

Instant coffee

Process technologies for the instant
coffee industry



Turning raw materials into finished products



Green bean treatment

Solutions for cleaning, blending and storage using technology from selected partners



Roasting

Solutions for batch mode or continuous operation and storage using technology from selected partners



Roast bean treatment

Grinding and conditioning of the roasted product



Extraction

Batch mode or continuous operation



Extract treatment

Clarification, storage and aroma recovery from the coffee extract

**Concentration**

Freeze concentration and evaporation

**Liquids****Freeze drying**

Complete solutions for freeze dried coffee

**Agglomeration**

For low dust powder and customized granules

**Spray Drying**

Complete solutions for spray dried coffee

CIP System

Fast and flexible Clean-in-Place features

Packing

Powder: Packed in bulk or retail quantities
Liquid: Supplied in cans or drums

Process control

Plant supervision and monitoring, recipe control, logging functionality

Solutions for high quality instant coffee production

GEA is a world leader in instant coffee technology. With decades of experience in this field, our expertise within spray and freeze drying, evaporation and freeze concentration, extraction, extract treatment, aroma preservation, agglomeration/granulation, and powder handling and packing is unrivaled.

So, whether the instant coffee is to be a granulate, a fine — or coarse — powder or in liquid form, a GEA instant coffee plant offers the best solution. GEA equipment and process lines are used by producers of instant coffee all over the world.

As a solutions provider, no one knows more about processing instant coffee than GEA. Our expertise and production technology, combined with our plant design knowledge and engineering experience, deliver high quality product with defined properties and strong natural flavors.

Proven ability

We have maintained our leading position by repeatedly proving our ability to provide reliable and innovative technical GEA solutions for the entire process from product testing to plant installation and after sales support.

Our constant focus on providing cutting-edge quality to our customers is the main reason why we have installed more than 200 GEA plants for the instant coffee industry worldwide.

A complete range

We supply solutions for all aspects of successful coffee production, making us the obvious supplier of individual GEA plant as well as complete lines. Our solutions include our own unique GEA technologies as well as equipment from trusted partners in coffee bean handling, roasting, and packing of the finished product.

Our customers frequently benefit from higher product quality and significant cost reductions owing to efficient waste treatment and recycling systems.

Furthermore, our commitment extends beyond the actual plant. A strong international network of companies gives our customers the comfort of local service combined with the quality that comes from a global presence.

Quality engineering solutions at a glance

With data gathered from more than 80 years of experience and a reference list of some 10,000 installations, we're perfectly equipped to engineer the exact product you want from your coffee — and the processes needed to produce them.

Our coffee powder engineering specialists will help you to design the ideal system for your needs — including dedicated process control — that meets precise specifications. In addition, using our advanced “gentle processing” technology, the coffee’s natural essence is retained, guaranteeing outstanding quality and flavor for your final product.

Partnering for success

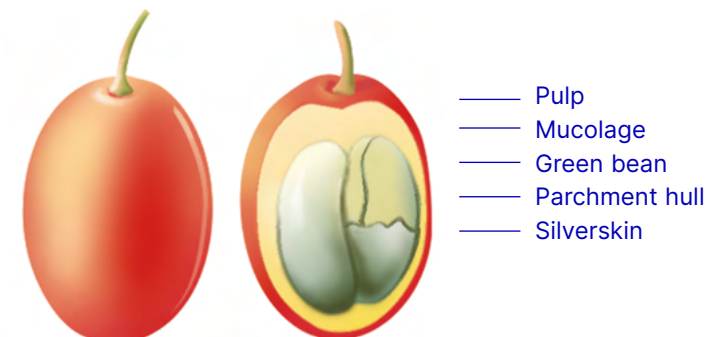
We have the experience and know-how to ensure that every stage of your project is completed as smoothly as possible, including

- product testing at our test station in Denmark
- process evaluation and optimization
- design and engineering
- project management
- plant delivery, installation and commissioning
- operator training
- technical service and the supply of spare parts
- project financing

Ultimately, our goal is to help you to stay ahead of the competition with superior product quality, high productivity and high-yield processes.

With market demands changing all the time, the coffee industry is dynamic. So, whether you need a new investment, process modification or optimization, it's all part of the GEA solution. From advanced equipment to full integrated plant design, from feed formulation to competitive powders and from sanitation to safety, GEA has the answer.

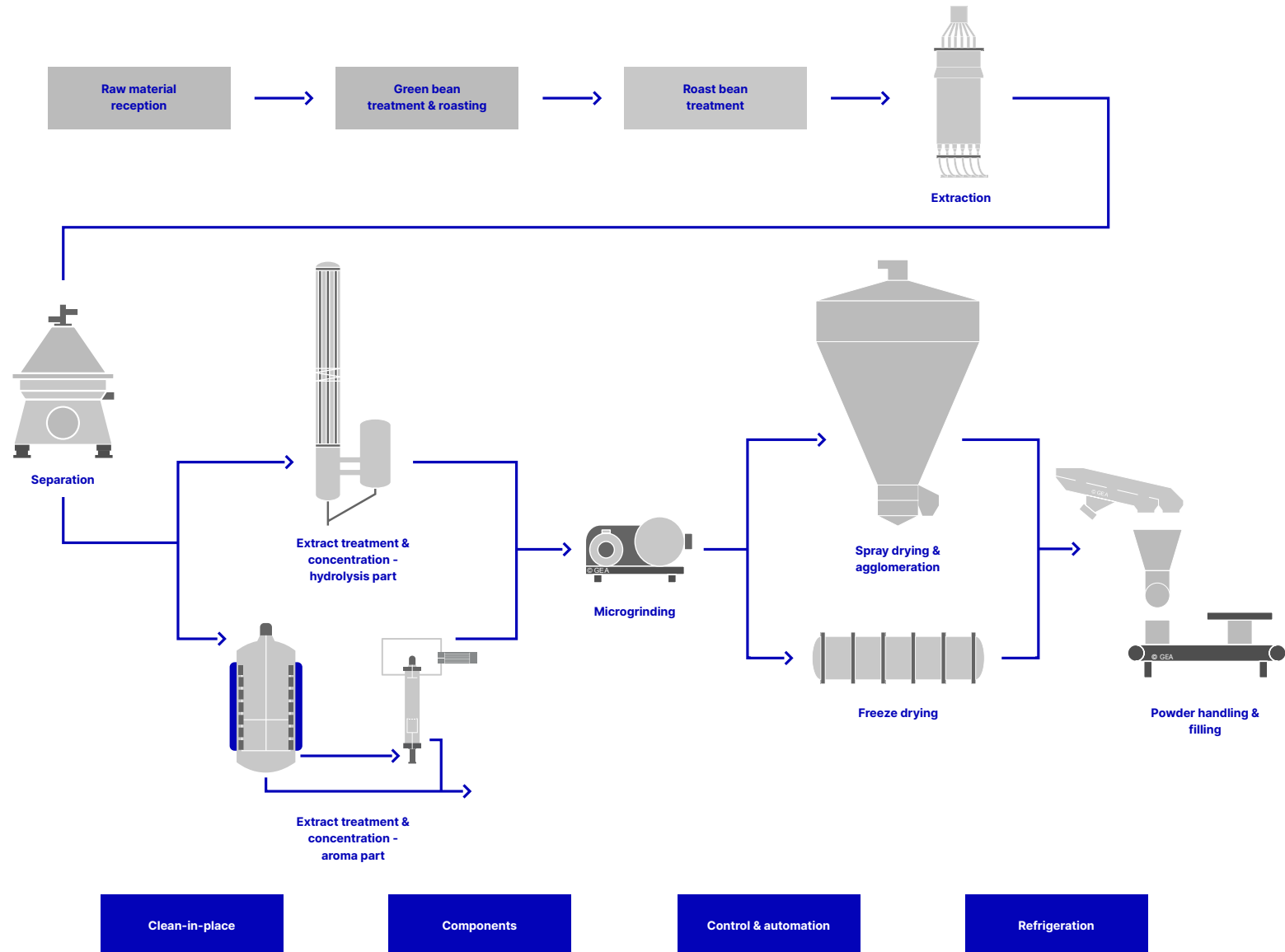
Coffee cherry



Coffee facts

Coffee beans are seeds from the fruit of the coffee bush. When roasted, the beans lose 15–20% of their weight, but increase up to 25% in size.

Technology overview



Technology overview

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Instant coffee extraction

No matter how you process your coffee beans and whatever the yield, aroma is key. For great-tasting coffee, the more of that aroma you can extract, contain and preserve, the better the final product.

Time and temperature play a significant role in determining the quality of the aroma. Short extraction times at moderate/low temperatures deliver high quality extracts.

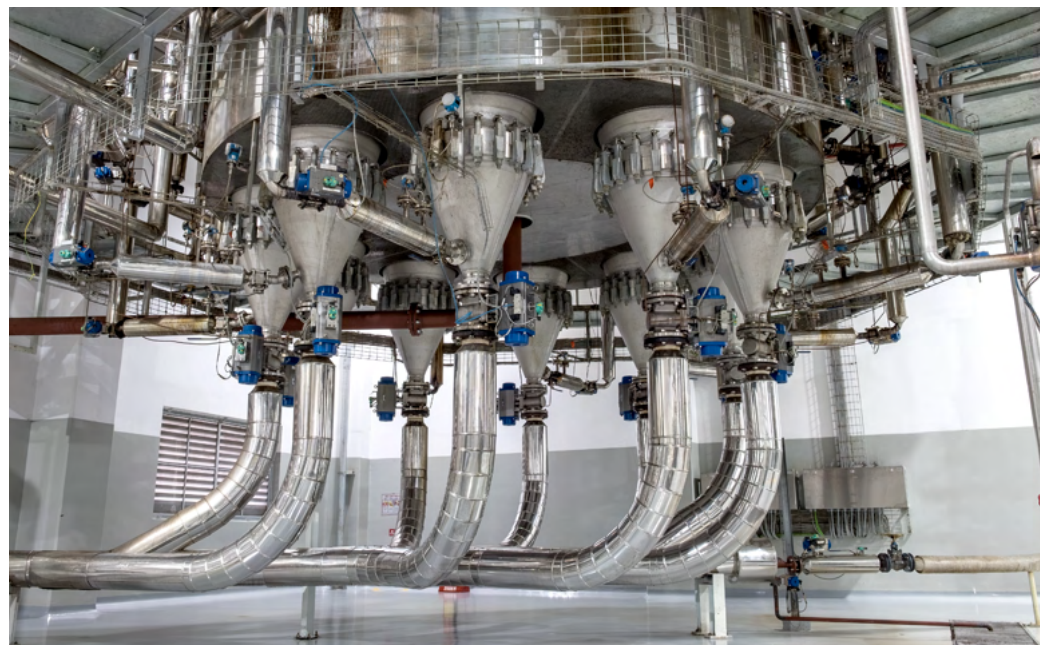
The FIC® provides a fast, turbulent water flow around the coffee particles to enhance the extraction rate at the desired temperature. The CARINE, employing prolonged extraction times and higher extraction temperatures, has been developed for customers wishing to obtain the highest possible yields.

Designed for high performance

Eliminating the need for manual operation, the compact and fully automated FIC® and CARINE ensure precision processing that meets the world's highest standards. With an integrated PC/PLC (Programmable Logic Controller) system, the FIC® and CARINE offer easy operation and uniform extract quality.

Furthermore, every FIC® and CARINE component is designed to the highest manufacturing standards for efficient, long-lasting performance.





GEA CARINE extractor – bottom view

Flexibility, high yield: CARINE

Compared with the FIC®, the CARINE extraction plant is equipped with ten percolator columns. The two additional columns operate at a higher temperature, 185–195 °C, resulting in the highest possible yields of approximately 60%.

After the high temperature treatment, the extract is cooled to approximately 160 °C to avoid the formation of off-notes. Following the extraction (hydrolysis) process, the extract is harvested at a temperature of 140 °C before cooling, and the freshly roasted coffee is separated at moderate temperatures of approximately 130 °C to obtain a high-quality aroma extract.

If required, the CARINE can also operate in FIC® mode to obtain a higher quality end product. As such, users have the option of maximizing yield or maximizing quality in FIC® mode, depending on the requirement and application. For ultimate flexibility, the CARINE is the plant of choice.

Key points: CARINE

- High yields
- Extremely versatile
- Can also operate in FIC® mode
- High temperature operation
- High quality
- Process capacities of 125–1500 kg/h soluble solids

Fast extraction, high quality: FIC®

The highly efficient FIC® delivers a high yield (up to 53%) with better quality attributes than other equipment. In addition, the FIC® performs 50% faster than conventional manual extraction methods.

The fully automated, continuous FIC® extraction system comprises eight percolator vessels that operate in a flowing battery design. What's more, this highly flexible system can perform in a variety of different modes for a wide range of coffee types.

Operators can choose between one, two or all three modes of operation — and easily change from one mode to another — to create a finished product that meets the specific requirements of your market and application. Considering the best finished product starts with the best extraction — and the best extraction is closely tied to extraction time — the FIC® ensures you're always up to speed. The FIC® can do it all.

Key points: FIC®

- Three modes of operation
- Full- and pilot-scale plant available
- Fast extraction
- High quality
- Process capacities of 125–1500 kg/h

CONTEX extraction solutions

The continuous countercurrent extraction process has been a focus of dedicated research and development for many years at GEA, resulting in the successful application of the technology to a wide range of coffee products.

We now offer six standard plant sizes with volumes of 27, 180, 300, 830, 1400 and 2750 L. Incorporating four extraction steps in one, this versatile yet robust equipment offers short extraction times and higher quality extracts in a continuous process. Eliminating the need for a decanter and reducing the number of concentration stages means the process is more cost-effective and efficient.



GEA FIC® extractor – top view

Gentle liquid processing: extract treatment

Whereas other available systems involve working with the whole coffee extract, the GEA process actually separates the good aromas from the bad ones, which results in a higher quality end product.

Aroma recovery

To prevent the loss of valuable aroma components during thermal concentration, the extract is stripped of its volatiles in a flash evaporator. During evaporation, the flashed off aroma mixes with flashed off water. The combined mixture of aroma volatiles and water vapor is then further concentrated (up to 10 times) using a distillation column. The resulting aroma distillate is recovered in a two-stage condenser system, kept cold and subsequently added back to the coffee concentrate prior to the freeze or spray drying stage.

Clarification

To comply with international standards for convenient coffee, clarification is an essential part of the process. A system consisting of filters and centrifuges is used to separate insoluble parts from the extract.



GEA aroma recovery plant

Evaporation: extract concentration

As the coffee extract is a thermally sensitive product, mild processing conditions throughout the concentration step are essential. Concentration by evaporation is an important and highly energy efficient dewatering step that maximizes the solids content of the extract prior to freeze or spray drying. In our multi-stage evaporators, the water is gently removed under vacuum at low temperature keeping the original coffee extract taste.

GEA evaporators are designed to maintain all the parameters required to achieve the highest quality of the final product. Many of the functional properties of powders, such as solubility, heat stability and the WPNI index, are determined during evaporation, and can only be achieved by carefully managing the heating and handling processes.

The design of our evaporator systems ensures that the highest product quality is maintained with optimal energy efficiency with extended operating cycles. They are equipped with either mechanical vapor recompression (MVR) or thermal vapor recompression (TVR) for this purpose. Our design fulfills our customers' highest requirements for technology, product quality, energy efficiency and environmental sustainability.

Microgrinding

To prevent the loss of valuable aroma components, the microgrinding of roast coffee beans is done just before the concentrated coffee extract is dried. This wet grinding technique operates at a low temperature so that it captures and preserves both the flavor and aroma of the coffee bean, producing an even better tasting product and a unique drinking experience.

It also increases both the overall yield of the coffee beans and the capacity of the dryer. The GEA MicroWet grinding system can be integrated within an existing coffee line or work as a standalone system.



GEA MicroWet grinding system



GEA's IceCon® freeze concentration system

Freeze concentration

In high end markets, wherein maximum quality retention is a key driver, freeze concentration provides an optimal solution for concentrating coffee extracts.

GEA's IceCon® freeze concentration system ensures gentle coffee extract concentration without thermal impact on the product owing to its subzero processing temperatures. Moreover, as water is converted into pure ice crystals and these are efficiently separated from the concentrate, there are no detectable aroma losses included in the separated ice.

The system can run for weeks without cleaning and provides easy and efficient operation. Freeze concentration is most effective for concentrating aroma-rich, high-quality extracts. Blending with evaporated hydrolysis will provide an extract that's suitable for spray or freeze drying.

Freeze drying for a premium product



GEA CONRAD® freeze dryer

To prepare the freshly concentrated coffee for freeze drying, it is cooled, foamed and subsequently prefrozen. The prefrozen product is then pumped and fed to a belt freezer (continuous air blast freezing) or a rota freezer to produce a solid phase (deep frozen flakes), which is then granulated, sieved into desired granulate size and shape and automatically charged into trays.

The filled trays leave the cold room and enter the vacuum lock of the freeze dryer. Here, they are stacked and conveyed horizontally through the different temperature sections of the drying tunnel. Finally, the dried, granulated instant coffee leaves the freeze dryer through the outlet vacuum lock for further processing, such as oil spraying, metal detection and subsequent packing (bulk or directly into jars).

Benefits include

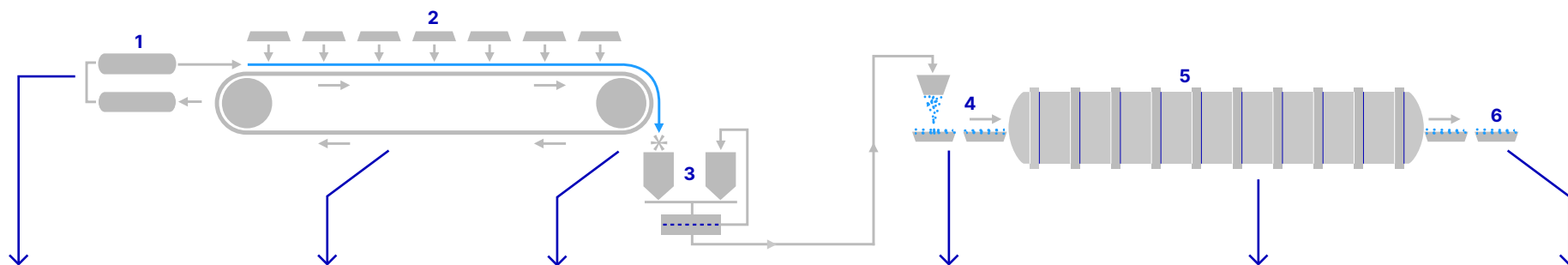
- Fully continuous and automatic operation for the CONRAD® solution
- Automated color and density control
- Optimized energy consumption
- Integrated plant design

Using our proven Structure Control System (SCS) for the prefreezing and foaming process, product color, solubility and bulk density can be controlled to meet any specific requirements. Subsequent freezing can be done using our Continuous Air Blast (CAB) belt freezer or our Rota Drum freezer.

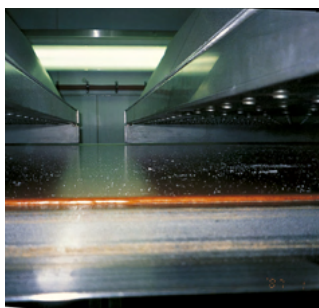
Granulating the frozen coffee slabs using a carefully designed system ensures the right granule size and distribution and optimizes the process prior to freeze drying.

Freeze drying preserves all the desirable aspects of the concentrated coffee extract. The finished product commands a premium price by meeting market demands for quality parameters such as shape, size color, density and moisture.

Ideal for both batch-based and continuous lines, our easy to use RAY® and CONRAD® units enable a unique degree of control over all of these crucial quality parameters and are designed to eliminate product loss, reduce energy costs and maximize plant reliability.



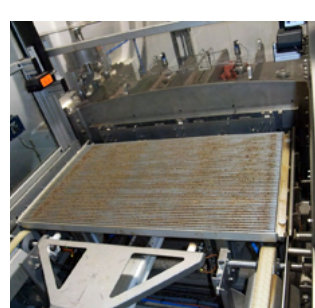
1. Foaming and prefreezing



2. CAB freezing



3. Granulation



4. Freeze drying – tray going into the Atlas CONRAD® freeze dryer



5. Atlas CONRAD® freeze dryer



6. Freeze drying – tray with the finished product

CONRAD® freeze dryers are ideally suited for large volume, high value products. The CONRAD® range is fully automated and requires only minimal staff for continuous operation. All movement and process parameters are carefully controlled, monitored and logged. Protecting all the qualities obtained in the concentrate, a consistently first-class instant coffee is produced thanks to the integrated entire-process control system.

A unique feature of all GEA freeze dryers is the internal vapor condenser with a built-in deicing system. Compared with external condenser systems, the equipment is compact, uses up to 40% less energy, minimizes product loss to as little as 0.1% and, because the condenser system does not

rely on large external vacuum valves, it's significantly more reliable. In addition, they're economical to operate and easy to maintain.

To further optimize the productivity of the CONRAD®, an ECO version is available; with a larger diameter and an increased condenser surface, the refrigeration system can be made up to 10% more energy efficient.

Our RAY® batch freeze dryers are used for smaller capacity requirements or as add-on units to existing coffee processing plant. Designed as modular systems for batch-based applications, RAY® freeze dryers offer several advantages during installation and operation, and provide easy access for cleaning and maintenance.

Refrigeration

An absolute prerequisite at the freeze-drying stage is refrigeration, when precise temperature control helps to ensure that the instant coffee product retains its key characteristics, as well as optimizing energy consumption. Designed for any stage of instant coffee processing, our portfolio further encompasses water chillers and industrial cold room refrigeration solutions that can be tailored to match your specific application, plant layout and available space.

Cost-effective spray drying

The most economical way to produce soluble coffee is spray drying, which results in free-flowing and agglomerated/granulated powders.

Thanks to a high level of control and GEA process know-how, our customers can manufacture products that meet and exceed the demands of their individual markets regarding bulk density, residual moisture, flowability, color and solubility.

GEA offers two types of spray dryers for the manufacture of spray-dried soluble coffee:

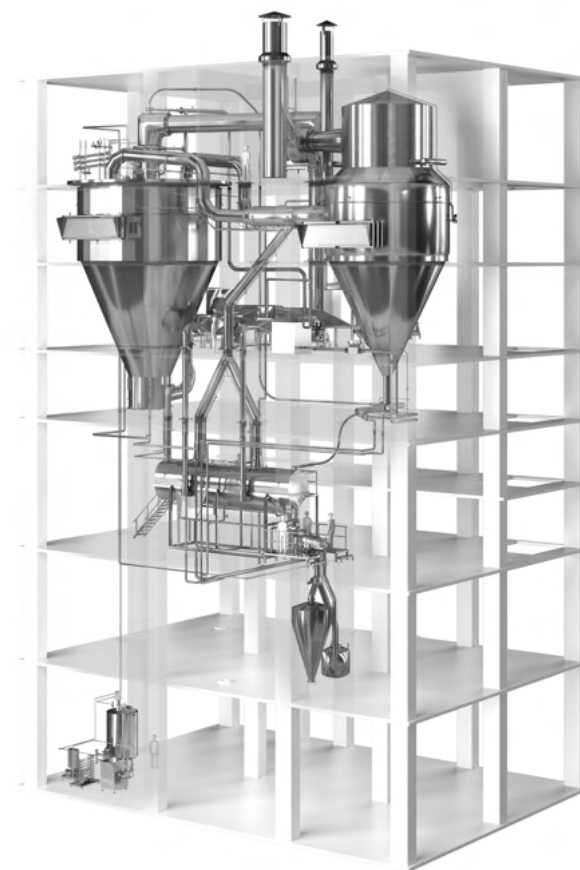
Nozzle Tower (NT) spray dryers have traditionally been used to produce free-flowing powders comprising individual round, soluble beads with an average particle size of 100–250 μm . The tower-like chamber design allows for a long residence time to dry the product in a single operation.

Fluidized Spray Dryer, FSD®: The most common type of spray dryer used today, the compact FSD® is equipped with an integrated fluid bed. To achieve the required moisture content and temperature, post-drying and cooling are

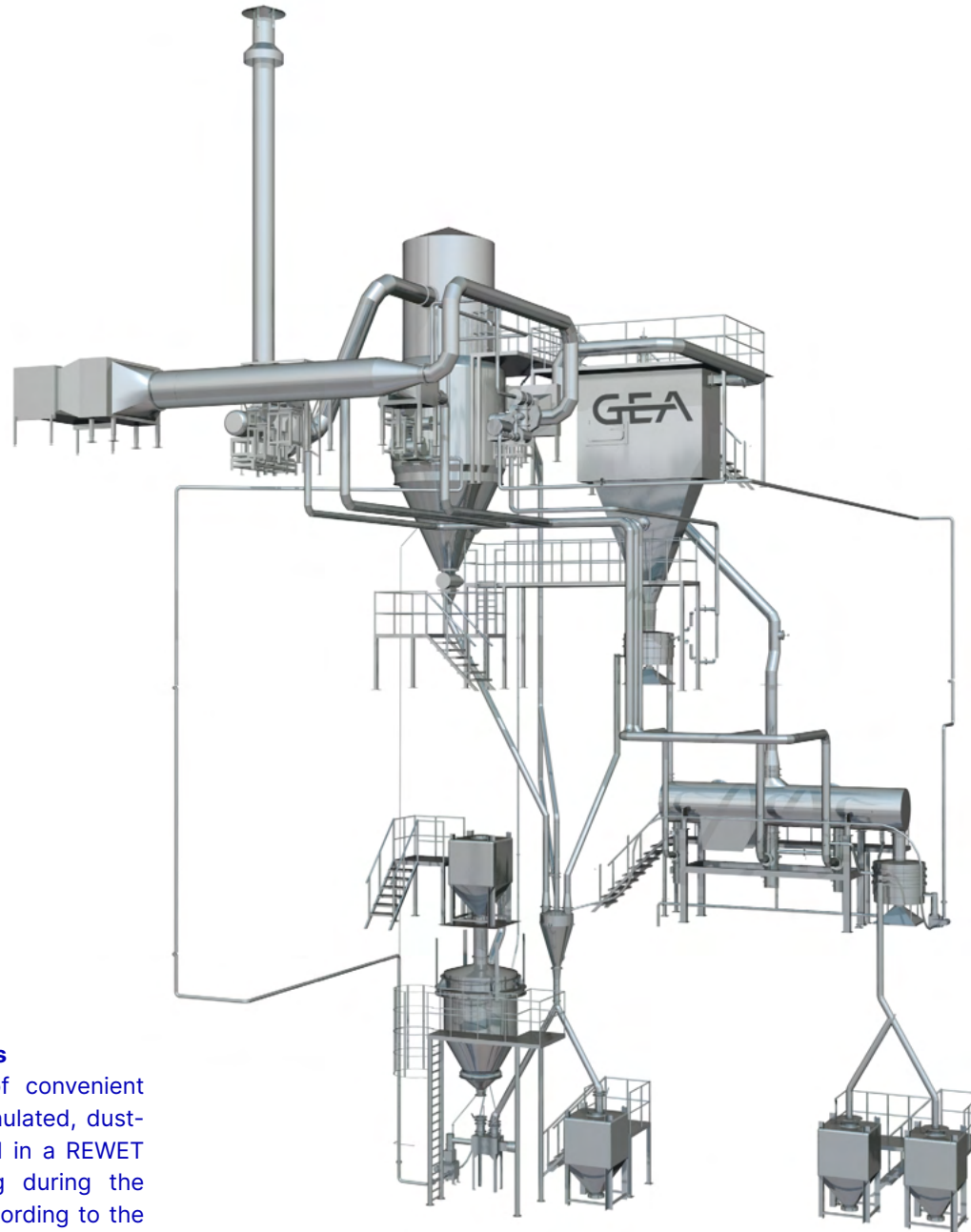
done in an external VIBRO-FLUIDIZER®. FSD®s produce a free-flowing agglomerated/granulated coffee powder with average agglomerate sizes of 100–300 μm . The lower temperatures used during drying give improved aroma properties.

All our spray dryers conform to the highest industry standards of hygiene, energy efficiency and plant performance to ensure safe operation and maintenance. Control and automation software continually monitor and adjusts in-process parameters to meet the requirements of the recipe and ensure repeatability.

Optimized for fast, effective cleaning and reduced downtime, our spray dryers offer gentle processing and controlled drying conditions that preserve both organoleptic and sensory properties. And, as every application is different, our test centers are available to help you develop and trial your new products and processes.



GEA FSD® spray dryer



REWET agglomeration for large agglomerates

Different markets require different types of convenient soluble coffee. To meet the demand for granulated, dust-free products, the powder can be processed in a REWET AGGLOMERATOR® (RWA). Material handling during the agglomeration process itself is controlled according to the desired properties of the end product (the average particle size is approximately 1400 μm).

GEA REWET AGGLOMERATOR®



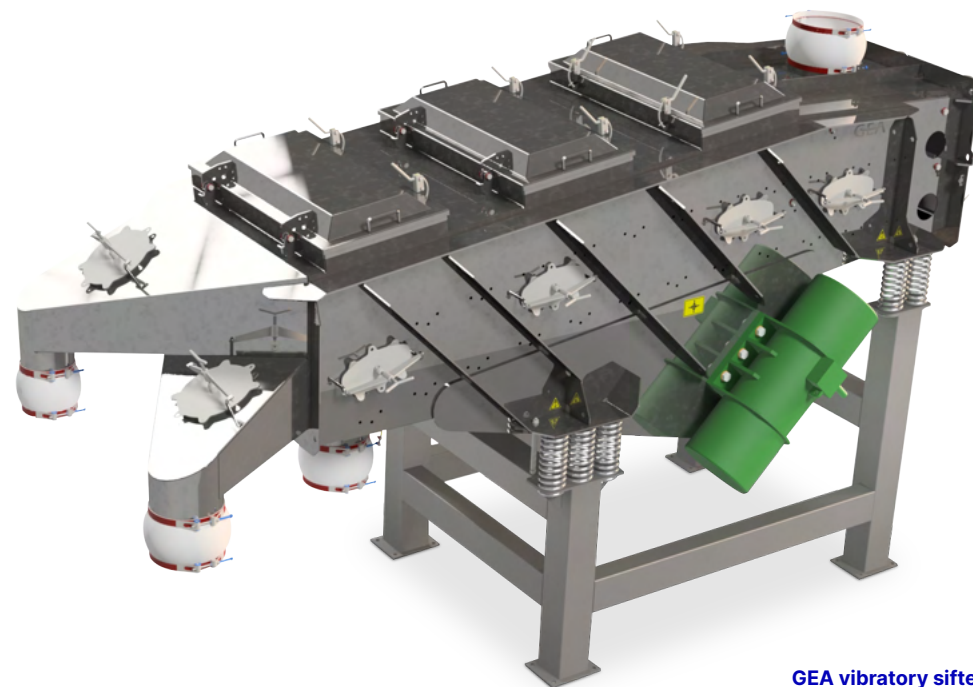
Powder produced on GEA FSD®



Powder produced on GEA REWET AGGLOMERATOR®

Product handling and packing

Following the main processing steps, powder handling and packing systems from GEA ensure that the finished product is handled safely and gently during storage, conveying and packing whilst ensuring critical quality characteristics are retained.



GEA vibratory sifter

Powder handling and packing is an important part of the instant coffee production process as this is when the product is at its most valuable and fragile. By bringing many unit operations together, plant and systems from GEA offer numerous benefits.

Precise dosing techniques ensure that the product is consistently uniform. For instance, a mounted feeder before the CONRAD® freeze dryer guarantees that a defined amount of coffee enters the equipment. An uneven layer would result in non-homogenous coloring and the batch would be discarded.

Accurate sifting also has a role to play. A sifter makes sure that the end product is uniform in size. Dust and oversized particles are removed before packing, thereby giving the end product a consistent appearance.

Furthermore, vibratory technology provides gentle handling of fragile products such as freeze-dried coffee during conveying, sifting or dosing, contributing to the required “edgy” shape and preventing the granules from becoming worn down and “rounded.”

In addition, GEA offers granulate sieving and conveying in cold room environments at temperatures as low as $-53\text{ }^{\circ}\text{C}$. Freeze-dried coffee prepared using a Continuous Air Blast (CAB) belt freezer is transferred to a granulator and then to our sifters, elevators and conveyors. Finally, a tray filler is used to feed the CONRAD® freeze dryer.

GEA's precision dosing and sifting machinery enables manufacturers to deliver a high-quality product. Plus, by incorporating vibration technology for conveying to other processing steps, there is less chance of the coffee

product suffering from physical or aesthetic damage during production.

GEA offers a range of solutions to fill coffee powders into bags and boxes. From low capacity manual systems to automated high volume lines, our machinery can be tailored to meet specific production requirements where we focus on minimizing product loss or damage, thereby protecting product quality.

Integrated case erection, liner insertion, sealing and closing systems can also be included to provide a complete solution for filling and handling. At the end of the line, we can also provide case handling, labeling and palletizing for a turnkey process.

Pilot plant and test facilities

GEA test facilities help you to achieve greater confidence in the safe and repeatable production of your instant coffee products prior to market release.

To minimize product development risk, GEA's center of excellence in Copenhagen, Denmark, offers customers access to laboratory and pilot plant facilities and a wide range of equipment to try out new recipes and work on process optimization and validation before investing in industrial-scale machinery.

Talk to us at GEA to test out our equipment for extraction, aroma recovery, freeze concentration, freeze drying, spray drying and agglomeration. With our state-of-the-art aroma management equipment, we can help you to monitor 50 of the most valuable aromas to optimize the quality of your product for the end-user.

RAY® Pilot Plant (PP) freeze dryer

Operated via a touchscreen, the RAY® PP is designed for hygienic processing and, as such, is easy to clean and maintain. Once product has been placed in the chamber, the process runs fully automatically and all vital parameters are monitored and stored to provide full documentation and ensure repeatability.

Although designed to operate at 0.2 mbar, the RAY® 1 can tolerate pressures as low as 0.1 mbar. In addition, the RAY® concept ensures short downtimes between batches, based on rapid evacuation times, effective deicing and efficient tray loading.



FIC® pilot plant

The RAY® PP offers the following economic and technical advantages:

- Gentle heat treatment
- Preservation of product structure and size, as well as key attributes such as color and nutrients
- Stable products with a long shelf-life
- High throughput and large capacity
- Condenser continuous deicing
- CIP-compatible hygienic design.

FIC® and CARINE Pilot Plant

Depending on the desired yield and quality, the versatile FIC® and CARINE Pilot Plant is designed to operate in three standard modes: dual-dual, dual-split and single-split. With a processing capacity of 5–7 kg/h of roasted and ground coffee, fast, batch-wise extraction is achieved using eight to ten columns (seven to nine in production mode and one in service mode).

The Pilot Plant uses a very efficient, high-speed, double extraction process, which means that the aroma compounds can be separated in as little as 15–20 minutes. The resulting aroma extract is of extremely high quality. Customer benefits include the ability to exercise hot and cold brew conditions, and run high yield CARINE-extractions.

More than just a plant

Typical sizes	IC-125	IC-250	IC-330	IC-550	IC-750	IC-1000	IC-1200	IC-1500
Green coffee input (kg/h) 10% H ₂ O	275-375	550-750	750-1000	1200-1650	1636-2250	2200-3000	2640-3600	3300-4500
Roasted, ground coffee (kg/h) 6% H ₂ O	240-330	480-650	635-860	1055-1430	1440-1950	1920-2600	2300-3120	2875-3900
*Yield % FIC® Extractor	47-53	47-53	47-53	47-53	47-53	47-53	47-53	47-53
*Yield % CARINE Extractor	55-59.5	55-59.5	55-59.5	55-59.5	55-59.5	55-59.5	55-59.5	55-59.5
Instant coffee (kg/h) 3% H ₂ O	125	250	330	550	750	1000	1200	1500
Annual production (t/year) Based on: 7500 (h/year)	940	1875	2475	4125	5625	7500	9000	11250

*Yield is a result of the type and mix of beans. Robusta will typically give a higher yield than Arabica.

Plant sizes

General operational data for GEA Instant Coffee (IC) plant is given in the table. Available sizes refer to the amount of kg that is produced each hour; for example, an IC-250 plant will produce 250 kg of instant coffee each hour.

Sustainability



Environmental protection and sustainability have become an essential part of any production process. In the instant coffee business, these concepts have now come into sharp focus and consumers increasingly demand processes that do not damage the environment or waste the Earth's natural resources.

As more and more organizations elect to follow the UN Sustainable Development Goals, they're increasingly relying on GEA's extensive know-how and technical insights to tackle climate change and preserve our oceans and forests.

GEA works continuously to refine its equipment and processes, leading the way in sustainability and helping its customers to build tomorrow's plant today. Key focus areas in the coffee production sector include decreasing both energy and chemical consumption, and the reduction of wastewater and water usage by recycling and reuse.

The use of heat pump technology in certain process steps can significantly reduce the need for non-renewable energy sources and provide tangible deliverables. We supply technology and application solution packages that ensure measurable benefits with a short payback time.

Consistent product quality reduces waste and the need to rework product, reduced emissions saves disposal costs and helps to protect the world's ecosystem, and the clever use of energy reduces utility expenditure and preserves fossil fuels.

By combining the strengths and process knowledge in applications such as freeze drying, refrigeration and heating for Sustainable Energy Solutions (SEnS), separation, filtration and digital solutions/capabilities, our unique insights ensure operational excellence, cost benefits and environmental responsibility.

Clean-in-Place (CIP) and process control

Controlling and monitoring a process line is an absolute prerequisite for any operator. GEA's proven process control system meets all requirements for safety, flexibility, hygiene and ease of use.

Using standard hardware components, the process system enables you to supervise and monitor automatic plant start-up, shutdown and cleaning procedures work with several product recipes in one system log every process activity for real-time and historical trending.

Instrument and system specifications are selected in co-operation with our customers to ensure the best hardware service during the lifetime of the plant. Cleaning, albeit necessary, can be an expensive and time-consuming part of the process. Drawing on more than 80 years of work experience with sanitary processes, GEA has developed a series of Clean-in-Place (CIP) systems.

With features such as retractable nozzles in the main drying chamber, as well as highly efficient process water recovery, the GEA CIP system makes a significant contribution to the profitability of the entire process line.



Advanced process optimization

Increased process stability and optimum performance from your instant coffee production line with GEA OptiPartner



GEA expertise helps you to get optimum performance from your instant coffee production line. GEA OptiPartner is a digital software solution that combines GEA's process design and operational know-how to optimize process and production lines. Using digital technologies, such as advanced machine learning algorithms, GEA OptiPartner increases the efficiency and productivity by reading the process data, applying real-time analytics, identifying the optimum operation point at a given process state, and generating new set-points leading to that point. In other words, GEA OptiPartner acts as an “autopilot” on top of the existing control system.

Benefits at a glance

- Process stability improvement
- Increasing plant availability
- Improving all key performance indicators
- Reducing the impact of variable operator skills
- Fail-safe operation even with semi-skilled staff

Focusing on productivity

We focus on improving your productivity by providing digital optimization modules for evaporation, foaming, CAB freezing, granulation and freeze-drying process units. For example, in freeze drying, our customized analytic

algorithms provide real-time optimization of residual moisture content on the final product. Similarly, the granulation module enables real-time reduction of fines flow and prediction of blocking conditions in the freezing process.

The various GEA OptiPartner modules are delivered all the way from development and implementation to support and maintenance, for a yearly subscription.

Real-time assistance, anywhere in the world

Be on-site when you're off-site with
GEA Remote Eye Wear

Specifically designed to enhance communication and provide real-time connectivity, GEA Remote Eye Wear offers an instant on-job support and troubleshooting tips from industry experts that reduce response times, almost eliminate travel costs and foster improved supplier-partner relationships.

For service engineers and technicians operating in the instant coffee field, the GEA Remote Eye Wear offers a range of functions. Once installed, an operator can hold a live conversation through the headset and microphone see what the user is seeing through the camera talk and send descriptions via the Chat function take "live" screen pictures and send it to the user's headset take a high-resolution picture, edit it and send it to the user's headset send full procedures in PDF format send pictures from his desktop and/or laptop.

Benefits at a glance

- Instant troubleshooting in real-time
- Extend equipment life-time
- Increase know-how of the equipment
- Reduce operational costs
- Maximize production time
- Minimize incidents

Scope of supply

Available as a standalone unit and as part of the GEA SLA framework, the product's scope of supply includes the Smartglasses, a spare battery, an email invitation for QR code registration, a microphone and earplugs, an access point router and full documentation. When no Smartglasses are available on-site, receiving support via a mobile phone is integrated.



GEA Remote Eye Wear

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