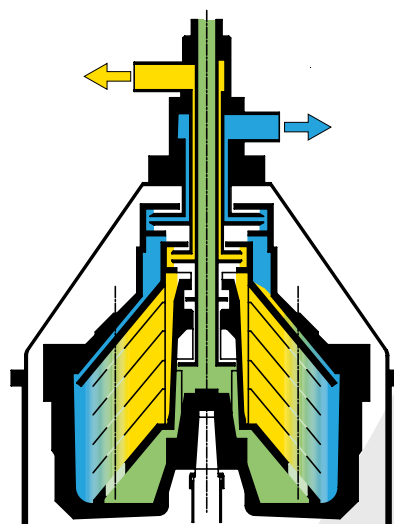
The mechanism ensures complete discharges of the bowl and, in this way, allows a high level of operating reliability. After the metering device has been filled with the exactly pre-set quantity of water compressed air is led into the lower chamber of the metering device. When the opening water valve has been operated, the compressed air acts on the piston of the metering device, and the set quantity of water is injected into the opening chamber. This ensures very precise discharge quantities to be achieved.

Centripetal pumps

The centripetal pumps enable the separating zones to be set precisely even in conjunction with very high density differences. This is the only way to achieve optimum separating efficiency with nitroaromatic compounds. If the light phase is valuable, the separating zone can be positioned towards the periphery of the bowl, whereby the light phase can be allocated to the maximum clarifying area.

At the same time, the twin centripetal pump can discharge the heavy phase under pressure in an enclosed system. This is a major advantage particularly in the case of explosive or aggressive media. Unlike processes that discharge under gravity, nothing can be discharged onto the hood of the centrifuge, avoiding the risk of corrosion.

No electric pump, no costs: The mechanical centripetal pump consists of a cylindrical disc equipped with channels and is installed in the so-called centripetal pump chamber of the rotating bowl. It is stationary, and its external periphery is immersed in the rotating liquid. The liquid is discharged towards the center of the pump through the channels, and the rotational energy of the liquid is converted into pressure. This means that an additional pump is not necessary, thus achieving savings in investment and operating costs.



*The pair of centripetal pumps for maximum separating efficiency.
Image: solid-wall bowl*

Decanter centrifuges

Decanter centrifuges have been developed over decades by GEA for high clarifying performance and the maximum possible degree of solids dewatering. Essential conditions for this include, among others, high bowl speed and an adequate gear torque in conjunction with a control system to synchronize differential speed and solids load.

Decanter separation principle

The product enters the decanter centrifuge through the feed tube and the distributor conveys it into the separating chamber where it is accelerated to operating speed. The centrifugal force quickly causes solid particles to sediment on the bowl wall. The cylindrical section of the bowl allows for an effective clarification of the liquid, whilst the solids are dried in the conical section. The scroll rotates slightly faster than the bowl shell and conveys separated solids continuously towards the narrow end. Due to the conical shape there, the solids are lifted from the liquid, dewatered by centrifugal force and discharged.

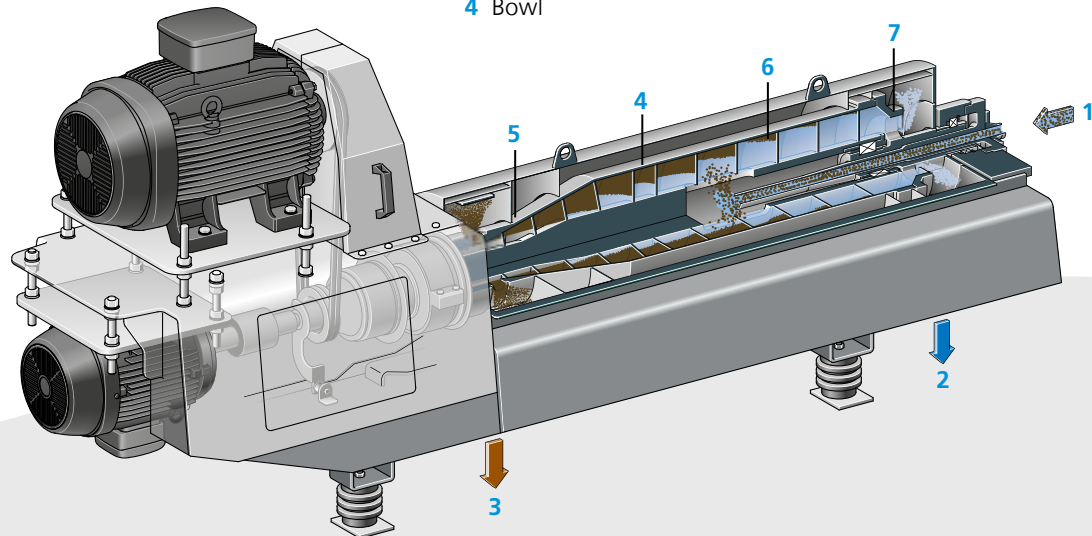
The liquid flows to the opposite end. Remaining impurities are spun out by centrifugal force as the liquid flows through the clarifying zone and is conveyed by the scroll to the solids discharge. The clarified liquid is discharged by centripetal pumps or gravity.

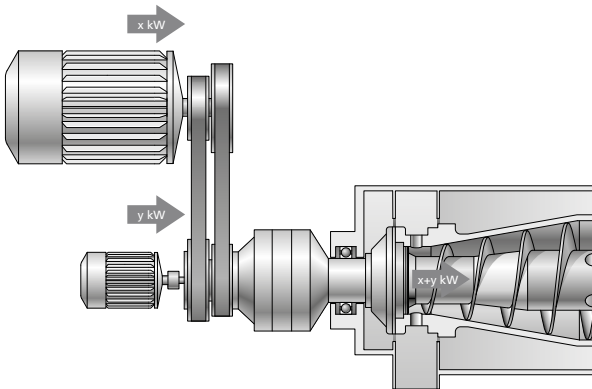
Decanter centrifuges are equipped with 3-phase AC motors with frequency converter. This allows start-up current and current peaks on start-up to be reduced. The power is transferred by belts and gear.

The current GEA **ecoforce** decanter generation is extremely robust and uniquely combines excellent performance with a significant reduction of power consumption. Machines can be adapted and even subsequently modified to individual process needs with 2-phase or 3-phase design, varying gear sizes, lubrication systems, differential speed ranges, bowl designs and liquid outlets.

2-PHASE DECANTER CENTRIFUGE

- | | |
|------------------------------|--------------------|
| 1 Feed | 5 Conical section |
| 2 Clarified liquid discharge | 6 Scroll |
| 3 Solids discharge | 7 Regulating rings |
| 4 Bowl | |





GEA summationdrive with intelligent kinematics ensures high differential speeds and torques, which enables processing of high solid capacities.

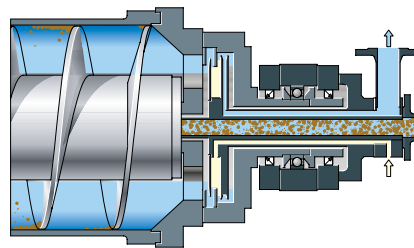
GEA summationdrive

The decrease in power consumption of up to 30 percent is mainly realized by the GEA **summationdrive** available as a standard in all GEA models. This high-torque drive with intelligent kinematics for high differential speeds and constant torques reliably provides the optimum differential speed for the specific process, which in turn ensures maximum performance and high separating efficiency.

- Full torque up to the maximum differential speed for high solid capacities
- High efficiency since variable-speed motor feeds energy and does not brake
- Automatic adaptation of the differential speed by frequency-controlled motor
- Good accessibility to all drive parts
- Changing differential speed without replacing the complete gear

GEA varipond

The pond depth in the decanter is an important parameter with which various performance parameters can be influenced. The GEA **varipond** system gives the user the opportunity to alter the pond depth to GEA **varipond** adapt to specific conditions during ongoing operation. The GEA **varipond** disk dips into the clarified liquid phase directly in front of the regulating ring. This disc forms a hermetic chamber (GEA **varipond** chamber) together with the centripetal pump, to which pressure can be applied through a hole in the feed tube. Since the liquid level between the GEA **varipond** disk and the regulating ring is defined by the overflow diameter, overpressure in the GEA **varipond** chamber has the effect of enlarging the pond depth in the bowl according to the principle of communicating tubes. As a result, the clarification area is enlarged. The process operator can thus adjust dewatering and clarification efficiency with precision. Particularly in the case of gas-tight decanter centrifuges, the GEA **varipond** system has the advantage that it requires no mechanically adjustable parts such as rotary joints. It therefore provides a high level of protection against discharging harmful gases.



GEA varipond system for efficient and cost-saving operation, particularly in the case of changing feed conditions.

Maximum-protection solutions

High-temperature and high-pressure applications

Many applications in the chemical industry require operating the process at elevated temperatures, for example hot wax clarification, production of amines, petrochemical additives, catalyst recovery and fluid gases.

As a solution, GEA offers continuous high-temperature clarification with specially designed centrifuges. The pressure-stressed components hood, solids catcher and protective hood have been rated to meet the specific requirements of the European Pressure Equipment Directive and the American ASME code.

By way of example, nozzle separators can only separate particles suspended in viscous liquids effectively when their viscosity is reduced by increasing the temperature, in some cases to around 190 °C. Since many carrier liquids would evaporate at these temperatures at atmospheric pressure, the pressure must be kept at around 10 bar. Pressure-proof segregation of the product space from the drive chamber is achieved by means of a double-acting slide-ring packing. Stainless steel alloys are used as standard for process-wetted parts. Depending on model, nickel-based alloys are also available, as are suitable elastomers like FKM and FFKM or other specific gasket materials.

Self-cleaning disk stack centrifuges are successfully used in applications at process temperatures up to 140 °C. This proves high mechanical reliability. Special care is taken on the choice of materials, especially gaskets. Development of new polymer materials now makes it possible to use polymers for the bowl main gaskets instead of expensive steel-on-steel gaskets.

Wear protection with robust hard-facing

Many processes expose decanter and disk stack centrifuges to extreme material strain. For maximum wear protection, GEA installs hardfacing as required to all points of a decanter where increased levels of wear can be expected, particularly when the machine is used for processing very abrasive solids.

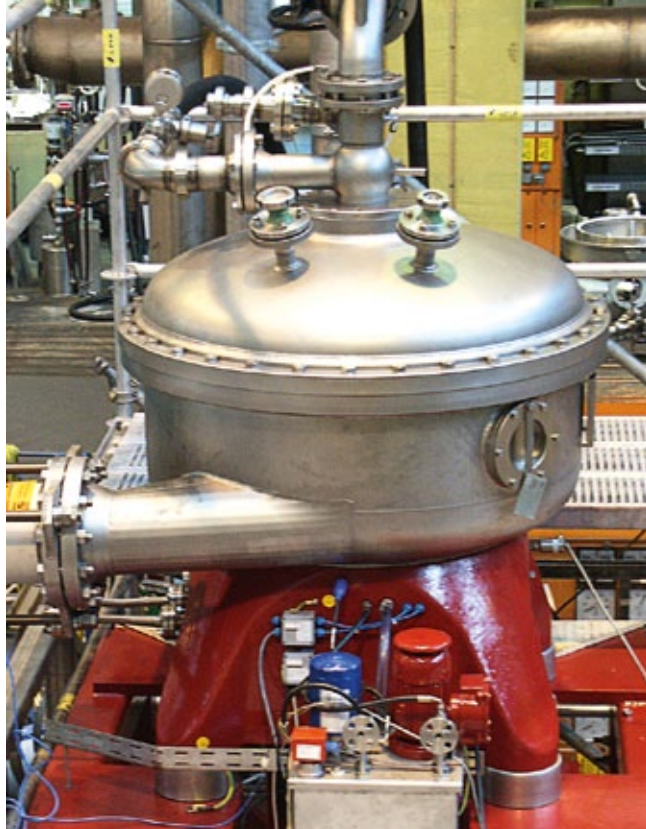
One possible solution is spray cladding in which carbide is welded onto the exposed parts of the centrifuge, for example:

- The vane of a decanter scroll
- The distributor of different centrifuge types
- The sliding piston of a self-cleaning separator

Other wear points particularly well protected by GEA are the points at which the solids are discharged through the solids discharge ports, and the suspension inlet holes of the distributor. However, these ports are not protected in the same way, as even hard metal welded on to the surface in this area would erode over a relatively short period and would require expensive repair work. Instead, GEA uses special sintered hard metal sleeves that provide a much higher abrasion resistance. These sleeves wear down on one side but can be easily turned around. Users must replace the sleeves only when both sides are worn. This requires much less maintenance compared with welding and results in considerably higher availability of the decanter. An elegant and customer-oriented method of ensuring that wear on the solids discharge is manageable.

Special materials

The proper tool for the job – this is the principle according to which GEA selects materials, considering corrosion resistance as well as mechanical strength. Because mechanical strength can be extremely important, suitable centrifuge materials are accordingly selected with utmost care and in some cases specially developed by GEA experts.



Standard materials offered by GEA are stainless steel alloys and, depending on the type of centrifuge, nickel-based alloys:

- Duplex or in some cases Super-Duplex for disk stack centrifuges
- Duplex, Super-Duplex or Hastelloy for decanter centrifuges
- Inconel for especially corrosion-proof components
- Hastelloy or e.g. Incoloy for solid-wall bowl centrifuges with cladding

Explosion-protected centrifuges

Centrifuges are used in the chemical industry for clarifying and separating flammable liquids. Theoretically, such applications can result in critical concentrations of solvent vapors and oxygen inside the centrifuge housing that can cause explosions or fires. Furthermore, process vapors must not leak from the centrifuge as not to pose a risk to the health of operators and the environment. Both these risks can be prevented reliably by using gas-tight centrifuges from GEA. No sparks, no static charges, no hot bearings – the test criteria of the strict European ATEX standard are of course implemented in all GEA explosion-protected centrifuges. In addition, before the start of operation, the centrifuge is purged with inert gas and blanketed with a slight excess pressure so that no further oxygen can penetrate. This is because fire is not possible without oxygen. When processing hazardous liquids, the necessary inert gas atmosphere in the centrifuge is automatically monitored throughout the entire operation.

An essential design feature of the gas-tight centrifuges from GEA is the gas-tight sealing chamber that separates the drive area from the product chamber. This sealing chamber is blanketed with inert gas, and the connecting spindle is protected with dynamic special seals. The sealing chamber reliably prevents the solvent from passing from the product chamber to the drive area or into the environment. This is beneficial not only from the point of view of fire and health protection, it is also not possible for solvent to dilute the oil, which would diminish its lubricating efficiency and thus pose a risk to the drive unit. In reverse, no oil can penetrate the product chamber and impact the quality of the valuable product.

According to the current ATEX 2014/34/EC directive, a risk assessment of the relevant machines must be carried out to identify any present or potential risks. Measurements are documented and submitted to an Entitled Body. For this, GEA centrifuges are equipped with failsafe vibration monitoring equipment and often also with a bearing temperature measurement unit and an inert gas supply unit. All electrical equipment carries an ATEX certificate or a manufacturer's declaration.

Improved inert gas concept

Requirements about safety and reliability are becoming more stringent for centrifuges used in zones with a risk of explosion. The inert gas concept from GEA is constantly improved to meet these requirements. The atmosphere in the centrifuge

is displaced with inert gas before every start-up and the excess pressure is maintained during operation to meet the requirement for minimum inert gas consumption. The fittings and measuring devices used have been subjected to extensive tests and have also been optimized as far as investment costs are concerned. The new inert gas supply facility complies with the ATEX 2014/34/EC directive but also with the TA Luft, which means that product leakages from the equipment are reduced to a minimum using state-of-the-art technology.

GEA places great emphasis on complete and easy-to-understand operator documentation as well as a carefully performed conformity assessment procedure (CE symbol). The company also provides information concerning the correct installation of centrifuges in zones that are exposed to the risk of explosion. Depending on the plant operation, the integration of a gas-tight centrifuge varies from plant to plant. With GEA expertise, our customers will find the optimum solution for their particular needs.



CE 346 package unit



GEA Service – For your continued success

GEA Service offers dedicated teams of service experts. Our focus is to help our customers build, maintain, and improve their performance, market presence and competitive edge for the entire life cycle of their plants and equipment.

Partnering with GEA gives you the benefit of our world-renowned, customer-tailored service and recommended spares upgrade, modernization and optimization services. With our support you can be certain that every piece of GEA equipment and technology will operate optimally from day one, and for its complete lifespan, to give you maximum return on your investment.

- Getting you started – Seamless support for instant productivity and performance
- Keeping it running – The cost-efficient way of ensuring safety and reliability
- Constantly improving – Sharing our knowledge to safeguard your investment
- Together with you – Enduring commitment to you and your business

We live our values.

Excellence • Passion • Integrity • Responsibility • GEA-versity

GEA is a global technology company with multi-billion euro sales operations in more than 50 countries. Founded in 1881 the company is one of the largest providers of innovative equipment and process technology. GEA is listed in the STOXX® Europe 600 Index. In addition, the company is included in selected MSCI Global Sustainability Indexes.

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