

Thermal Processing Technology



Choosing the right process

In order to be able to produce a product with specific product qualities in the most cost-effective way it is essential to make the correct choice with respect to processing system and technology.

In many cases the choice is straight forward, but in other cases there may be more options to choose between. Some of the more important questions to ask when choosing a system are:

- What is the specification of the product to be processed?
- Which are the quality requirements to the final product?
- Viscosity specifications of products and raw materials?
- Specification of particulate and fibre content/size and shape and variation in content?
- Acidity of product/high or low acid?
- Sensitivity to high temperatures/heat stability?
- Requirement for flexibility/multi-purpose systems?
- Requirement for variable capacity?
- Requirement for direct or indirect systems?
- Skills of technical personnel/operators?

The systems are often flexibly designed to allow for processing a range of products in the same plant.

It is quite common to process both low-acid ($\text{pH} > 4.5$) and high-acid ($\text{pH} < 4.5$) products in the same UHT plant. However, only low-acid products require UHT treatment to make them commercially sterile.

Spores cannot develop in high-acid products such as juice, and the heat treatment is therefore only intended to kill yeast and moulds.

Consequently high-temperature pasteurisation at 90 - 95°C for 15 -30 seconds is sufficient to make most high-acid products commercially sterile.

In some cases where new products have to be processed it may be necessary to carry out trials in small scale to observe the performance of specific products in different types of systems. APV has designed a pilot unit for this purpose.

The trend for processors to focus increasingly on flexibility to process a range of products and the importance of being able to produce high quality products has driven the choice of systems towards indirect tubular systems and direct steam infusion systems. The following sections will deal with the various heating principles and UHT systems followed by a more detailed comparison of the individual systems.



Infusion UHT Plant type SDH

Evaluation of the UHT systems

UHT process recommendation

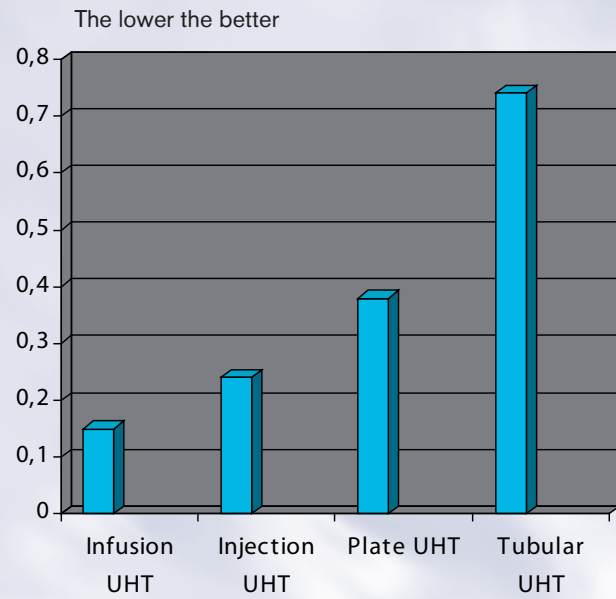
Plant type	Excellent	Not Recommended
Infusion Injection	High quality product Fauling product Sensitive Products Cream Ice Cream	Low cost products Fibres Coffee / Tea Volatile aroma
Tubular	Low cost products Volatile aroma Coffee whiteners Product with fibres Juice Coffee / Tea	
Plate	Low cost products Volatile aroma Coffee whiteners Juice Coffee / Tea	Fibres

Main advantages and limitations

Plant type	Advantages	Limitations
Infusion Injection	Gentle & accurate heating Accurate holding Superior product quality Long operation time	Capital cost Low regenerative Culinary steam Over-heating Holding time
Tubular	High regeneration Long running time Particulates and fibres No gasket Low maintenance cost	Lower regenerative than Plates UHT Higher degree of product Degradation
Plate	High regeneration Low space requirement Low investment Low running cost	Particulates or Fibres Gaskets High pressure drops

Evaluation of the UHT systems

The C* value with a B* = 1:

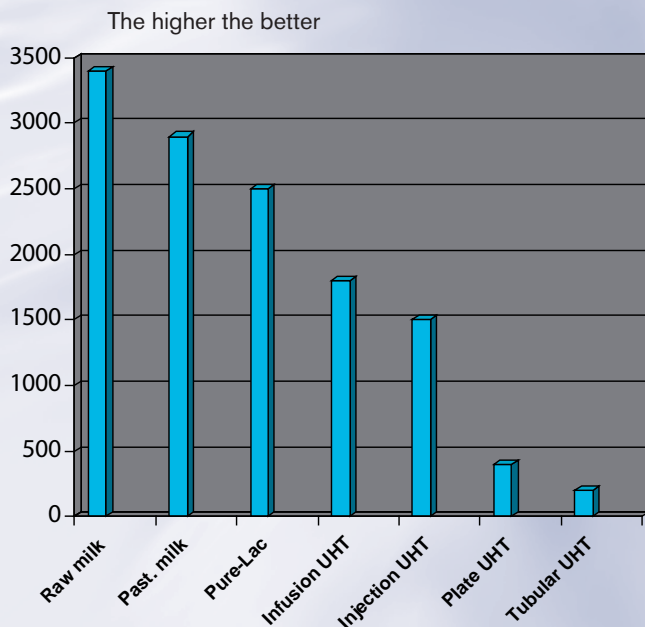


- Infusion UHT 0.15
- Injection UHT 0.24
- Plate UHT 0.38
- Tubular UHT 0.74

Design that fits

	0.1 - 1 mm	1 - 5 mm	6 - 25 mm
	Fibres and spices	Small particles	Large particles
Infusion	+	-	-
Injection	+	+	-
Tubular heat exchanger	+	+	(+)
SSHE	+	+	+
In situ processing	+	+	+

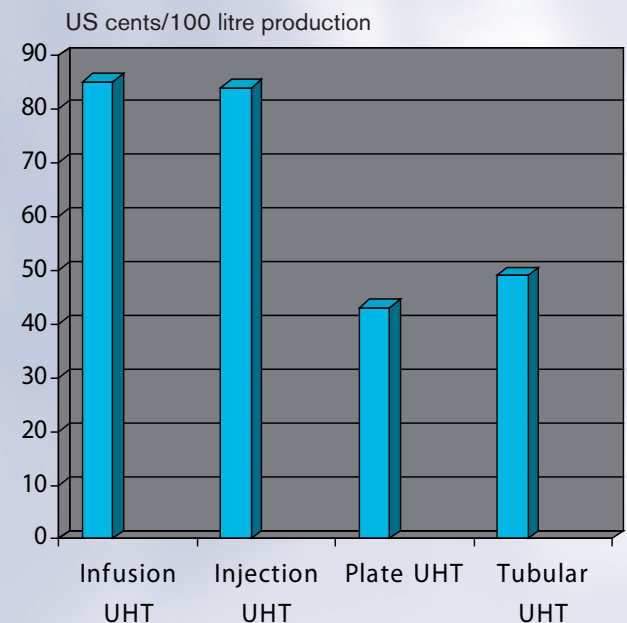
Beta-lactoglobulin level:



- Raw milk 3,400
- Past milk 2,900
- Pure-Lac 2,500
- Infusion UHT 1,800
- Injection UHT 1,500
- Plate UHT 400
- Tubular UHT 200

All in mg/l

Running cost of a UHT plant based on:



- UHT plant 10,000 l/h
- 10 hours/day
- 300 days/year
- Spare parts 3% of investment/year
- One service visit each 2500 hours
- Depreciation over 10 years
- Interest 5%
- Price of operator 120 DKK/hour
- Cost of steam, power, water, ice water, etc set at Danish prices.
- Cost of CIP included

Comparison between the most common used processing plants

Rated on a scale from 1 to 5: 1 = excellent; 2 = good; 3 = acceptable; 4 = possible; 5 = not recommended.

	Plate Steriliser	Tubular Steriliser	Steam Infusion Steriliser	Steam Injection Steriliser	High Heat Infusion Steriliser	Instant Infusion Pasteuriser	SSHE Steriliser
Milk Low cost	1	2	5	4	3	5	5
High quality	3	3	1	2	2	1	5
Poor quality raw material	4	2	1	2	2	1	5
Heat resistant spores	3	3	2	2	1	5	5
Flavoured milk Fouling product (chocolate)	3	2	1	2	2	1	5
Volatile aroma	1	1	3	3	2	3	5
Difficult to sterilise (cocoa)	3	2	1	1	1	3	5
Sensitive colour	3	3	1	2	2	1	5
Cream Whipping cream	3	3	1	2	2	1	5
Stabilised desserts	4	3	1	3	3	2	5
Cooked cream	2	2	1	2	2	4	5
Coffee whiteners Milk-based	1	1	2	3	1	3	5
Vegetable oil-based (emulsified)	1	1	3	3	1	3	5
Fouling/high protein content and stabiliser	4	4	2	3	4	1	5
Juice With pulp, fibres > 1 mm	5	1	5	5	5	5	5
With pulp, fibres < 1 mm	3	1	5	5	5	5	5
Without pulp and fibres	1	1	5	5	5	5	5
Yoghurt	1	1	4	4	4	4	4
Quarg	5	5	4	4	5	3	1
Baby food	3	3	1	2	3	1	1
Milk concentrate	4	4	2	3	4	1	2
Puddings Stabilised, high solids, starch	5	4	2	4	4	1	3
Stabilised with carrageenan	3	3	2	3	3	2	3
Soya milk Low cost	1	2	5	4	5	5	5
High quality	3	3	1	2	1	1	5
Poor quality raw material	4	3	1	2	2	1	5
Coffee and tea	1	1	4	4	4	4	5
Soups and sauces	5	2	4	4	5	5	1
Other considerations Heat stability	3	3	1	2	3	1	3
Aseptic product	1	1	1	1	1	3	1
Flexibility	3	3	1	2	1	1	1
Maintenance	2	1	2	2	2	2	3

UHT treatment

APV is a world leader in UHT technology with a comprehensive portfolio of tried and tested UHT plant solutions comprising plate, tubular, injection and infusion UHT plant technologies.

In addition to these basic technologies, variations such as scraped surface heat exchanger, high heat infusion and combi UHT plants are available as well as Add-On, Pure-Lac™, ESL, aseptic tanks, UHT pilot plants and Instant Infusion.

The UHT R and D centre based in Silkeborg, Denmark, operates a UHT pilot plant capable of running all the main UHT systems. This pilot plant is used for product testing and new

process development as well as by our customers wishing to test new processes and optimize existing process parameters with the assurance of production scalability.

APV introduced UHT infusion technology in 1960 and is today the world leader with a market share of some 90 percent

Today we offer four main infusion systems: Infusion UHT, 143°C (289°F) for 3 sec.; Infusion Pure-Lac™, 135°C (275°F) for 0.5 sec.; Instant Infusion, 135°C (275°F) for as little as 0,1 sec.; High Heat Infusion, 152°C (306°F) for 1 - 3 sec, giving an Fo of 40 - 70.

Infusion UHT plant - SDH

Flexible handling of a wide range of traditional, direct UHT products



Specifications

Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, custard, milk shake
Description	A UHT plant designed for very fast heat treatment, with an efficient bacteria spore kill rate and a very low chemical change to the product. Often named the most gentle UHT treatment on the market
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	5-75-142-75-25°C (41-167-288-167-77°F)

Advantages

- Gentle and accurate heating in the infusion system
- Fast heating 600°C/sec.
- Accurate holding time
- Superior product quality
- High product flexibility
- Low fouling rate
- Long operating time between CIP
- Operator friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Injection UHT plant - SDI

Flexible handling of a wide range of traditional, direct UHT products



Specifications

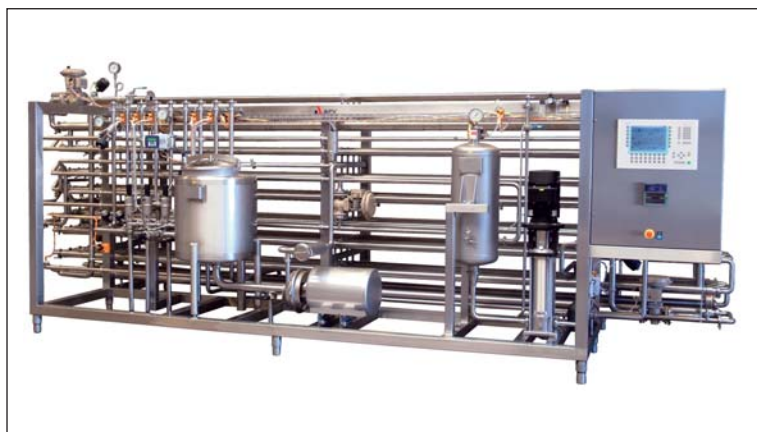
Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, custard, milk shake
Description	A UHT plant designed to give a very fast heat treatment, with an efficient bacteria spore kill rate and very low chemical change to the product
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	5-75-142-75-25°C (41-167-194-280-167-77°F)

Advantages

- Gentle and accurate heating in the infusion system
- Fast heating 300°C/sec.
- Superior product quality
- High product flexibility
- Low fouling rate
- Long operating time between CIP
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Tubular UHT plant - STH

Flexible handling of a wide range of traditional, indirect UHT products



Specifications

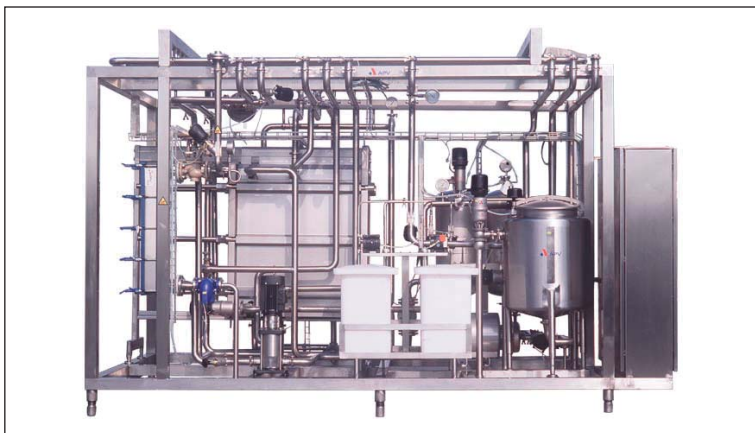
Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, custard, milk shake
Description	Robust and flexible UHT plant. Back pressure tolerance up to 60 bar and heat regeneration of approx. 85%
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	5-75-90-138-75-25°C (41-167-194-280-167-77°F)

Advantages

- High up-time
- Flexible product range
- Easy inspection of product and medium surface
- High pressure tolerance
- Low energy cost
- Low maintenance cost
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Plate UHT plant - SIH

Flexible PHE-based heat treatment of a wide range of traditional, indirect UHT products



Specifications

Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, milk shake, tea, coffee, juice, etc.
Description	A UHT plant designed for cost efficient running and a heat regeneration of up to 96%
Capacity	2,000 - 30,000 l/h (550 - 5,500 U.S. g/h)
Temperature	5-75-90-138-75-25°C (41-167-194-280-167-77°F)

Advantages

- High energy recovery, giving low running cost
- Flexible low viscosity product range
- Low pressure drop
- Pare Clip gaskets (non-glue)
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Scraped surface heat exchanger UHT plant - SSHE

For heat treatment/UHT of products with very high viscosity and/or particle content



Specifications

Field of application	High-viscosity products
Description	A UHT plant designed for robust and flexible running of products with very high viscosity for which a tubular or plate UHT plant is not suitable
Capacity	200 - 20,000 l/h (550 - 5,500 U.S. g/h)
Temperature	5-75-90-138-75-25°C (41-167-194-280-167-77°F)

Advantages

- Effective processing of high-viscosity products and products containing particles
- Operator-friendly
- Pre-assembled and factory-tested

High heat infusion steriliser - SHH

Flexible heat treatment of a wide range of traditional direct UHT products



Advantages

- Kill rate over Fo 40
- Increased operating time
- High recovery (up to 72%)
- Reduced maintenance costs
- Efficient deaeration prior to heating

Specifications

Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix
Description	A UHT plant designed to give a very high kill rate of bacteria spores (Fo 40 to 70) and higher heat regeneration (approx. 65%) than a conventional infusion plant
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	5-90-60-125-150-75-25°C (41-194-140-257-302-167-77°F)

- Non-aseptic flavour dosing of the vacuum chamber possible
- Destruction of heat resistant spores (HRS)
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Combi UHT plant - Combi

Ultra-versatile handling of a wide range of traditional indirect and direct UHT products



Specifications

Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, milk shake, tea, coffee, juice
Description	Versatile UHT treatment using a choice of UHT systems - tubular, infusion, ESL and high heat infusion in the same plant. Able to combine all APV UHT plant technologies
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	5-75-90-138-75-25°C (and others) (41-167-194-280-167-77°F)

Advantages

- Very high degree of flexibility, towards products and temperature profile
- Can run both direct and indirect UHT
- Can also run ESL/Pure-Lac™
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Add-on UHT plant - Add-On

Add-On, direct and indirect UHT system for an existing pasteurizer



Specifications	
Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, milk shake, tea, coffee, juice
Description	A UHT plant designed to be added on to an existing heat treatment plant (pasteurizer or UHT)
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	5-75-90-138-75-25°C (and others) (41-167-194-280-167-77°F)

Advantages

- Very high degree of flexibility
- Direct and indirect UHT
- Low investment
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Bactofugate steriliser - SSU

An infusion UHT system designed to sterilise bactofugate



Specifications	
Field of application	Bactofugate and whey cream
Description	A UHT bactofugate sterilisation plant with extra long running time between CIP cleaning
Capacity	200 - 5,000 l/h (55 - 8,000 U.S. g/h)
Temperature	50-140-(50)°C (cooling direct in the main product) 122-284-(122)°F

Advantages

- Over 10 hours between CIP
- High spore kill rate in bactofugate
- Low chemical change
- Operator-friendly
- Pre-assembled and factory-tested

Infusion Pure-Lac™ plant - Pure-Lac™

Pure-Lac™ the new milk with protected freshness and extended shelf life



Advantages

- Gentle and accurate heating in the infusion system
- Fast heating 600°C/sec.
- Accurate holding time
- High bacteria spore kill rate
- Superior product quality - low chemical change, pasteurized milk flavour
- Shelf life up to 45 days

Specifications

Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, milk shake
Description	Infusion plant with very fast heat treatment involving pasteurisation for 0.5 seconds at 135°C (275°F)
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	5-75-135(0.5 sec)-75-5°C (41-167-275(0.5 sec)-167-41°F)

- High product flexibility
- Low fouling rate
- Long operating time between CIP
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Infusion ESL plant - ESL

ESL - the new milk with protected freshness and extended shelf life



Advantages

- Gentle and accurate heating in the infusion system
- Fast heating 600°C/sec.
- Accurate holding time
- High bacteria spore kill rate
- Superior product quality - low chemical change, pasteurized milk flavour
- Shelf life up to 45 days

Specifications

Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, milk shake
Description	Infusion plant with very fast heat treatment involving pasteurisation for 0.5 seconds at 129°C (264°F)
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	5-75-129(0.5 sec)-75-5°C (41-167-264(0.5 sec)-167-41°F)

- High product flexibility
- Low fouling rate
- Long operating time between CIP
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Instant infusion plant - SII

Ultra-short, high-temperature treatment with precision-controlled holding time



Advantages

- Gentle and accurate heating in the infusion system
- Fast heating 600°C/sec.
- Efficient bacteria spore kill rate
- Up to 70% less vitamin loss
- Precision-controlled holding time down to 0.09 sec.
- Very low chemical change

Specifications

Field of application	Baby food, milk concentrate (max 58% TS) for spray drying
Description	Infusion plant designed for very fast heat treatment and ultra-short, precision-controlled holding time
Capacity	2,000 - 30,000 l/h (550 - 8,000 U.S. g/h)
Temperature	75-140(0.09 sec)-75°C (167-284(0.09 sec)-167°F)

- Superior product quality
- High product flexibility
- Low fouling rate
- Long operating time between CIP
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, 3A

Multipurpose UHT pilot plant - SPP

The most flexible pilot UHT plant on the market



Specifications

Field of application	All liquid food products
Description	Up to five heating systems - plate, tubular, injection, infusion and SSHE UHT, or any combination. Also runs Pure-Lac™ and ESL
Capacity	80 - 150 l/h (designed for 100 l/h) (21 - 40 U.S. g/h (27 U.S. g/h)
Temperature	5-75-140-75-20°C (41-167-284-167-68°F)

Advantages

- Very reliable system for product trials before upscaling to commercial production
- Highly flexible
- Quick and easy installation
- One unit with small footprint
- Operator-friendly
- Pre-assembled and factory-tested

Sterile technology

Technology and technical expertise for large-scale production under sterile or aseptic conditions



Specifications

Field of application	Chemical, dairy, food, pharmaceutical industries
Description	Industrial fermentation for a wide range of products, based on APV's long history in UHT-applications. Since the inception of its first loop fermenter in 1998, APV has developed and implemented continuous and batch fermentation processes requiring sterile conditions
Capacity	Industrial fermentation applications from pilot-scale to production-scale

Advantages

- Wide range of end-products
- Experience in long-term (30 days plus) industrial fermentation applications
- Loop or batch fermentation
- Solid experience from many years of aseptic technology applications
- Specialised in application of customer-owned processes

Processing lines for production of ESL products

Flexible, precise and cost-effective processing



Specifications

Field of application	Milk, cream and other dairy and food products
Description	Fully automatic processing based on UHT, PHE, THE, SSHE, membrane filtration etc., depending on the product
Capacity	Any
Temperature	70 - 140°C (160 - 280°F), depending on product and pH

Advantages

- Optimum process control and safety
- Higher number of running hours between CIP
- Easy CIP
- High heat recovery
- Operator-friendly control system
- Low running costs
- Low maintenance costs
- Improved product quality
- Improved flavour
- Combination of the ESL methods to tailor shelf life and flavour
- ESL processing lines can be combined with traditional pasteurisation lines for milk and cream

Aseptic tank - SST

Aseptic tank system with PLC system



Specifications

Field of application	All UHT-treated liquid aseptic products
Description	Modular design comprising tank body, valve battery, CIP system and PLC system, and controlled from the UHT plant
Capacity	2,000 - 30,000 l (550 - 8,000 U.S. g)

Advantages

- Modular system
- Easy and fast installation
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, 3A

Aseptic tank - SPT

Aseptic tank system with PLC system



Specifications

Field of application	All UHT-treated liquid aseptic products
Description	Small aseptic tank for the pilot UHT plant.
Capacity	500 l (132 U.S. g)

Advantages

- Mobile tank, easy to move
- Easy and fast installation
- Operator-friendly
- Pre-assembled and factory-tested

Pasteurization and other non-aseptic systems

The non-aseptic part of the portfolio of thermal processing technologies covers a wide range of heat treatment units and systems designed to operate at maximum efficiency in modern processing lines within Dairy, Food, Beverage and Brewery Industries around the world.

An example is pasteurization where the primary function is to reduce the number of micro-organisms (pathogenic) in food so that they are unlikely to cause disease. The secondary function of heat treatment is the physical and chemical changes of the product which influence the quality of the end product. The choice of time and temperature combination is therefore a matter of optimization in which both microbiological effects and quality aspects must be taken into account. The portfolio behind is based on many years of experience and thousands

of project references with different applications around the world. On that background we have different standardized systems adapted to specific applications and/or specific segments (or regulations). For example the standard Pasteurizer configuration is primarily designed for the European market while the PMO Pasteurizer is primarily designed for the US market.

By using Reusable Engineering we aim to be more competitive. Further design objectives are energy savings and reduced waste products - all offering higher profitability and reduced impact on the environment.

Safety is paramount, all food legislations can be adhered to with APV Pasteurizers and all systems are designed for sanitary conditions and made cleanable.

Engineered heat treatment system



Specifications

Field of application	Any
Description	The plant is designed for cost efficient running, delivering up to 96% heat regeneration. The plant is made as a unit
Capacity	Any
Temperature	Processing temperatures, thermisation, pasteurization (low/high)

Advantages

- Fully automated lines
- High energy recovery for low operating cost
- Flexible low-viscosity product range
- Low pressure drop
- Operator-friendly
- As option designed according to PMO and 3A

Options

- PHE or THE
- Separator (non APV supply) (for separation of cream and standardization of milk)
- APV homogeniser (for subdivision of particles or droplets and to create a stable emulsion or dispersion for further processing)
- APV Dearator (to avoid problems caused by dispersed air)
- APV CompoMaster (for milk fat standardization)
- Bactofuge (non-APV supply) or APV Microfiltration (to remove bacteria and spores from milk)
- APV ultrafiltration (for standardization and concentration of proteins)
- APV holding cells (to hold the product for a specified time at pasteurization temperature)

Plate pasteurization plant

General plate pasteurisation plant for the dairy and related industries



Specifications

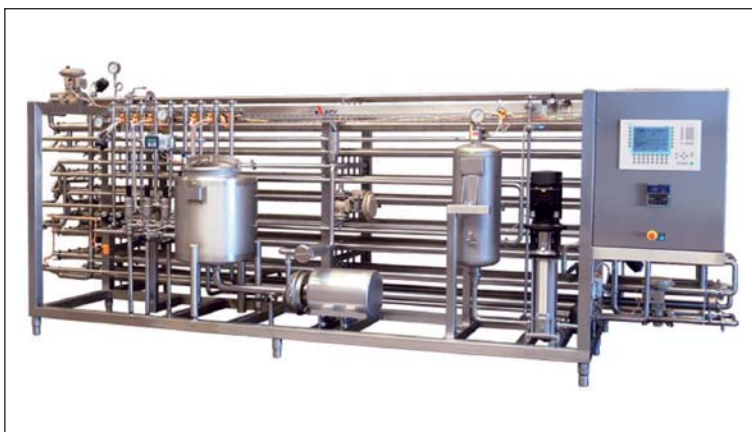
Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, milk shake, tea, coffee, juice, etc.
Description	The plant is designed for cost efficient running, delivering up to 96% heat regeneration. The plant is made as a unit
Capacity	100 - 30,000 l/h (27 - 8,000 U.S. g/h)
Temperature	5-72/85-5°C (41-162/185-41°F)

Advantages

- High energy recovery for low operating cost
- Flexible low-viscosity product range
- Low pressure drop
- Pare Clip gaskets (non-glue)
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Turbular pasteurization plant

General tubular pasteurisation plant for the dairy and related industries



Specifications

Field of application	Milk, flavoured milk, coffee cream, cream, ice cream mix, milk shake, tea, coffee, juice, etc.
Description	The plant is designed for cost efficient running with a heat regeneration of up to 90%. It is further designed for robust running and can stand pressure drops of up to 60 bar. The plant is made as a unit
Capacity	100 - 30,000 l/h 27 - 8,000 U.S. g/h
Temperature	5-72/85-5°C 41-162/185-41°F

Advantages

- Can run fibres and particles
- High energy recovery, giving low running cost
- Flexible low viscosity product range
- Low pressure drop
- Operator-friendly
- Pre-assembled and factory-tested
- As option designed according to ASME, PMO, 3A

Controlled beer pasteurisation - PU pasteurizer

Gentle and accurate heat treatment that protects delicate aromas and flavour



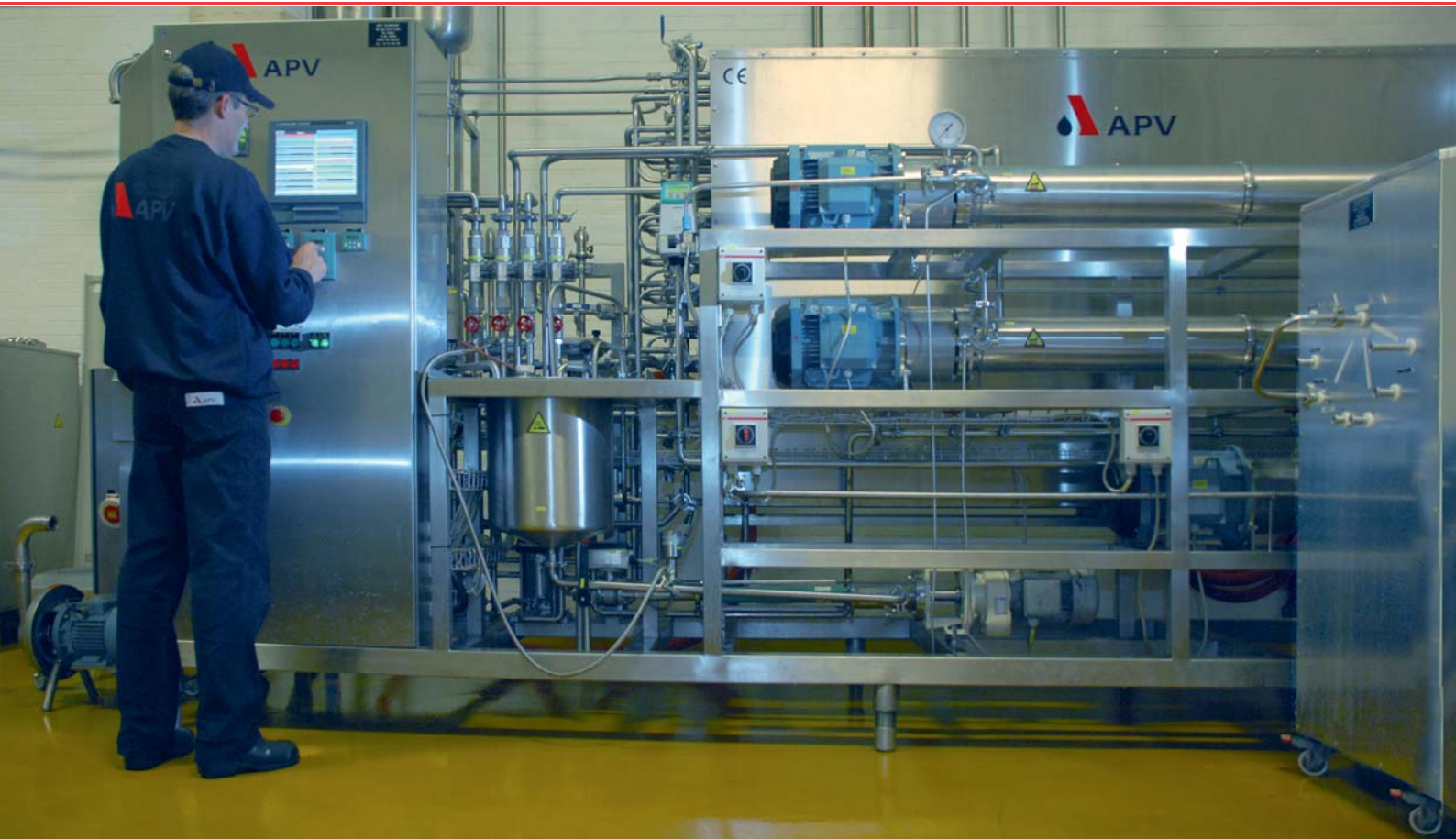
Specifications

Field of application	Brewery
Description	The PU pasteurizer enables continuous, gentle and effective heat treatment of beer and other carbonated drinks. The PU pasteurizer ensures precision temperature control at high working pressures
Capacity	50 - 500 hl/h (1,000 - 10,000 U.S. g/h)

Advantages

- Very high accuracy (computer controlled PU regulation)
- Low ΔT between product and heating media
- Large heat regeneration (up to 94%) with low-temperature filling
- Waste-saving design (beer/water zone)
- Turn down ratio 40% of nominal capacity
- Constant overpressure downstream
- Constant monitoring and control of final product

Research and development – APV Innovation Centre



➤ The APV Innovation Centre cooperates closely with APV companies and customers around the world in order to provide a constant stream of innovative, world-class solutions that add decisive competitive value to the businesses of our customers.

Located in Central Jutland, the heart of Danish dairy farming country, the Centre is the focal point of APV's dairy process development activities. The APV Innovation Centre extends its reach far beyond this, however, offering a raft of services for the food industry in the broadest possible sense.

These include after sales service, laboratory analyses, technical information and training of APV employees and APV customers.

The APV Innovation Centre leverages the extensive industry experience and expertise of a permanent staff of food technologists, process engineers and production engineers together with knowledge gained over many years throughout the worldwide APV Group to contribute actively to all types of development, testing and application of APV equipment, systems and processing lines. All facilities and services are designed

to provide added value by minimising waste and energy requirements, or by converting commodity ingredients into new, competitive products.

Important keywords for the Centre are innovation, optimum plant dimensioning, high-quality products, and up-to-date knowledge of market requirements. The trials are custom-tailored and can be performed in the Innovation Centre or on customer site. All work on behalf of individual customers is subject to the strictest confidentiality and the highest standards of customer service.



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