EDUCATIONAL RESOURCES

October 2006

CANNED FOOD OPERATIONS

At Simplot's Bathurst factory food canning operations involve the following processes:

1. Inspection and sorting of incoming raw materials such as corn.
2. Food preparation (thawing, cleaning, washing, sorting, grading, peeling, trimming, slicing or dicing for vegetables and fruits.
3. Blanching
4. Filling the can
5. Exhausting
6. Sealing the can
7. Heat processing
8. Cooling
9. Incubation and quality control checks
10. Labeling, warehousing and dispatch

ABOUT CANNING

Canning aims to produce a product which is free of pathogens and all micro-organisms which might spoil the food in the container to produce a heat stable product.

Canning is a severe heat process. Traditional canning involves packaging the food, then sterilising both food and package at temperatures at around 115 to 112°C for low acid foods (pH is greater than 4.5) or at about 100°C for high acid foods (pH is less than 4.5).

The food is sterilised initially in aseptic systems. The food may be cooled and held under aseptic conditions before being filled into a previously sterilised container and sealed under aseptic conditions. The food is usually sterilised using HTST and restricted to products that can be pumped into a can.

HEAT PROCESSING - PROCESSING EQUIPMENT

Once cans are sealed they must be processed as soon as possible. The usual heat transfer fluids are:

- saturated steam
- water
- steam - air mixture

Air may be used during processing and cooling. An over pressure of air is used to prevent excessive distortion when processing the following types of packages:

- large cans
- glass
- flexible pouches
- formed foil containers
- plastic cans

In some retorts a mixture of air and steam is used to process products. The mixture must be agitated to prevent stratification of the air. Air is also used to maintain pressure in the retort during cooling.
Water is used during the process to cool the containers after processing. The water used for cooling must be chlorinated to a level of 5mg/L free chlorine after 30 minutes contact time.

While the vacuum is being formed the seams in hot containers are slightly expanded and the sealing compound in the double seam is still soft so many containers may suck in water. Chlorination is essential as it reduces the chance that micro-organisms will enter the can (many food spoilage losses have been attributed to this cause).

All retorts have two sets of valves:

1. Automatic Valve controlled by the controller

2. Manual Valve which is manually operated and also known as the by-pass valves. Retorts also have safety valves to release pressure if necessary.

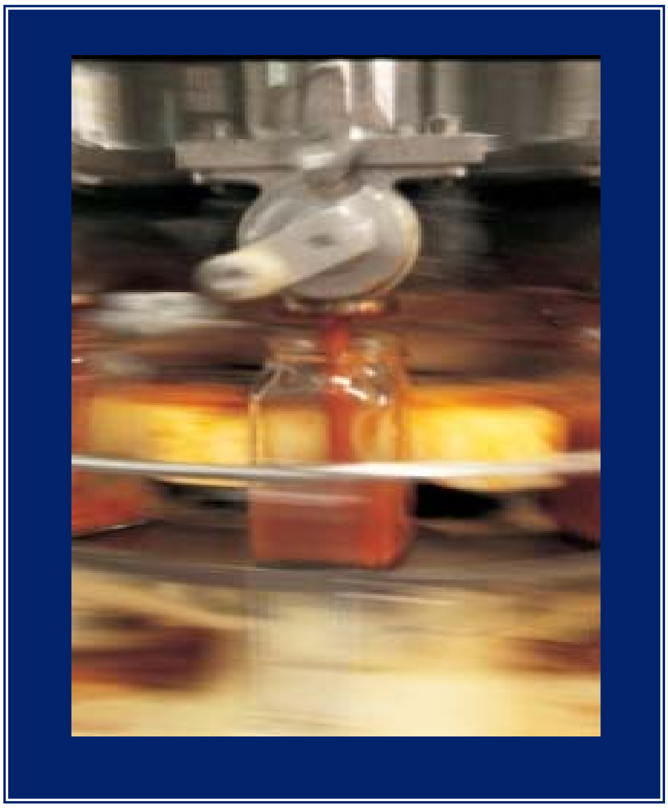
Venting valves control air elimination and are kept open during the venting cycle. After venting they are closed.

Bleeders are located on the retort. Bleeders are kept fully open during the process to provide steam circulation within the retort and remove any air which may enter with the steam. A bleeder must be located near the instrumentation to ensure that conditions are the same as those in the retort chamber.

Drain valves remove cooling water.

Retort instruments must be placed in free flowing steam in a place where they are easy to read, adjust and service.

A mercury in glass thermometer is used to measure the temperature inside the retort. The Controller/Recorder maintains the temperature + 0.5°C throughout the process. Process temperature and the pressure during cooling are recorded on a 24 hour chart and kept as a permanent record.



RETORT OPERATION

1. Containers are loaded into baskets.

2. The retort lid is sealed.

3. Venting stage - Air trapped inside the retort is removed prior processing.
   If air is present at a given pressure the temperature inside the retort will be lower than that attained by steam alone. A mixture of air and steam may stratify leading to cool spots where there is air. This mixture is a less efficient heat transfer medium than steam alone. Air in the retort cuts down the heat penetration of steam by insulating the cans and can accelerate external corrosion.
   When venting is completed the venting valve closes and pressure begins to build up in the retort. When process temperature is reached the thermometer and pressure gauge readings must agree.

4. The time from when the steam is turned on to when the process temperature is reached is the come-up time. Once this has finished the process begins.

5. Process time is from the end of the come-up time to the commencement of cooling.

6. During cooling the steam is turned off and water is added to the retort immediately to prevent overcooking.
   There are two methods of cooling; for small cans at temperatures less than 116°C atmospheric cooling may be used.
   For cans with a diameter greater than 6cm or processed at temperatures greater, than 116°C pressure cooling is used.
   In pressure cooling the pressure around the containers is maintained by compressed air during the addition of water. The water addition causes the steam to condense and the pressure outside the package drops suddenly. As the internal pressure inside the container does not drop until the contents cool, seam distortion may occur if the external pressure is not kept high.

7. At this stage can seams are very fragile and cans must be handled very carefully. All water used for cooling heat processed foods must be chlorinated to disinfect it in case water is sucked into the can during cooling.

AGITATING RETORTS

Some retorts agitate the cans during processing in order to increase the rate of heat penetration into the cans. Agitation may either be axial or end over end. Agitation is useful for products which are too viscous to heat or cool by natural convection. By using agitation, the process time may be reduced by up to 80%. Mixing is largely due to the movement of the headspace during agitation and to be effective there must be a sufficiently large headspace inside the can. A small headspace may lead to under processing.

CONTINUOUS RETORTS

Still and agitating retorts may be batch or continuous. Continuous retorts have four sections:

- can warmer
- pressure section
- pressure cooler
- atmospheric cooler

These retorts have self sealing valves which maintain pressure and tolerate temperatures up to 143°C.

HYDROSTATIC RETORTS

A hydrostatic retort is a continuous agitating retort. Cans are conveyed through the retort by carriers connected to heavy duty chains. The water legs act as valves into the steam chamber and these water legs also balance the pressure in the steam chamber. Cans enter the first water leg where initial warming occurs. The lower the can goes, the warmer the water becomes. The can then travels to the steam chamber where it may make 2, 4, or 6 passes depending on the required process time. The can then passes through the cooling leg where the water becomes cooler as the can rises to a final spray cooler and then a water bath. The can is then off loaded near the entry point.

Heating and cooling are quite gradual so there are a few strains on the can seams. Cans are rotated axially to speed heat transfer. This system requires reduced floor space and can save energy since it uses regeneration to warm and cool the cans. The water usage is lower than that of conventional retorts.

Unfortunately, hydrostatic retorts have a high capital cost and require very high production volumes.

FLAME STERILISATION

Flame sterilisation involves heating cans by passing them over a gas flame. This method is extremely fast. The can will reach 116° C in a few minutes.
The cans are closed under a very high vacuum then pass into the four stage process.

Flame sterilisation operations:

1. Cans are first preheated in steam.
2. Cans are passed over a gas flame whilst agitated to stir the contents.
3. The can is held for the required holding time.
4. Can is cooled.

The entire operations of preheat, process to 130°C, hold and cool takes 12 minutes. The process is limited to low viscosity liquids or solids. The internal pressure in the can during processing is very high and this may strain can seams.

BLANCHING

Blanching is a mild heat process applied to foods for a time period. The aims of blanching include the following:

1. Shrink the product and release respiratory gases
2. Inactivate enzymes
3. Aid other processes such as peeling, cutting, dicing etc.
4. Lower microbial load
5. Set and fix colour
6. Remove raw flavours or surface materials which may lead to off flavours

Blanch efficiency is determined by checking the activity of the peroxidase enzymes.

Blanching Methods

Blanching methods include the following:

1. **Steam blanching** - less loss of water soluble nutrients leaching - oxidation of product becomes a problem
2. **Water blanching** - fast process due to a better rate of heat transfer
   - severe on nutrients
   - effective washing process
   - blanch water can be used to transport the raw materials to the next stage of the process.
3. **Microwaves** - very expensive and complex equipment is required - low leaching losses
4. **Hot Gas** - expensive - hot gas from a furnace is blown down through the product along with team which reduces dehydration and increases the heat transfer rate

FILLING

At this stage the food is placed into the container. Underfilling gives a large headspace. Large headspaces result in the following:

1. Low vacuum off heat exhaust is used.
2. Mushiness of the contents due to excessive movement inside the can.
3. Contravening the Pure Food Act Regulations due to underrilling

Overfilling produces excessively small headspaces, resulting in the following:

1. Low vacuum if steam flow closure is relied on for vacuum.
2. Swelling of can due to hydrogen production.
3. Under processing if the process depends on agitation to mix the contents during processing.
4. Springiness or distortion of can.
5. Increased chance that food may be trapped between the can lid and body with the production of a faulty seam.

   The cans are periodically weighed on line, headspaces, drained and net weights are determined on the finished products in order to check the adequacy of the filling process.

EXHAUSTING

Exhausting aims to remove air from the package before closure. Correct exhausting will:

1. Remove all gases from the headspace which will minimise strains on seams during retorting.
2. Remove oxygen, otherwise ether corrosion, oxidation and discolouration will result.
3. Give a vacuum on cooling to give space for the gases which are formed on storage.

There are three exhausting methods available:

1. **HEAT EXHAUST**
   Contents are heated before sealing. This is ideal for products containing lots of trapped air. Final temperature depends on closing temperature and headspace.
2. **STEAM INJECTION** also referred to as STEAM FLOW CLOSURE
   This flushes the headspace out with a jet of steam just before closing. This method is more effective where products are packed in hot brines and syrups and where a large headspace exists.
3. **MECHANICAL EXHAUST**
   Uses a vacuum pump to remove air from the package. Food is filled at low temperatures. This method is useful for foods which trap a great deal of air.

A vacuum gauge may be used on a cooled can to determine the vacuum of a can. The minimum acceptable pressure is about -23kPa. Desirable vacuum will vary for different products.

To exhaust, the open can is passed through a steam chamber operating at 88ºC - 93ºC and taking 2 to 4 minutes to pass through. During exhausting, the contents of the can are heated to about 80ºC - 85ºC, entrapped air is released and the head space is filled with steam, thereby displacing the air.

Other methods of removing air from the head space are by steam flow closing or vacuum closing. With steam flow closing, a jet of steam is injected into the head space as the lid goes on, thereby displacing the air. The vacuum is released after closing, making room for the next can. This is not a high speed operation.

CLOSING

Can closing machines vary in type and speed, but most carry out the seaming operation in two stages. Closing is a very critical stage of canning and expert knowledge is required to keep the closing machines operating correctly.

STERILISING

Sterilising is carried out for two reasons:

1. to cook the product
2. to render it commercially sterile

Normally in low acid foods, the cooking is reached first and further heating is required to destroy the harmful microorganisms. However, in some acid packs, when less cooking is required to sterilise the product, further heating to reach the required texture is given.

Sterilising or cooking can be carried out in two ways:

1. In static retorts as a batch operation. These cookers are large scale pressure cookers automatically controlled and usually operate between 116ºC and 121ºC.
2. In hydrostatic sterilisers the operation is continuous. These cookers maintain their internal pressure and, therefore, temperature by a head of water supported in columns on either side of the cooking section. Because of the pressure it requires, these cookers are tall, but occupy little floor space.

CAN MAKING OPERATIONS

Manufacture of cans from tinplate is a highly technical and precision operation. At the can makers plant, in conventional three piece can making, can bodies are manufactured by first cuffing or slitting rectangular body blanks form the tinplate sheet. These body blanks are then formed into cylinders in a machine which subsequently resistance welds the overlapped edges to form body cylinders at speeds of up to 500 units per minute.

Corrugations, known as beads can be rolled into the can walls to give added strength. The next operation flanges the cylinder in order to receive the can ends and finally one end is double seamed onto the body cylinder to give the finished can, which is pressure tested to ensure an airtight can has been produced before dispatch to the food canner.

QUALITY ASSURANCE IN CAN MAKING

Can making is a high speed precision engineering industry and throughout all manufacturing operations of slitting, body making, flanging and pressing, curling, compounding and double seaming, extensive checking and charting of measurements are undertaken.
The integrity of the welded body seam is automatically monitored and controlled by the welding machine. Double seam evaluation involves measurement of at least five parameters and is conducted on line and in the Quality Assurance laboratory. The performance of a can making line can be evaluated by entering data into a computer terminal which then can produce rapid statistical analyses.

In the OA laboratory, microscopic examination of seam cross-sections is a very accurate method of analysing the seam integrity. These modern tools available for quality assurance of can making operations have the following advantages: