Types of Reduced Oxygen Packaging Processes
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ROP Workshop

Overview of ROP
- Introduction
- Definition
- Benefits
- Misconceptions and Risks

Types of Processes
- Vacuum packaging
- Cook chill
- Sous vide
- Modified Atmosphere Packaging (MAP)

Safety Concerns
- Microbiology
- Micro Applied to ROP
- Sanitation
Vacuum Packaging: Equipment

• **Single Vacuum Chamber:**
  - The lid is closed and air is removed
  - A heat seal inside the chamber that will seal the bag
  - Chamber sealers are typically used for low-to-medium-volume packaging

• **Double Vacuum Chamber:**
  - Used for medium-volume packaging
  - Spring-weighted lids or fully automatic lids
  - Commonly used for: fresh meat, processed meat, cheese (hard and soft), candy & chocolate
Vacuum Packaging: Equipment

• **Automatic Belt Vacuum Chamber:**
  o Used for high-speed packaging of large items
  o The lid generally travels straight up and down
  o Commonly used for: fresh meat (large portions), processed meat, large sausage logs, cheese

• **Thermoforming Vacuum Packaging:**
  o Products are loaded into thermoformed pockets
  o Customization for size, color, clarity, and shape
  o Commonly used for: fresh/marinated meat, sausage, cheese, candy/chocolate, grain, grab-and-go snacks (beef jerky, snack sticks)
### pH for vacuum packaging

<table>
<thead>
<tr>
<th>aw Values</th>
<th>&lt;4.2</th>
<th>4.2 – 4.6</th>
<th>&gt;4.6 – 5.0</th>
<th>&gt;5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.88</td>
<td>Non-TCS*</td>
<td>Non-TCS</td>
<td>Non-TCS</td>
<td>Non-TCS</td>
</tr>
<tr>
<td>0.88 – 0.90</td>
<td>Non-TCS</td>
<td>Non-TCS</td>
<td>Non-TCS</td>
<td>PA*</td>
</tr>
<tr>
<td>&gt;0.90 – 0.92</td>
<td>Non-TCS</td>
<td>Non-TCS</td>
<td>PA</td>
<td>PA</td>
</tr>
<tr>
<td>&gt;0.92</td>
<td>Non-TCS</td>
<td>PA</td>
<td>PA</td>
<td>PA</td>
</tr>
</tbody>
</table>

*TCS: Time/Temperature Control for Food Safety  
**PA: Product Assessment Required
Cook Chill

• The technique involves the full cooking of food, followed by rapid chilling and storage at controlled temperatures (for up to five days)

• Advanced food preparation designed to provide more flexibility in foodservice

• Maintain food quality, nutritional value, flavor and appearance
Why Use Cook Chill?

- Works well for refrigerated and frozen foods
- Savings in manpower can be substantial
- Less time and labor required
- No trained cooks are necessary at the serving locations
- Storage and inventory are easier to handle
- Cook-Chill bags are easily stackable
- Deliveries can be reduced
Why Use Cook Chill?

• Food safety:
  o Less human product contact
  o Safer handling of food since it is in a pouch
  o Pathogenic organism control
  o Spoilage organism control

• Reduces cross contamination

• Help prevent foodborne illness
Cook Chill: The Process

1. Cook
2. Pump
3. Seal
4. Blast chill or water bath
5. Store and re-heat
Cook Chill: Equipment

- Bags
- Combi-ovens
- Kettles
- Tumble chillers
- Hot water baths
- Pumps
- All-in-one tanks
If you cook then chill food: 158°F (70°C) to 38°F (3°C) within 90 minutes

If freezing cooked food: 158°F to 0°F (-18°C) in no more than 240 minutes

Bacteria grows between 41°F (5°C) and 146°F (63°C) (danger zone)
# Cook Chill

## pH for cook-chill

<table>
<thead>
<tr>
<th>aw Values</th>
<th>pH Values</th>
<th>4.6 or less</th>
<th>&gt;4.6 – 5.6</th>
<th>&gt;5.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.92 or less</td>
<td>Non-TCS*</td>
<td>Non-TCS</td>
<td>Non-TCS</td>
<td>Non-TCS</td>
</tr>
<tr>
<td>&gt;0.92 – 0.95</td>
<td>Non-TCS</td>
<td>Non-TCS</td>
<td>PA**</td>
<td></td>
</tr>
<tr>
<td>&gt;0.95</td>
<td>Non-TCS</td>
<td>PA</td>
<td>PA</td>
<td></td>
</tr>
</tbody>
</table>

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**PA: Product Assessment Required
Sous Vide

- Food is placed in a plastic pouch or a glass jar and cooked in a water bath
- 1 to 7 hours (up to 48 in some cases) at an accurately regulated temperature
- 55 to 60 °C (131 to 140 °F) for meat and higher for vegetables
- The intent is to cook the item evenly while retaining moisture
Why should I cook sous vide?

Consistency

Taste

Waste

Flexibility
The degree of accuracy and constancy of cooking temperature varies:
  - A 15 millimeters (0.59 in) thick piece of fish will cook in 17 to 18 minutes from 44°C (111°F) to 61°C (142°F)
  - But for an egg constant temperature is more critical

Sous-vide cooking continues until the center of the food has reached its target temperature:
  - Depends on the initial temperature
  - Thickness and shape of the food
  - Temperature of the bath
Sous Vide

- **Sous-vide steak vs. traditionally cooked steak:** The steak on the left was cooked with sous vide at 129°F, while the steak on the right was pan-cooked.

  - Perfectly cooked, from edge to edge
  - Loss of volume from losing moisture while cooking
  - Grey bands show overcooked edges

- **Sous-vide salmon vs. traditionally cooked salmon:** The salmon cooked with sous vide (left) remains a translucent pink. The pan-cooked salmon (right) has overcooked edges.

  - Perfectly cooked, from edge to edge
  - Loss of volume from drying out while cooking
  - Bands show overcooking
Sous Vide: Equipment

- A sous vide precision cooking device
- Packaging for your food, like resalable bags or canning jars
- A container to hold the water
Modified Atmosphere Packaging (MAP)

- Also known as reduced oxygen packaging
- Blend of pure oxygen, carbon dioxide and nitrogen within a permeable package
- An adjusted gas blend is developed for each packaged food product
- MAP reduce or delay oxidation reactions and microbiological spoilage
Modified Atmosphere Packaging (MAP)

- Extended shelf life without the addition of chemical preservatives or stabilizers
- Film permeability, water vapor transmission rates and sealing characteristics are measured
- Packaging films are selected to match the characteristics and needs of the food product
Modified Atmosphere: Packaging Materials

**Flexible films**
- Fresh produce
- Permeability for gases and water vapor

**Pre-formed trays**
- Filled at the food packaging facility
- More flexible
- Less damage of the package

**Thermoformed**
- Received as roll of sheets
- Formed at the packaging station

**Advantage:** Thermoformed packaging uses 30% to 50% less material
Modified Atmosphere Packaging (MAP)

- Fresh Meat
- Cheese
- Fruit and Vegetables
- Coffee
- Prepared Foods
- Processed Meat
- Fish and Seafood
- Bread Products
Modified Atmosphere Packaging: The Technology

• Mixture:
  o Carbon dioxide (CO2)
  o Nitrogen (N2)
  o Oxygen (O2)

• Microbial growth can be inhibited by:
  o Nitrous oxide (N2O)
  o Argon (Ar)
  o Hydrogen (H2)

• These gases can be applied individually or mixed according to specific ratios
Modified Atmosphere Packaging: The Technology

• **CO₂:**
  - Most effective in inhibiting microorganisms
  - It dissolves into the food’s liquid and fat phase
  - pH reduction
  - Changes in permeability and function

• **Nitrogen:**
  - Used to replace oxygen in packaging
  - Prevent oxidation
  - Prevent package collapse by maintaining internal volume
Modified Atmosphere Packaging (MAP)

- **Red meat** needs high oxygen to maintain the red color
- **Bread** requires low oxygen to avoid mold
- **Vegetables** often need a three-gas mixture
Modified Atmosphere Packaging (MAP)

<table>
<thead>
<tr>
<th>Product</th>
<th>Oxygen (%)</th>
<th>Carbon Dioxide (%)</th>
<th>Nitrogen (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read meat</td>
<td>80-85</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>Poultry</td>
<td>25</td>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td>Fish</td>
<td>-</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Cheeses</td>
<td>-</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Bread</td>
<td>70</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>Fresh pasta</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Fruits and vegetables</td>
<td>3-5</td>
<td>3-5</td>
<td>85-95</td>
</tr>
</tbody>
</table>
Controlled Atmosphere Packaging (CAP) — The composition of the atmosphere inside a sealed package is altered from normal aerobic conditions (21% oxygen concentration).

Unlike MAP, which is not required to maintain its conditions, the atmosphere in CAP can be controlled by using impermeable packaging or use of oxygen scavenging products.
In Summary

Types of Processes

- Vacuum packaging
- Cook chill
- Sous vide
- Modified Atmosphere Packaging (MAP)