

Technologies for Processing
Value-Added Fruit & Vegetable Products

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Introduction

JBT is a prime solutions and equipment provider within the fruit and vegetable industry segment. From preparation to preservation, conveying and packaging, our comprehensive range of technologies captures the freshness, taste, texture, appearance and nutritional value of fresh and processed fruit and vegetable products.

JBT's global network of Research and Technology Centers is a unique resource that serves two key purposes: a place where customers can test and hone their processes, and where we can develop and refine our products.

Our Research and Technology Centers offer customers access to advanced technical expertise, application-specific data and state-of-the-art equipment and laboratories to test anything from cooking or freezing times to portioning, filling, cleaning and other processes. With eight locations in Europe, North America, South America and Asia, JBT Tech Centers provide customers with the ability to fine-tune their processes without stopping their own production lines.



Vegetable Puree & Juices

Consumers are demanding safer, more hygienic and healthier foods. While the share of conventional fruit juices in western markets is declining, a growing number of vegetable and superfruit based juices can be found in the beverage section of supermarkets.

Non-thermal and low thermal processing technologies like high pressure processing (HPP) have led to the development of more natural recipes with maximum retention of nutrients. JBT has developed equipment and processes to maximize yields from raw materials while optimizing the desired physical qualities of the product.

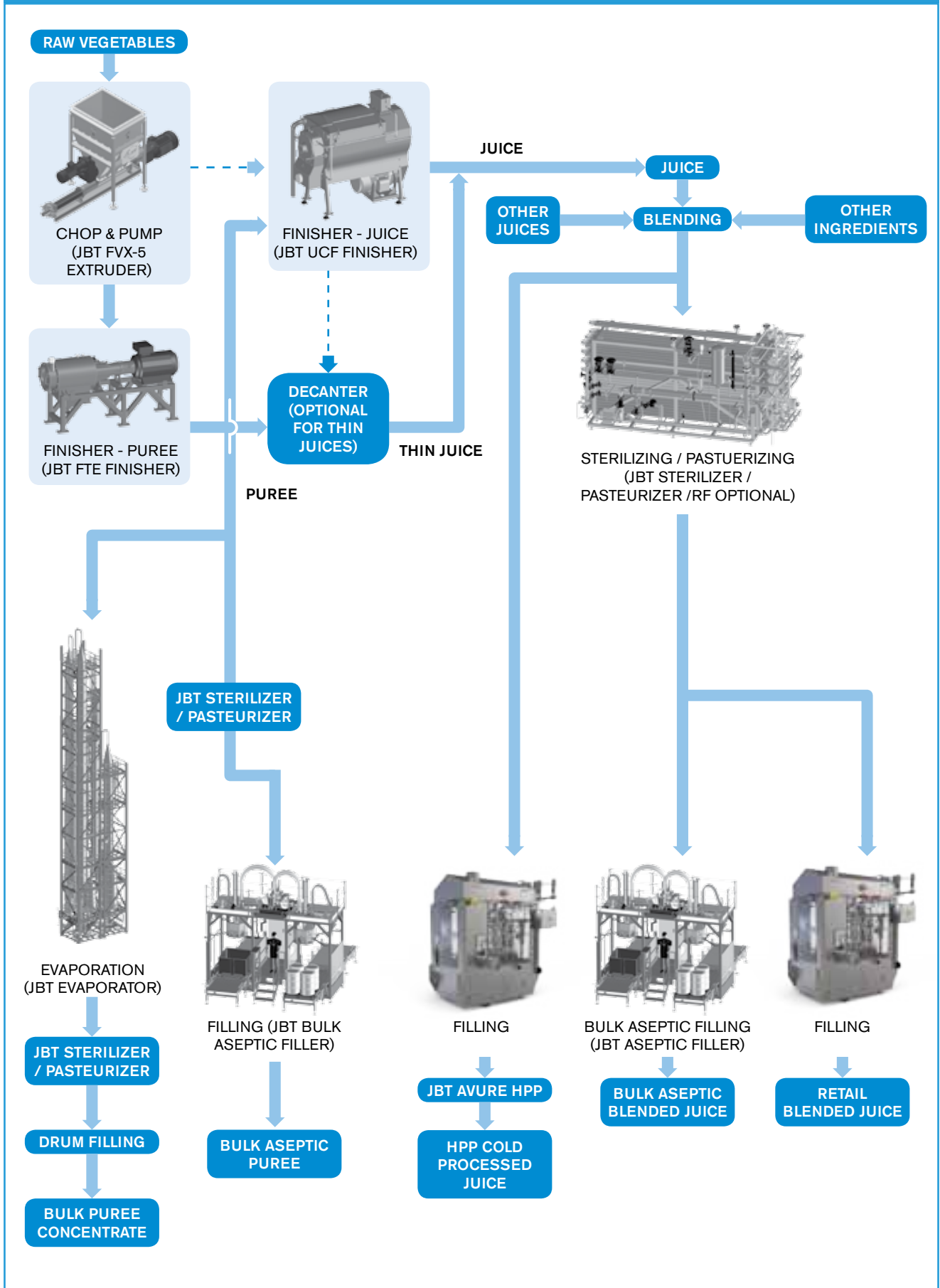
New vegetable and fruit juice blends currently on the market range from thin “cold extracted” juices to smoothies and juice drinks containing purees and other components. Vegetable juice and puree production involves three major operations: 1) size reduction;

2) extraction; and, 3) finishing. While there are many competitive processes, JBT has developed a new system and adapted existing machines to provide a modular, continuous and hygienic system capable of processing up to five tons per hour of raw product generating 15 to 25 GPM of juice/puree. JBT's primary process uses three major pieces of equipment: 1) FVX-5; 2) FTE-50; and, 3) UCF110 Finisher. These three machines can generally be offered for the majority of fruit and vegetable puree/juice.

Cold processed juice can be filled into the bottles of various sizes through JBT fillers. The bottles can undergo high pressure processing through JBT Avure's HPP food processing machines. The cold processed juice can also be either conventionally pasteurized followed by retail bottle filling or be sterilized followed by bulk container filling process.



Processing Line for Vegetable Puree & Juices



Tomato Paste

Receiving, Washing, Sorting and Chopping

Tomatoes are delivered to the plant and transferred to flumes through manual, mechanical or hydraulic means. Tomatoes are conveyed through the flumes to the washing and sorting area. Field material is removed from the tomatoes and then manual or electronic systems sort the product.

Hot/Cold Break

This procedure provides even heating that inactivates the natural enzymatic process. The choice of hot or cold break depends on the final product to be obtained.

Juice Refining

The juice is refined by removing the peel, and seeds from the pulp. This step results in juice that is ready for concentration.

Evaporation

The highest quality paste is obtained by removing the water while preserving the color and organoleptic properties of fresh tomatoes.

In-Container Filling, Closing and Sterilization

Containers filled with paste enter a closing machine where a lid is seamed to the can. The seamed cans are then conveyed to a cooker where the product is heated to sterilization temperature, held, cooled and made ready for warehousing.

Aseptic Sterilization and Filling

Quality improves when commercial sterility is achieved with minimal heat damage. In a closed system tomatoes are heated, held at temperature to obtain commercial sterility, and aseptically cooled to ambient temperature. The sterilized paste is then filled into aseptic bags. 300-gallon (1000 liter) bags are filled in a box. 55-gallon (200 liter) bags are either filled flat and then placed in a drum or filled directly inside the drum. Drums or bins are labeled and ready for shipment and/or storage at ambient temperature.

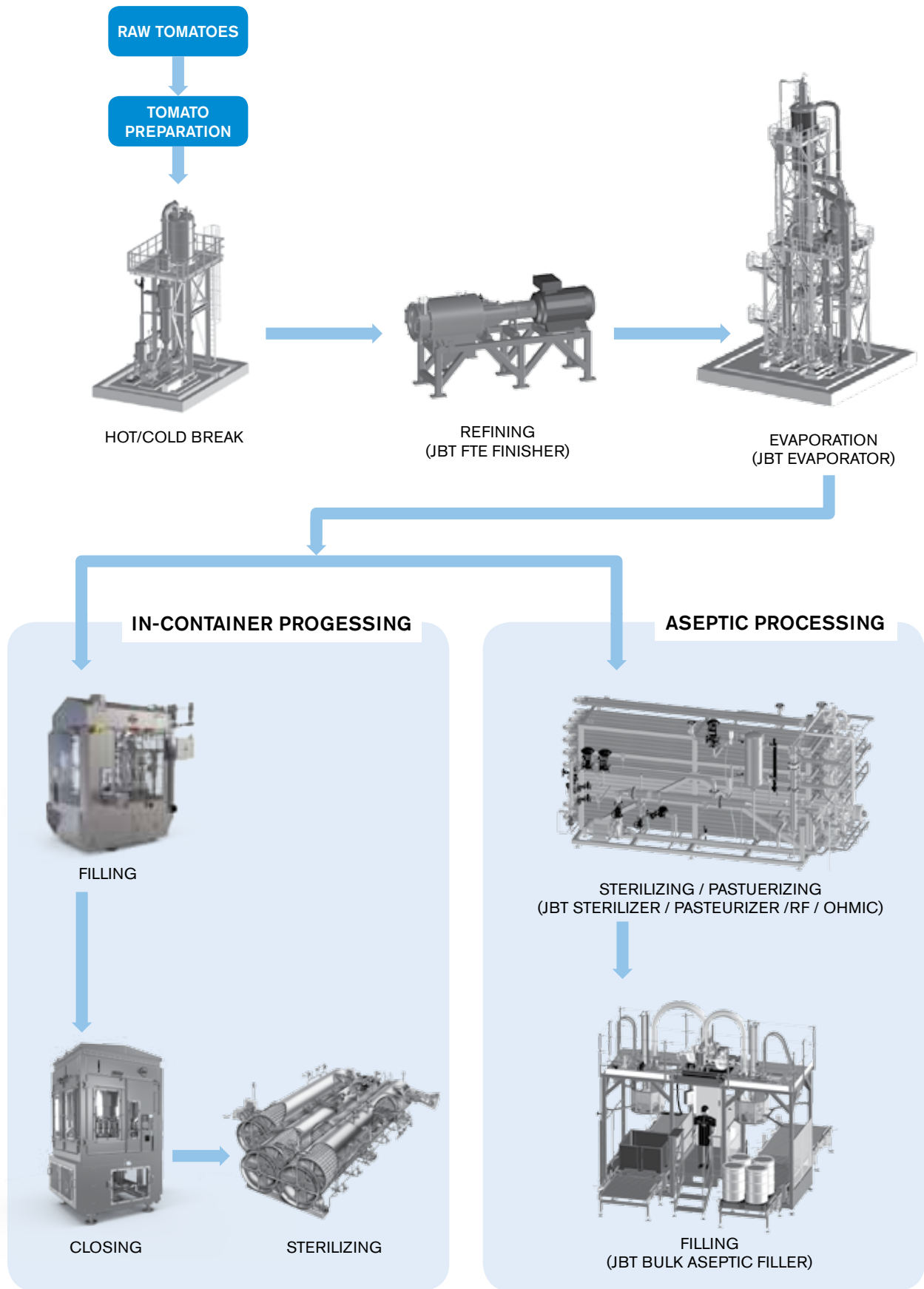




Global leadership supports stability and growth

Tomato processors use JBT equipment throughout the world. This turnkey, greenfield tomato paste plant opened in China during 2009. It utilizes equipment built at our Nigbo, China facility and illustrates our growing Asian presence and scale.

Processing Line for Tomato Paste



Temperate & Tropical Fruit Puree and Juices



Receiving, Washing, Grading, Preparation and Sorting

Fruit is delivered to the plant and transferred to flumes or conveyers through manual, mechanical or hydraulic means. Fruit is conveyed to the washing and sorting area. Field material is removed from the fruit and then the product is initially sorted by manual or electronic systems. The appropriate combination of preparation processes depends on the type of fruit to be processed and whether the end-product includes juice, particulates, whole pieces or puree. Typically, fruit preparation includes a combination of peeling, coring, pitting, re-pitting, crushing, slicing, deaerating and refining as well as additional grading and sorting.



Evaporation

Water is removed from the juice stream to concentrate the product. The specific evaporation method used depends on the desired final product. The highest quality is obtained by removing the water while preserving the color and organoleptic properties of the fresh fruit.

Filling, Closing and In-Container Sterilization

Fruit and juices are conveyed to the appropriate types of filling machines where containers are filled at predetermined ratios. The container then enters a closing machine where a lid is attached and seamed to the can. Closed containers are conveyed to a pasteurizer/sterilizer where the product is heated to sterilization temperature, held, cooled and made ready for labeling and warehousing.



Aseptic Sterilization and Filling

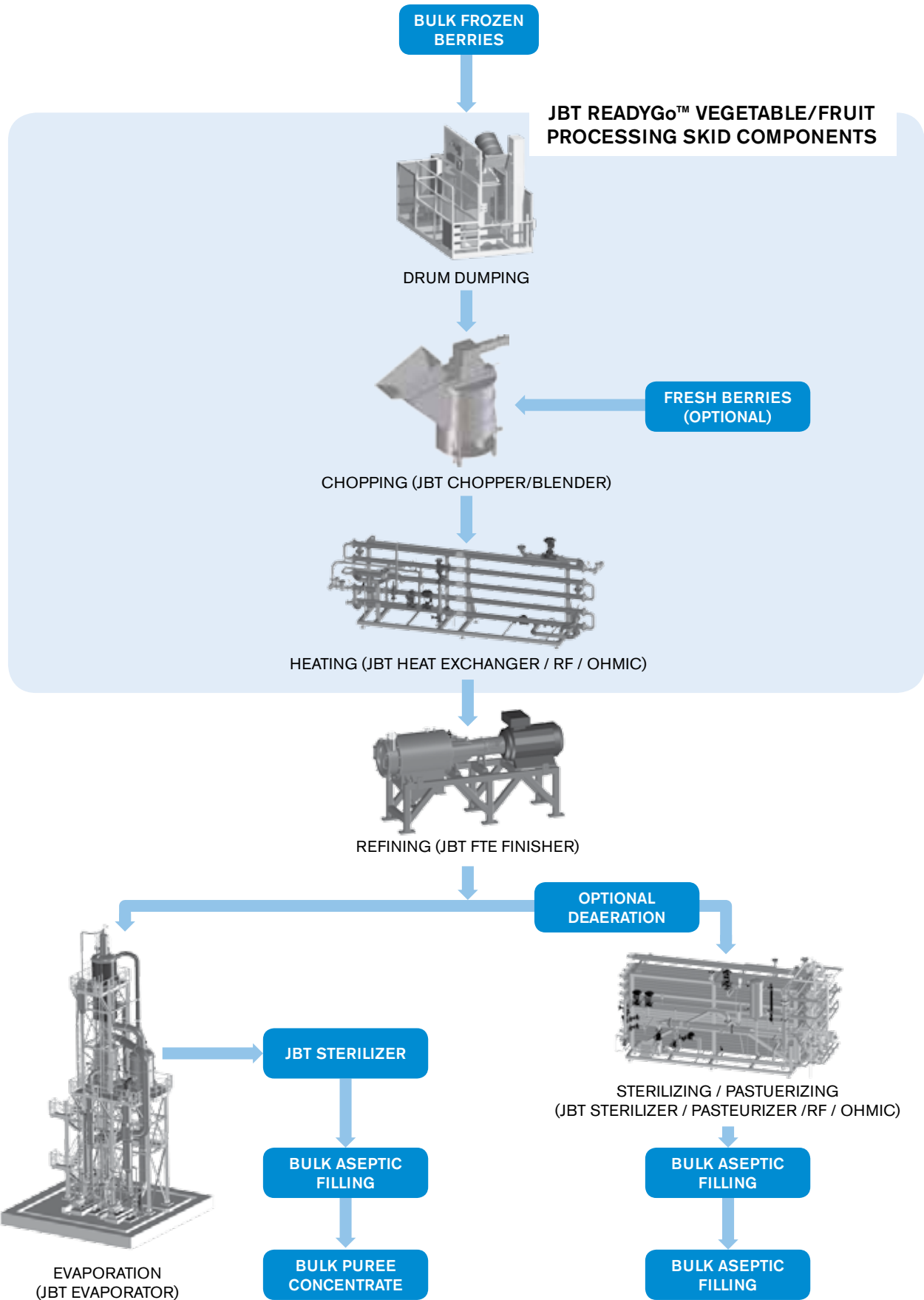
Quality improves when commercial sterility can be achieved with minimal heat damage. In a closed aseptic system, particulate tomatoes in a carrier media are heated, held at temperature to obtain commercial sterility and aseptically cooled to ambient temperature. The sterilized particulates are then filled into aseptic bags. 300-gallon (1000 liter) bags are filled in a box. 55-gallon (200 liter) bags are either filled flat and then placed in a drum, or filled directly inside the drum. Drums or bins are labeled and ready for shipment and/or storage at ambient temperatures.



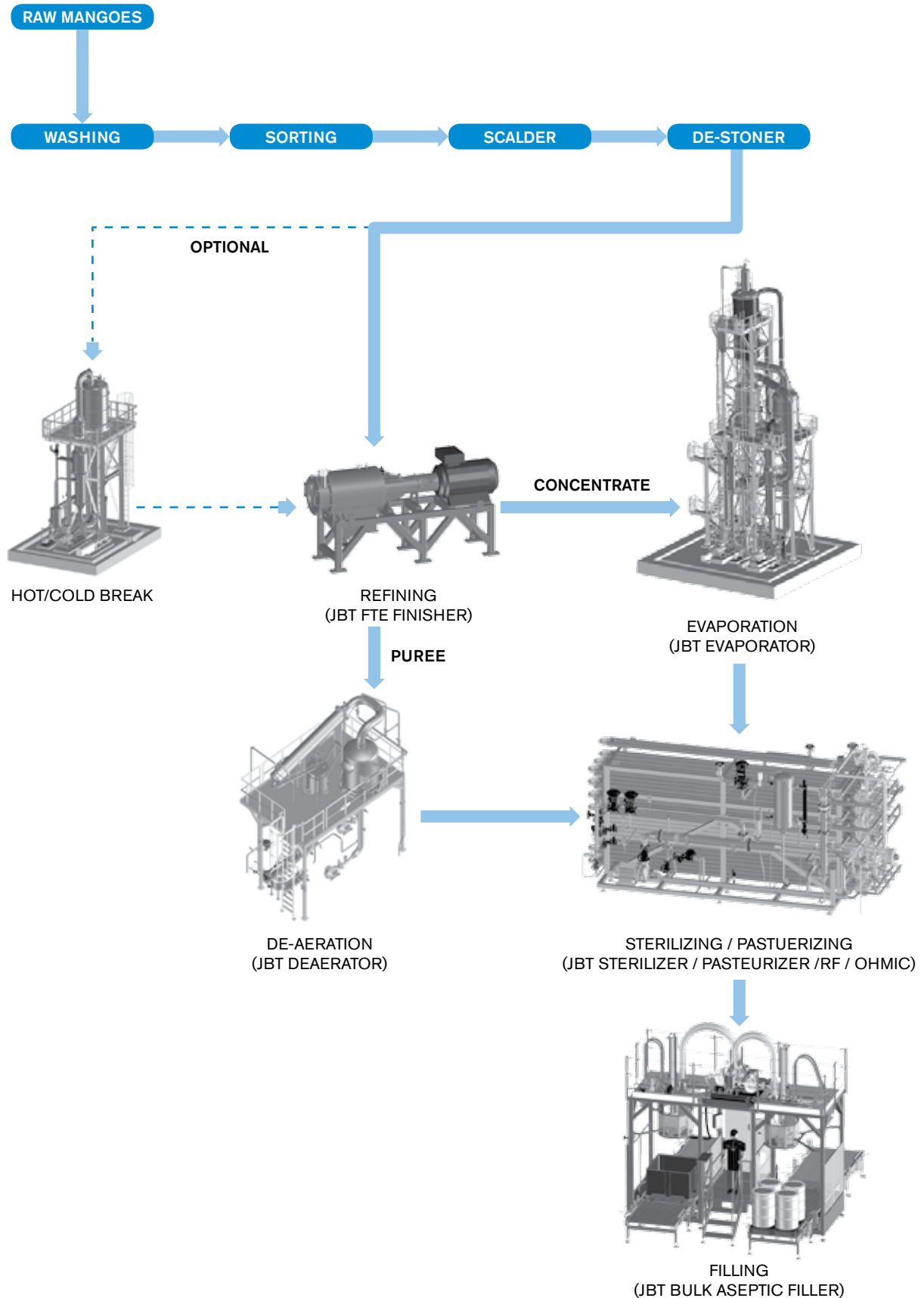


JBT systems squeeze more than
75% of the world's citrus juices

Processing Line for Berry Puree



Processing Line for Mango Puree



FTE TURBO FINISHER:

Powerful Partner to the Puree Industry

The FTE Turbo Finisher is designed for puree production from chopped chunks of fruits and vegetables



Puree Extraction: JBT FTE Turbo Finisher

The pulp containing viscous fruit or vegetable based paste obtained by the mechanical process from sound ripe fruits and vegetables is referred as puree (Bates, Morris, and Crandall, 2001). Almost every fruit or vegetable can yield a juice if required; however, for many fruits and vegetables puree serves a better purpose for some commercial applications. Chopped, heated/ unheated chunks from a feed tank can be processed via the FTE line of JBT turbo finishers. The FTE Finisher can also be made to work as a cold extractor for the whole fruit or vegetable by changing the product inlet hopper and adding a pre-rotor with six knives (Fig. 1), thereby combining the size reduction step and refining step in a single operation.



Fig. 1 - Pre-rotor with Knives

The rotors, with the help of centrifugal speed, push the chopped product towards the inner surface of the screen allowing the separation of puree from seeds and peel; a larger screen size can also be employed to retain seeds in the puree. The top part of the rotor blades and holes of the screen are aligned with perfect precision, allowing smooth cutting of the fibers and permitting the mashing of fruit and vegetable components into a homogenous puree. Puree quality and yield can be controlled by varying the following FTE parameters:

1. Rotor angle and speed
2. Screen angle
3. Gap distance between screen and rotor

The rotor paddles (18 paddles per rotor) are offset at 2.5° or 5° angle with higher angle resulting in a lower residence time. On the FTE 100, it is possible to stagger the rotors in an offset configuration to facilitate aggressive extraction which is typically used when sticks and stems are present.

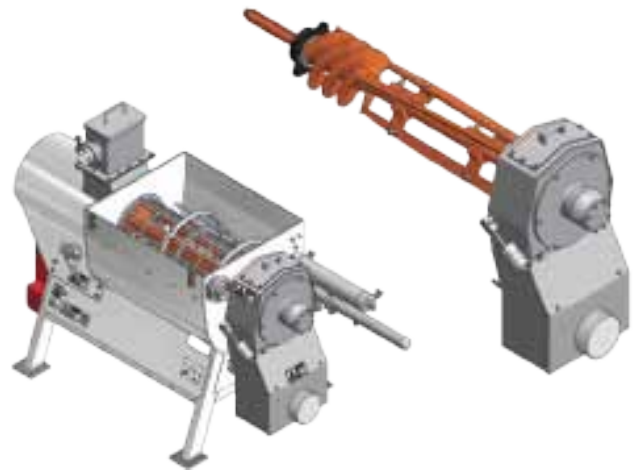
The hygienic design of the rotors is devoid of any bolts or catch points, preventing accumulation of material inside the finisher.

JBT Juice Finishers

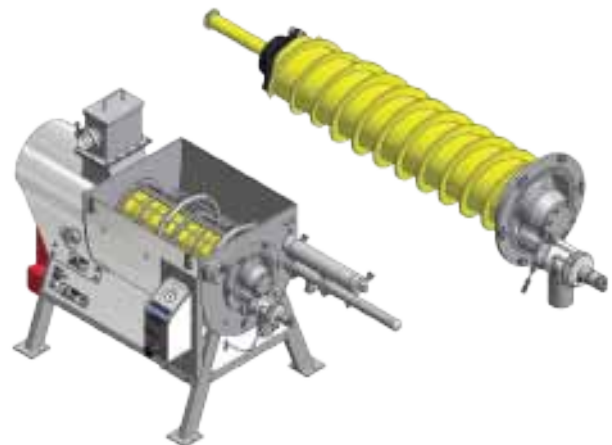
The same processing line, with a change in finisher, can yield a high quality juice thanks to JBT finishing (separation of juice from pomace) technology. The UPF (paddle finisher) and UCF (screw finisher) are more suitable for juice extraction purposes. With options of different sizes and throughput rates, the JBT family of finishers is designed from the ground up to handle the full range of fruit and vegetable juice finishing operations. All-stainless steel construction, a fully enclosed and guarded drive system, an adaptable intake to meet application requirements, and a spray ring to minimize screen blinding are some of the JBT design and development features that provide easy-to-clean and easy-to-operate systems.

A paddle finisher is appropriate for high volume juice finishing applications when low dryness control is not a critical parameter. Adjusting the gap between the paddles and the screen determines how much force is applied to the separation process. The remaining pomace is discharged through a weighted gate where a small amount of restriction is used to assist with further separation at the discharge outlet.

A screw finisher, on the other hand, uses a rotating screw to separate and dry pomace through a "plug valve" which provides backpressure against the exiting pomace as product material is separated. Controlling the air pressure of the plug valve manages the consistent dryness of the exiting pomace. Generally, screw finishers run at lower incoming feed flow rate to provide improved control over dryness. Depending on the specific fruit or vegetable characteristics, throughput rates and plant set-up, processors can choose either of the two designs available with JBT's finishing technology portfolio.



Paddle Finisher with Spiral Screen



Screw Finisher with Plug Valve



JBT Pasteurizers/Sterilizers

Thermal processing of food is designed to meet three objectives (Ramaswamy and Meng, 2007):

1. Reduction of microorganisms, both pathogenic and spoilage type to statistically insignificant levels
2. Creation of an environment that suppresses further microbial growth
3. Hermetic and/or aseptic sealing of package to prevent recontamination at post packaging and storage

Several factors need to be factored in while determining the extent of thermal processing including, but not

limited to: 1) properties of food; 2) nature and type of spoilage and pathogenic microorganisms; and, 3) storage conditions. Fluid foods including puree are often subjected to surface heat exchangers to meet the thermal processing objectives. For a juice/puree, temperature requirements resulting in an effective thermal treatment can lie anywhere in between 90-100°C, depending on the viscosity and density.

JBT offers different sterilizer designs meeting the needs of a variety of juices/purees having different flow behavior properties (Table 1).

JBT Sterilizer Types

TABLE 1. - JBT STERILIZER DESIGN AND HEAT TRANSFER COEFFICIENTS BASED ON BERRY JUICE/PUREE VISCOSITY

JUICE/PUREE VISCOSITY (cP)	STERILIZER TYPE	HEAT TRANSFER COEFFICIENTS (W/m ² ·K)
>500	Quad Tube	600 - 800
100 - 500	Sterideal® Coil	>1000
1 - 100	Dimple Multitube-in-Shell	>1000



Quad Tube Design

JBT tubular heat exchangers are available in various configurations which include specific product hold and process controls to assure critical temperatures and hold times are satisfied. They follow a similar construction format with a single tube or number of smaller tubes enclosed within an outer shell. The key to an ideal thermal treatment lies in the design of the heat exchanger. Puree, though generally categorized as medium viscous fluid, can still have a wide range of product viscosity and density. It is therefore imperative to enhance the heat transfer and limit the pressure losses while designing the sterilizer. Typically, a quad tube design heat exchanger would suffice for the requirements of highly viscous puree sterilization.

JBT Sterideal® QT (Quad Tube Design) heat exchangers come with specially designed fins, acting as a static mixer, placed inside annular product space providing effective heat exchange even at low fluid speeds of high viscous products. The presence of these fins provokes dynamic turbulence, drastically improving the heat transfer efficiency by convection at low fluid velocity (Fig. 2).

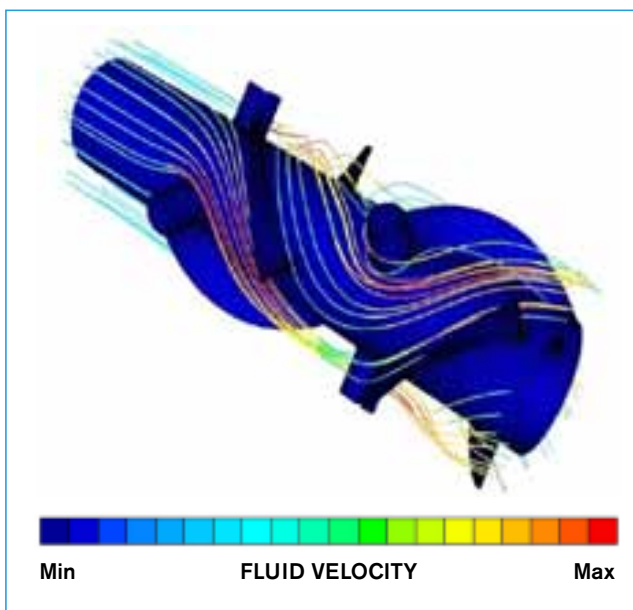


Fig. 2 - Simulated Fluid Velocity in JBT Quad Tube Sterilizer

JBT Sterideal® Coiled Tube

With over 50 years of experience in UHT processing and over 1000 worldwide installations, the Sterideal® Coil sterilizer has been a reliable partner of food industry for sterilization applications. The most striking characteristic of the Sterideal Coil is the continuous coil of the pipes. The heat exchanger consists of two or more concentric tubes. In the case of two concentric tubes, the product to be treated flows through the inner tube and the heating or cooling medium through the outer tube. For larger capacity, the Sterideal Coil uses bundles of pipes in which several tubes (up to a maximum of seven) pass through a single common enveloping tube.

There are three main advantages of coiled tube design:

1. Continuous coiled tube design lacks blind angles, resulting in better cleanability due to reduced probability of fouling
2. A helically coiled tube has a favorable effect on the longevity of the heat exchanger, since coiled tubes are more resistant to thermal stress
3. Improved heat transfer due to the enhanced mixing caused by Dean vortices

Dean vortices represent a secondary flow perpendicular plane relative to the forward flow in the tube. These vortices cause mixing in the cross-section and ensure markedly improved heat transfer, during both heating and cooling.



JBT Sterideal® Ohmic

Ohmic heating of foodstuff is the application of high voltage to the product flowing inside an aseptic sterilizer.

The liquid food reacts as an electric resistor and generates heat by the Joule effect. The higher the voltage and the food electrical conductivity, the higher and faster the delta temperature achieved.

The major advantage of ohmic heating is obtained in dice processing: the product quality is better compared to standard heating technologies since the center of the dice is heated at the same velocity as the liquid carrier, thus preventing parts of the product from overheating.

Excellent for all kind of products:

1. Liquid, semi-liquid, concentrated and high viscosity products
2. Containing fibers, small cells and featuring high viscosity such as puree and soups
3. Thermo-sensitive products
4. Fruit preparations and fruit jam with dices
5. Soup and sauces
6. Ideal for large size particles, 50-70 mm



Fruit Jam with dices



Vegetable soup



Fruit dices

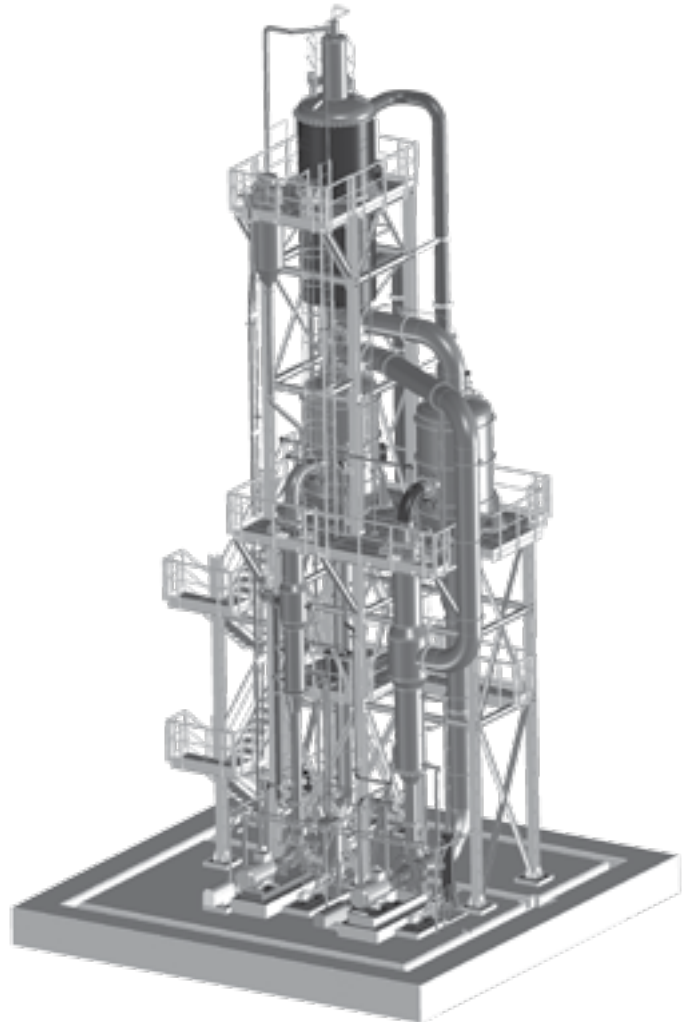


JBT Evaporators

Concentration is an important step used to expel water from liquid foods for reducing its storage and transportation volume and improving shelf life. However, concentration is an intricate step requiring enough care to be taken to prevent any loss of volatiles and degradation of essential chemical compounds present in the liquid food. The quality of concentrate is hugely dependent on the flavor and aroma components and suspended solids in a liquid food. High quality concentrates can be obtained by (Thijssen, 1970):

1. Keeping lower process temperature and shorter residence time
2. Clean operation for minimizing any microbial activity
3. Selective dewatering to retain all components except water

The JBT T.A.S.T.E. evaporator (thermally accelerated short-time evaporation) is designed to stabilize and sterilize juice during the pre-heating cycle and first evaporation stage. With over 200 units sold worldwide for various applications such as berries, citrus, and tomato, T.A.S.T.E. evaporators can be used conveniently to form a juice concentrate (up to 45–68 °Brix) from juice (10–18 °Brix).



JBT Forced Circulation Evaporator



JBT Fillers

Aseptic bulk filler

Continuous aseptic filling of juice/puree/concentrate is a standard benchmark for the fruit and vegetable industry. The JBT line of aseptic fillers offers a highly effective and reliable method of aseptically packaging bulk fruit and vegetable products. JBT fillers use a revolutionary design filling tube which eliminates the traditional stem-and-plug configuration. Years of research have led to development of the following features and advantages:

1. High production speeds
2. Improved reliability from a fully PLC-controlled, self-diagnostic operational mode
3. Greater versatility by matching various packing and product standards and combinations
4. Complete sanitation via automatic CIP system
5. Aseptic filling chamber which can be opened without losing asepticity
6. Roller conveyors under the dosing and filling platform to eliminate palletizers or similar devices
7. No chemicals or sterile gasses used
8. "Steam only" sterilization of filler heads
9. Increased profitability by keeping constant fill weight accuracy and reducing labor costs.



JBT Bulk Filler

Juices in glass and plastic bottles

A JBT Level Filler for juice in bottles provides the best solution for premium quality juice with an extended shelf life (ESL). It fills a broad range of package formats to precisely the same level. The product can be filled hot or cold and can even contain fibers and soft particles.

The JBT weight filler, in its Ultra Clean Precifill™ configuration, provides the best solution for premium quality ESL juice. The design for ESL juices features an extra small filling zone and self-draining surfaces to minimize the risk of contamination. The sterile air system has additional features that maintain a constant down-flow to prevent unfiltered ambient air from entering. The product can be cold filled, even when containing fibers or soft particles.

Both JBT Level and weight fillers can be combined with a bottle preheating/rinsing unit and a capper/sealer to form a Monoblock machine to reduce footprint and improve handling efficiency.



JBT Level Filler



JBT Weight Filler



Fruit & vegetables in cans and glass jars

The JBT Unifiller offers unmatched product versatility for filling fruit and vegetables: from low viscosity products without particles, to high viscosity products with particles; both hot and cold filled. The custom-fit nozzles increase accuracy and minimize product drip for even the most complex products.

The JBT Unifiller is the perfect fit for filling jams, tomato paste, sauces, baby food, ready meals and soups in almost any kind of semi-rigid or rigid container.

The JBT Unifiller can also handle juices with particles as a pre doser of particles, an over-filler or single-shot filler of juice and particles.



JBT Unifiller in a stand-alone configuration



The JBT TwinTec™ is the integration of the JBT Unifiller and a JBT seamer in one single machine. The TwinTec provides short, gentle and highly reliable can transfer from filling to seaming station running at a line speed from 100 to 600 cpm.



High-capacity Unifiller with 81 filling stations, synchronized with the X-59 seamer. This configuration is engineered to run cans at a line speed of up to 1500 cans per minute.



Juices with bits

JBT has developed a Vacuum-Assisted High-Precision Granular Filler to accurately pre-dose small volumes of high-value sticky particles for premium beverages with fruit bits. These particles (coconut jelly, coconut meat, grass jelly, bird nest jelly, aloe vera jelly, etc.) are added to beverages in order to enhance mouthfeel, taste and nutritional value. The vacuum-assisted granular filler yields high fill precision and assures minimum give-away and maximum product savings. The gentle product handling results in a high quality product.



Vacuum-Assisted High-Precision Granular Filler

JBT Avure High Pressure Processing

High Pressure Processing (HPP) is cold pasteurization in pure water; it uses ultra-high pressure purified water to keep refrigerated foods free of pathogens and staying fresh longer. HPP is used in several segments of the food industry to inactivate foodborne pathogens and spoilage organisms. For fruit and vegetable juices and purées, HPP provides an FDA-recognized process for inactivation of Salmonella, *Listeria monocytogenes*, and *E. coli* O157:H7. HPP allows producers to ensure food safety while delivering convenient, highly nutritious, and fresh-tasting products to consumers.

Food products, sealed in their final packaging, are loaded into a vessel then subjected to tremendously high isostatic water pressure reaching up to 87,000 psi. By applying pressure in all directions uniformly for about one to three minutes, packaged HPP foods retain their shape. The lack of heat (thermal processing) means HPP products taste better and retain their nutrients and vibrant colors, which ensures producers deliver the tastiest, most nutritious products on the market.

Popular Hpp Fruit and Vegetable Products

- Juices
- Smoothies
- Fruit and tree waters
- Soups
- Baby foods
- Dips, guacamole, hummus
- Salsas and chutneys
- Sauces and dressings
- Fruit and vegetable purées and toppings

Benefits of Hpp Fruit and Vegetable Juices and Purees

- Inactivates pathogens to ensure food safety
- Creates products with higher quality and perceived value than their thermally processed or frozen counterparts
- Cleans up ingredient labels by eliminating chemical preservatives
- Extends refrigerated shelf life
- Offers fresh, healthy appeal by preserving flavors, textures, colors, and nutrients

HPP offers both microbiological benefits and process enhancement for most fruits and vegetables. Innovative food processors use HPP to expand their product offerings and transition products from shelf-stable or frozen, to the more popular and profitable refrigerated marketplace.



Avure HPP Machines

Avure HPP machines have the industry's largest vessel diameter to deliver the highest possible throughput at the lowest cost of ownership. These machines come in a range of sizes and throughput capacities ranging from 10 million to 70 million pounds of product per year.

AV-10

The AV-10 can process up to 10 million pounds per year with minimal footprint to optimize plant space and enable quicker production.

AV-M Series

The AV-20M easily upgrades to the AV-30M, increasing annual throughput from 20 million to 30 million pounds, and the AV-40M, increasing annual throughput to 40 million pounds.

AV-X Series

The AV-40X easily upgrades to the AV-50X, AV-60X or AV-70X, increasing annual throughput from 40 million to 50, 60 or 70 million pounds.



AV-10



AV-M Series



AV-X Series

IQF Fruits and Vegetables: JBT IQF Freezer

The JBT Frigoscandia FloFREEZE® freezer, with its IQF (Individual Quick Frozen) track, ensures gentle handling of fresh fruits and vegetables. JBT Frigoscandia pioneered the fluidization process for individually quick frozen (IQF) products, installing the first IQF freezer in 1962.

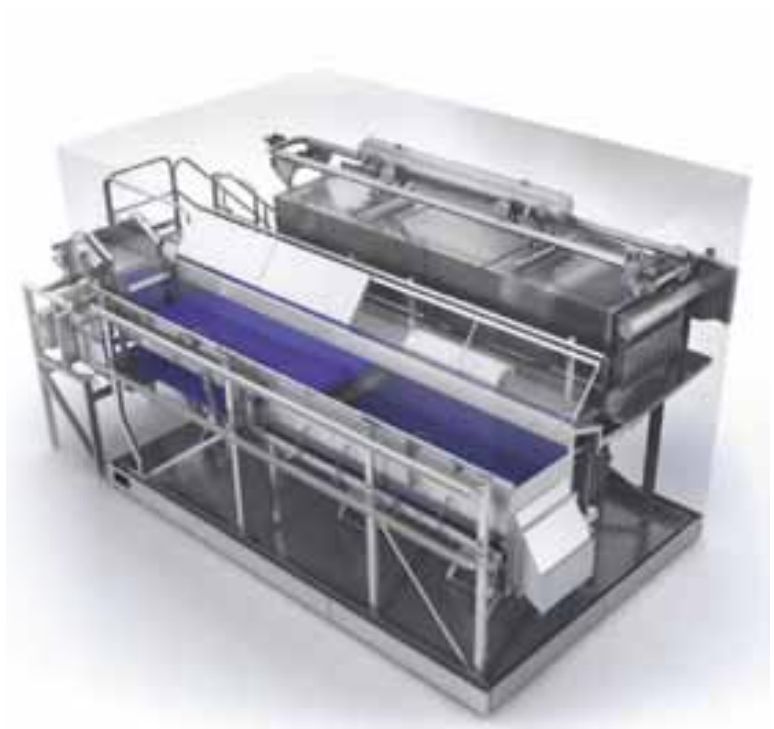
Fluidization involves quickly freezing each piece of fruit or vegetable separately, using refrigerated air that is blown at a high velocity on a "fluidized" bed. Put simply, fluidization means that the product behaves like fluid, suspended on a cushion of refrigerated air, as it "floats" throughout the freezing process.

The primary product parameter that influences the energy transfer during fluidization process is the mass of the product.

FloFREEZERS deliver higher air velocity (around 15 meters per second), resulting in a heat transfer coefficient that's more than three times higher than traditional linear freezers. This higher rate of heat transfers - the very heart of "quick freezing" - ensures superior quality. Among its many versatile features and options, the FLoFREEZE® IQF freezer features following remarkable concepts:

1. FloFREEZERS can adjust the air pressure during fluidization, making it capable of freezing a wide range of berries of different shapes, size and weights
2. IQF tracks can be optimized with a patented agitation feature that moves the track in a jerky motion, improving the fluidization by enhancing the track's ability to "break up" or separate individual fruit and vegetables
3. FloFREEZERS make use of a pulsating air flow through the IQF track, vertically separating the pieces from each other, preventing "cluster freezing".

FloFREEZERS have a patented, optimized airflow feature for differently sized/shaped fruits and vegetables in the initial freezing zone.



Providing Solutions, Not Just Machinery

As the demand for better, higher-quality value-added fruit and vegetable products intensifies, processors need the best machinery available to maintain and gain greater market share, especially in the face of growing competition. From freezing to filling, JBT offers single machines as well as complete processing lines for creating value-added fruit and vegetable products.

JBT's FLoFREEZE® IQF freezers offer manufacturers proven, cutting edge fluidization technology that help meet the growing demand for frozen fruit and vegetable products.

The JBT family of finishers offers a continuous extraction process with a variety of designs well suited for both juice and puree applications. With over 200 units sold worldwide, JBT's T.A.S.T.E. evaporators and Hybrid evaporators are the industry's choice for concentration operation.

JBT tubular and coiled heat exchangers, available in various configurations and dimensions, ensure uniform heat treatment to fruit and vegetable value-added products, helping preserve their quality, flavor, and texture.

JBT's innovative series of aseptic fillers with easy to operate control systems provide high production speed, fill weight accuracy and reduced labor costs. JBT's Rotary Weight Fillers have an extremely accurate, non-contact filling system which minimizes product give-away.

Only JBT Avure Technologies has complete HPP solutions to take a processor from new product conception to market launch and beyond. JBT Avure Technologies has been the leader in high pressure technologies since 1950 and our equipment has been involved in the creation and delivery of 70% of commercially available HPP products today.

With locations in Europe, Latin America and the US, JBT Corporation's Research and Technology Centers offer a range of services including laboratory testing and access to application-specific technology experts. Simply put, JBT Corporation not only provides machinery; it provides solutions to the ever-changing challenges of the global food marketplace.



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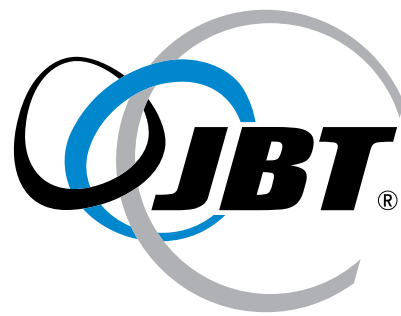
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