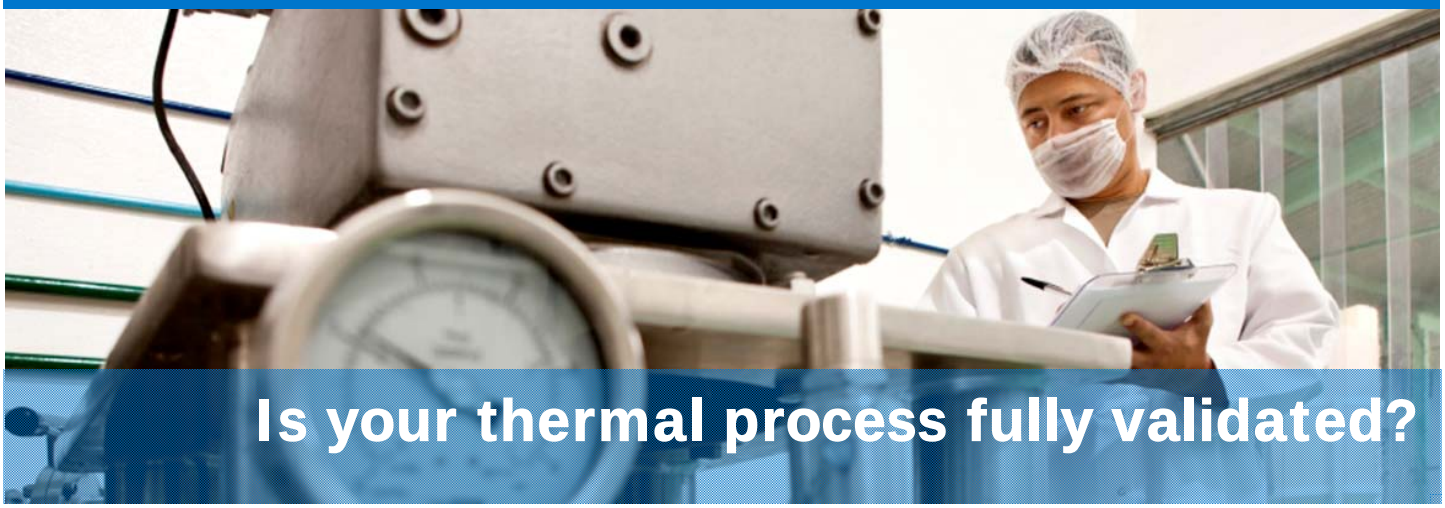


Is your thermal process fully validated?

JBT's Process Technology Center

The reputation of your brand is only as good as the quality of your products. Producing the best possible quality is one thing; making sure your production is done at the highest level of efficiency and food safety, and at ever lower cost, is quite another. To effectively address new consumer needs, packaging trends and opportunities in the market, your lines need thoughtful process development and process validation to deliver safe and high-quality output.
In this white paper we take a closer look at how JBT's Process Technology Center can work behind the scenes to make the food and beverages you process even better, allowing your brands to stay ahead of your competitors.

Put our promise to the challenge!
Simply e-mail us.

ptc.belgium@jbtc.com

Shelf-life extension

Driving demand for consistent food quality & safety

Demand for shelf-stable food is steadily growing. Changing consumer lifestyles have led time-constrained consumers to seek out more convenient, quick-to-prepare meal solutions. But above all they are searching for a wider range of healthy, nutritious and flavorful products, retailed in a variety of container types. They are clearly moving away from foods that utilize chemical preservatives, have high levels of salt or acid, or are heavily processed, and favor products that appear fresh and natural.

Retailers respond with great enthusiasm to this growing demand and go about expanding their store range, urging manufacturers to lengthen shelf-time and expand their product range in more convenient container types.

Food processors by global brands or private-label manufacturers know that the product mix must be changed on many different levels to meet local demand and retailers' needs. These adaptations not only include product formulation and labeling, but also parameters for packaging and processing. Steel cans, retort pouches, plastic bowls and bottles, glass bottles and jars, plastic cans and trays now offer marketing departments a large number of options to create new and unique brands. Package appearance and food sensory characteristics play a major part in the search for ways and means of making fast-moving consumer goods more attractive to both consumers and retailers. Marketing departments continually and with great eagerness refine their search for innovative concepts. But ultimately it is the processing line that needs to deliver high quality output and put safety controls in place, consistently and continuously. Demand for thoughtful process development and process validation is at issue.

Putting the heat on Thermal Process Design

Preservation techniques extend the period during which food remains wholesome by inhibiting microbiological or biochemical changes. These techniques prolong shelf-life allowing processed foods to stay useable during the logistics, retail sales and home consumption phases. Thermal processing of food products is the most widely applied technology for improving the shelf-life of packaged food, besides chilling, freezing, frying, and others. The objective of thermal processing in food products, which involves heating and cooling, is to produce shelf-stable products, free from pathogenic organisms, which will not produce food spoilage.

Sterilized food processing lines come in two basic solutions: aseptic lines and in-container lines.
On an ***aseptic line***, a sterile container is filled with sterile product in a sterile environment. It is a continuous process typically limited to liquid products with small particles.
In-container sterilization, on the other hand, is a proven technology that provides safe and effective low acid food products and renders them shelf-stable (pH > 4.5). An unsterile container is filled and sealed with unsterile product in an unsterile environment. The product is then sterilized inside the container as it passes through a heating and cooling regime. (*)

The heating and cooling regime for a *specific product*, packed in a *specific container size* and heat processed in a *given type of sterilizer* is known as the thermal process. Although product formulation plays an important role in retorted products, it is the thermal process that ultimately affects the finished product's quality. It is important to consider nutrient destruction, loss of vitamin potency, and overall quality deterioration as an effect of the duration and severity of the thermal process. Consequently, there is a need to determine an optimum process that delivers the necessary sterilization requirements and minimizes quality degradation. The accurate design of the thermal process for your specific product is therefore the key to designing your process.

(*) To be thorough, we mention the heat treatment process at lower temperature, so-called pasteurization, for food with pH<4.5. Unlike sterilization, pasteurization is not intended to kill all micro-organisms in the food because the low pH inhibits growth. Instead, it aims to reduce the number of viable pathogens so they are unlikely to cause disease or food spoilage (assuming the pasteurized product is stored as indicated).

Product safety first

The goal of retort processing is to obtain commercial sterilization by applying heat. While the thermal process is designed to destroy or render spoilage organisms inactive, certain bacteria may survive the process, so the product is safe under normal conditions of storage, but not necessarily sterile.

The preservative effect of heat processing is due to the denaturation of proteins, which destroys enzyme activity and enzyme-controlled metabolism in micro-organisms. When food is heated to a temperature high enough to destroy contaminating micro-organisms, the same percentage die in a given time interval regardless of the number initially present.

There are important implications to this decimal reduction time: the higher the number of micro-organisms present in a raw material, the longer it takes to reduce the numbers to a specified level. In commercial operation, the

number of micro-organisms varies in each batch of raw material, but it is difficult to recalculate process times for each batch of food. A specific temperature-time combination is therefore used to process every batch of a particular product to ensure the final product has a satisfactory and uniform microbiological quality (commercial sterility).

The F0 value is commonly used to compare heat treatments and describes the amount of time needed to reduce the microbial population to obtain sterile commercial food. For Clostridium botulinum (target micro-organism for sterilization), the process of heating for 3 minutes at 121°C (250°F) reduces the population by factor 10^{12}, and is known as Botulinum cook (F0=3)

In order to ensure commercial sterility, the entire food mass in the container must undergo the required temperature for the required time. However, extended exposure to heat affects the quality of the finished product. The destruction of many vitamins, aroma compounds and pigments by heat follows a similar reaction to microbial destruction. As a result, nutritional and sensory properties are better retained by using higher temperatures and shorter times during heat processing. The higher the temperature, the faster the kill rate, and therefore the shorter the exposure to heat that will be necessary. Most retorted products will benefit from a high-temperature, short-time process (HTST), pasteurization or ultra-high temperature sterilization (UHT)

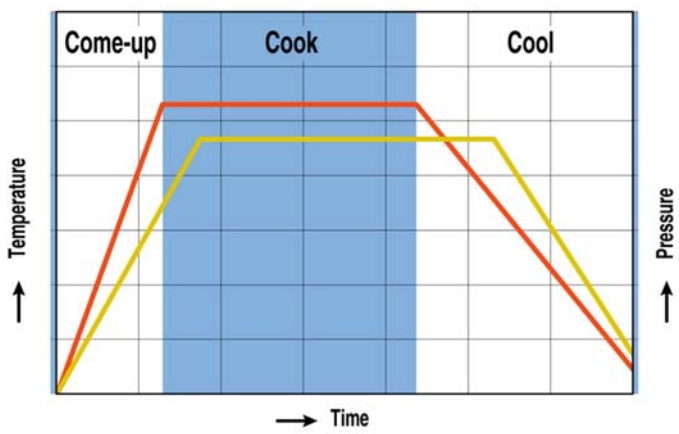
To the consumer, a major quality attribute of food is its sensory characteristic: texture, flavor, aroma, shape and color. They determine an individual's preference for specific brands of similar products. Food processors continuously aim to find improvements in processing technology which retain desirable sensory qualities or reduce the damage to food caused by processing.
Another perspective to consider is heat transfer within the product container: the time it takes to reach the thermal processing temperature (the come-up time) at the coldest point in the container. It stands to reason that different container shapes and types require special thermal designs. In the sterilization process, the heat must be transferred through the wall of the container to the product. Different types of packaging have different thermal conductivity values: metal having the highest and plastic the lowest.

Other critical factors to consider are, for example: the headspace in the container, the viscosity of the product, and the initial temperature of the product before it enters the retort. Lastly, does your product need agitation? Indeed, some products benefit from agitation during the thermal process to better induce convection heating and protect the part of the product to the outside from 'burning' at higher temperatures. Agitating the content speeds up the heat transfer in fluid products by moving the air bubble created by the head-space through them. Without this head space, there is little if any advantage in using an agitating system for solid pack foods.

During the retort process, pressure inside the container increases due to the expansion of the product, increased vapor pressure and the heating of air in the headspace. To maintain container integrity this phenomenon must be compensated for by overpressure in all the different process stages. This is why for some types of containers, the thermal process design has to include a scheduled temperature/pressure process too. The market trend towards thinner metal cans and flexible packaging makes the issue of pressure control even more important for food processors.

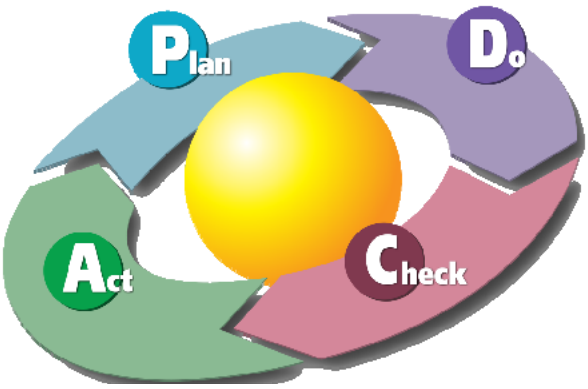
To conclude, there are two aspects that play a part in determining the optimal thermal process. There is the microbiological side, where we need to know what the resistance of a particular organism of concern is in order to determine the amount of heat needed. On the processing side, we look at how much heat is transferred to the product in a specific container under a given pressure. Bridging the two perspectives – while consistently maintaining high product quality - gives us the required thermal process.

▼ Thermal Process Temperature / Pressure graph in a retort



Food safety & quality assurance

Traditionally, quality control systems were based on inspecting products at various points within a process, and rejecting any product that did not meet the agreed standards. This approach to food quality focused mainly on end-product testing.



Nowadays, this type of control is recognized as being a waste of resources, as the ingredients have already been processed by the time the product is tested. In that case rejection means financial loss. A more proactive preventative approach to food safety and quality management based on the principles of Good Manufacturing Practice (GMP), termed 'Quality Assurance', was developed during the 1980s to ensure food safety at maximum quality and minimum process cost.

The GMP approach led to effective resource monitoring and control systems that ensure the consistent manufacturing of safe, high quality products. This led to the concept of Total Quality Management (TQM): to define and understand all of the processes, then implement controls, monitor performance and measure improvements.

The aim of TQM is to consistently provide retailers and end-users with quality products that meet their needs and expectations at competitive prices. A development of this mindset regarding customers and their satisfaction is brand loyalty, an important variable in a manufacturer's success. Thermal process validation, optimization and internal training are key parts of TQM.

Process control

The purpose of automated process control is to reduce the variability in final products in order to meet legislative requirements and consumer expectations in terms of product quality and safety. It also aims to reduce wastage and production costs by improving efficiency of processing.

As the scale and complexity of the latter have increased, timing and sequencing of valves has become more critical and errors by operators have led to more serious quality loss. This has caused food processors to move away from control based on the operator's skills and judgement to systems based on technology. Manually operated valves have been replaced by electric or pneumatic operation. The measurement of process variables, such as levels of liquids, pressures, pH, temperatures, etc., are no longer taken at the site of the equipment, but a transmitted to control panels.

For some products, there are laws that require monitoring, reporting and traceability of all batches produced which has further increased the need for more sophisticated automated process control.

Can we help in developing your thermal process?

Is your thermal process fully validated?


Hydromatic Sterilizers


Rotary Pressure Sterilizers


Batch Retorts


Fillers


Seamers

Your process needs to comply with FDA 21 CFR 113 (Thermally Processed Low-Acid Foods) / HACCP /GMP... etc. JBT is a recognized authority in thermal processing and is in the unique position of being able to offer extensive thermal process expertise regarding virtually all low - and high-acid foods in nearly every type of sterilizing system and every type of package.

We will help you optimize your current process or develop the most advantageous one for your particular equipment / product / packaging combination. Our state-of-the-art pilot plants can simulate different thermal processes on any type of sterilizer to optimize the safety and quality of your products. Besides *Process Validation* and *Thermal Process Development,* we can also assist in *Training & Audits* and *Container Performance Testing .*

Process validation

Validation of the thermal process is critical to ensure the safety and quality of the product over its intended shelf life. JBT food scientists can provide process authority assistance through support, review, testing and documentation. JBT's Process Technology Center is recognized as a process authority by the Food and Drug Administration (FDA), the U.S. Department of Agriculture (USDA), the European Food Safety Agency and the Institute for Thermal Processing Specialists (IFTPS). We can fully assist you in complying with regulations regarding the thermal processing of shelf stable foods.

JBT's Process Technology Center has a broad range of data collection equipment for temperature and pressure. We can measure up to 128 wired and/or wireless channels at the same time, for heat penetration studies, temperature distribution and heat transfer distribution studies, etc.

As a matter of fact, GMP,HACCP, the US Food and Drug Administration etc. require that the retort operation be evaluated before commercial production commences; correct process establishment methods are essential for the safe production of thermally processed commercially sterile foods. Process establishment involves two or three stages:

The sterilizer used to apply a thermal process should be operated in a controlled manner so that each processed container is exposed to conditions within specified standards. This type of testing is referred to as **TEMPERATURE DISTRIBUTION** study. New sterilizers and retorts that have undergone repairs or redesign can be presumed to require a temperature distribution study. Regular revalidations are often required too.

It should be determined what conditions are required for a product to achieve commercial sterility. The second phase of process establishment, which involves measuring temperatures inside the food containers (after determining the location of cold spots), is referred to as **HEAT PENETRATION** study.

Finally, **HEAT TRANSFER DISTRIBUTION** studies are mandatory for steam/air retorts. The objective of this study is to find the slowest heat location in the retort. It is imperative that heat transfer distribution tests are performed on every single retort in the system. Every basket is measured with at least 5 HIUs (HIU: Heat Input Unit) spread over the basket and equipped with a thermocouple to measure the center of the HIU.

Based on these studies JBT provides:

- Validation reports
- Process Deviation Analysis
  (based on NumeriCAL™ calculations)
- Reference letters for thermal Process Filing (FDA)

Thermal Process Development

JBT's Process Technology Center has accumulated widely appreciated know-how in virtually all process-related issues and will help you develop the optimal process for your equipment/product/package combination; either in your facilities or in our pilot plants. We can simulate any type of sterilizer to help you with, e.g.:

- **Development of a new sterilization process**

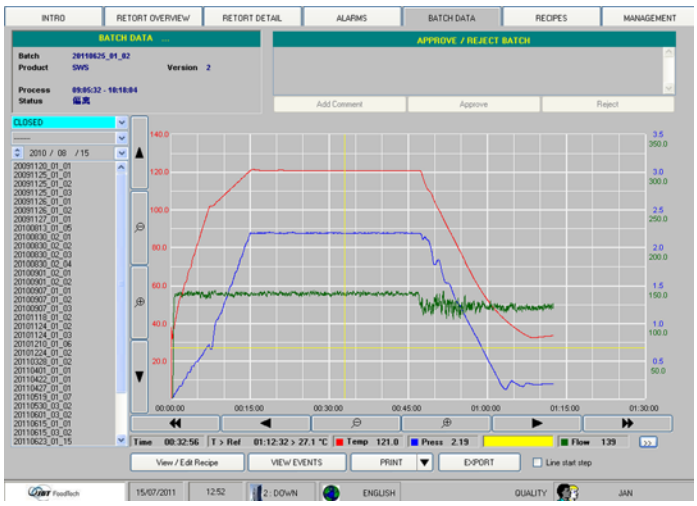
When you introduce a new product formulation, say, the optimal process for your product will need to be defined. If the packaging dimensions are changed for existing formulations, the process will also need to be re-evaluated.

- **Process Optimization**

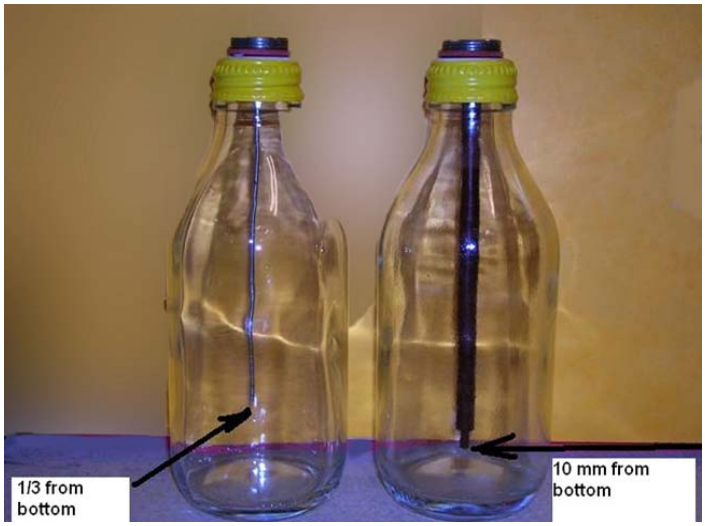
We can help you optimize existing processes to find the balance between energy consumption, product safety and product quality.

JBT's Process Technology Center also assists you in optimizing the filling and seaming operations for JBT can/jar fillers and can closers. A one-valve Unifiller and 6-head seamer are available for testing.

- **Can Seaming Performance**
- **Can / Jar Filling Performance**



Measuring the head space ▶
Retort process control ▶
Measuring temperature distribution in a batch retort ▶
Measuring the cold spot during heat penetration study ▼



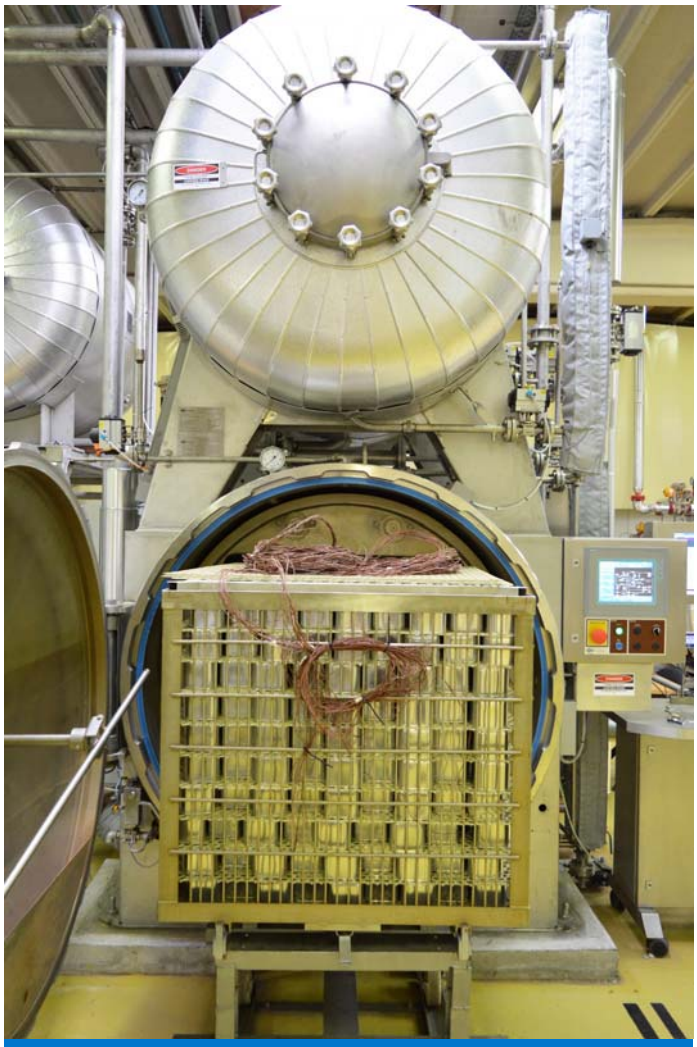
Container Performance testing

The evolution in packaging materials (new and flexible materials, reduced can tinplate, etc.) frequently requires the adaption of process conditions to guarantee package integrity. JBT's Process Technology Center provides process testing for all types of containers, including cans, glass and plastic containers, cardboard boxes, and retortable pouches and trays.

Both food processors and container manufacturers enlist our services to determine container specifications (can deformation testing, bulging, deflection, etc.) in relation to thermal processing. We also assist your line managers with the introduction of new packages on existing machines.

Are all your operators and line managers adequately trained?

JBT's PTC provides customized training for operators and line managers to match your quality assurance program. We provide Thermal processing Training, Operator Training and NumeriCAL™ Process Software Training.



Can we help? Sure we can.

JBT has developed a unique understanding of your market, which we are more than willing to share in the form of advice and cost-effective process solutions. You can rely on JBT's PTC to help you make the right choices to deliver safe and high-quality output at the lowest cost per unit produced.

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Food processing expertise at your service, around the globe

Our mission: providing you with maximum uptime and smooth operation. Therefore, you can count on JBT for technological support, installation supervision, training and after-sales support anywhere in the world.

JBT has a long history of food processing equipment. Having sold over 40,000 machines worldwide our service technicians have faced and solved some of the toughest problems for processors within the food industry. JBT offers OEM parts for repairs and maintenance. Over 6,000 parts can be shipped within 24 hours to all continents. Other examples of JBT customer service include the standard exchange assemblies and preassembled kit to reduce downtime due to maintenance and repair. Our range of service packages make sure your equipment keeps running as profitably as possible, for as long as possible. With minimum downtime.

More than 50% of the world's shelf-stable foods are filled, seamed or sterilized on JBT equipment. With several thousands of canning lines in operation worldwide, JBT is the world's leading supplier of integrated processing solutions for metal, glass and plastic containers. From single machines to complete processing lines, we enhance product value and safety. JBT equipment captures the quality, nutrition and taste of your product while producing them at the lowest cost per unit.

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