Hot Fill and Hold Processes

B. Barry Yang, Ph.D.
Director, Southern Taiwan Service Center
Food Industry Research and Development Institute
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Outline
1. Basic of Hot Fill Processes
2. Thermal Process Considerations
3. Potential Risk in Application of Low-acid Products
4. Summary

Hot Fill Processes
- a proven and recognized method for filling high acid foods (pH less than 4.6) that will be shelf stable at ambient temperatures.
- to provide a product free from microorganisms capable of growing in it at ambient storage.
- used extensively in the food industry for filling a glass, plastic containers, metal cans, or in paperboard cartons.

Advantages of Hot Fill Processes
- an inexpensive and conventional filling technology for high acid foods and beverages.
- does not require any chemical decontamination of the preform, container or closure.
- as compared to aseptic filling methods, hot filling involves a less rigorous level of technical training and product preparation.
- the stringent filling conditions required by aseptic processes to avoid any possible re-contamination of the product or the container during filling and capping are not highly demanded.

Thermal Effect of Hot Filling vs. Aseptic Cold Filling

Basic Steps of a Hot Filling System

1. Heating
2. Hold in holding cell
3. Trim cooling
4. Drying
5. Tunnel cooling
6. In-package hold
7. Filling & Capping
8. Packaged for labeling and distribution
Effects of Hot Filling to PET Bottle
- The PET bottle shrinks and the volume is reduced.
- Air in the head space may heat up adding to the pressure.
  - For this reason, many hot fill bottles are filled to the brim allowing no head space.
- Once the bottles are back to room temperature the liquid will have shrunk by 3% to 4% creating a vacuum of up to 0.5 bar (7 psi).
- Tightness of closure is crucial to avoid post-contamination.

PET Bottles Used for Hot Filling
- PET is a semi-crystalline thermoplastic, which softens at approx. 76°C (what is called “Glass Transition”).
- use heat-set bottle and specific design “vacuum panels” spaced in the circumference of the bottle.
  - These panels pull in during vacuum in a controllable manner allowing the container to keep its shape.
- PET preforms for hot fill are made from special resins, heated to a higher temperature and blown into hot blow molds in order to reduce shrinkage.
  - This effectively increases the crystallinity in the bottle sidewalls to 33% to 35% allowing them to withstand the higher temperature.

Hot Filling Juices in Glass Bottle
- Glass bottle used for juices are normally considered to have the best oxygen barrier properties.
- The filling temperature is usually between 90 to 98°C, the holding time may vary before the bottle is cooled in a tunnel.
- Preheating of glass bottles is necessary before filling in order to reduce the risk of glass splintering.
- Prior to closure the bottle neck is flushed with steam. Steam injection keeps foaming to reduces the oxygen content of the neck space and lowers the recontamination risk.
- Hot filled bottles are frequently overfilled or turn the bottle upside down in order to ensure sterilization of the neck by hot product.

Thermal Process Considerations
**Commercial Sterility**

"Commercial sterility means the absence of microorganisms capable of growing in the food at normal non-refrigerated conditions at which the food is likely to be held during manufacture, distribution and storage."

(Ref: Codex Alimentarius Commission (WHO/FAO) CAC/RCP 40-1993)

"The condition achieved by application of heat, chemical sterilant(s), or other appropriate treatments that renders the equipment and containers free of viable microorganisms having public health significance, as well as microorganisms of non-health significance, capable of reproducing in the food under normal non-refrigerated conditions of storage and distribution."

(Ref: 21CFR113.3)

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**Factors Determine the Sensitivity of Foods to Spoilage by Microorganisms**

- **Acidity (pH value):**
  - Low pH (high acidity) will restrict a number of microorganisms from growing and spoiling the food.
  - Foods are often divided into two main groups in terms of their acidity: high acid foods with pH 4.6 or lower and low-acid foods with pH higher than 4.6.

- **Temperature;**
- **Water Activity;**
- **Oxygen;**
- **Constituent.**

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**Target Microorganisms in Pasteurization Process for Acid Foods**

- **Target Microorganisms**
  - Yeasts;
  - Moulds;
  - Acid-tolerant bacteria (Lactobacillus and Leuconostoc)

- **Pasteurization Processes**
  - Temperatures from 90°C up to 95°C for 30 – 15 sec.;
  - or, 85°C to 100°C, 60 - 30 sec.;
  - achieve 5D – 7D reduction.

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**Target Microorganisms in Sterilization Process for Low Acid Foods**

- **Target Microorganisms**
  - Clostridium botulinum spores
  - Thermophilic spores

- **Sterilization Processes**
  - Temperatures above 100°C,
  - in-container sterilization: 115 to 120°C range and some minutes;
  - continuous flow sterilization: UHT (> 135°C) range and some seconds;
  - must achieve 12D reduction of Clostridium botulinum.

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**High Acid and Low Acid Products**

- **Food/Beverage Type**
  - High Acid (pH ≤ 4.6)
    - Juices
    - Black Tea (acidified)
  - Low Acid (pH > 4.6)
    - UHT Milk
    - Milk-based/dairy drinks
    - Juices
    - Black Tea (acidified)

Within some categories, including tea, there are some high acid products and some low acid products.

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**Hot Fill vs. Aseptic Cold Fill**

- **Semi-product**
  - Heater / Hold
  - Trim Cooler
  - Surf Tank
  - Bottle
  - Capping
  - Product

- **UHT Sterilization 135 - 140°C**
  - (85 - 95°C) (To room Temp)

- **Bottle**
  - Sterilant
  - Sterile water rinser
  - Bottle
  - Sterilant
  - Aseptic Tank
  - Capping
  - Aseptic Transfer
  - Product

- **Hot Fill**
  - Heater / Hold
  - Hot Filling
  - Bottle
  - Capping
  - Product

- **Aseptic Cold Filling Process**
  - Semi-product
  - Heater / Hold
  - Trim Cooler
  - Surf Tank
  - Bottle
  - Capping
  - Product

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**Aseptic Cold Filling Process**

- Semi-product
  - Heater / Hold
  - Trim Cooler
  - Surf Tank
  - Bottle
  - Capping
  - Product
Potential Risk Area of Hot Filling System for Low-acid Product

Hygienic Design of Filling Valve

Gravity Filling Valve

Summary

- Hot filling process is a proven and recognized method for high acid foods provided for shelf stable at ambient temperature.
- Asia countries have successfully put hot fill process of PET bottles in production of shelf stable low-acid tea drinks, especially Woo-long and green tea.
- Other sensitive low-acid products would become main stream products by using implemented hot fill technology.
- Hot fill system with implement hygienic design is the key factors for production low-acid products.

Thank you for your attention.