REDUCED OXYGEN PACKAGING
Script

Contents

Module 1: MODULE INTRODUCTION

INTRODUCTION

Welcome to the web-based course on reduced oxygen packaging of food. This course is an introductory level, self-paced course. The target audience of the course is federal, state, tribal, territorial, and local food regulatory personnel as well as industry participants.

Reduced oxygen packaging, ROP, is used to extend the shelf life as well as retard and control the microbial growth in foods. Reduced oxygen packaging can preserve flavor and food product aesthetics as well as prevent water loss leading to product shrinkage. This type of packaging also presents a public health risk in that it can allow the growth of two serious illness causing pathogens – *Clostridium botulinum* and *Listeria monocytogenes*. Whether or not a reduced oxygen food presents a risk to public health depends on the interaction of a number of factors which will be covered in the course.

This course is intended to provide food safety inspectors with general knowledge of how ROP techniques can be properly used to control pathogens which pose a risk to public health. The course will also be helpful for other individuals in developing a basic understanding of ROP.

Through four modules, this course will introduce the key concepts of reduced oxygen packaging. Different types of reduced oxygen packaging as well as the gases and packaging materials used will be described. Hazards and control measures required to ensure safety of potentially hazardous foods processed using reduced oxygen packaging will be identified.

You can use the navigation tab on the left to navigate ahead in the module or utilize the orange arrow in the lower right to sequentially progress through the module.

LEARNING OBJECTIVES

In this module of the course, three learning objectives will be addressed. After completion of the module, you will be able to:

Define reduced oxygen packaging
Describe key concepts related to the use of reduced oxygen packaging and
Identify the general difference in requirements for ROP foods based on federal, state, territorial, and tribal jurisdictions

ROP BASICS

Reduced oxygen packaging is a packaging procedure that results in a reduced level of oxygen in a sealed package.

ROP is accomplished by removing oxygen, displacing the oxygen, and replacing it with another gas or combination of gases, or otherwise controlling the oxygen content to a level below that normally found in the surrounding atmosphere.

Please click on each of the images below to learn more about the basics of reduced oxygen packaging.

ROP BASICS: Atmospheric Makeup

The Earth's atmosphere and the air we breathe is comprised of approximately 78% nitrogen gas, 21% oxygen gas, and 0.03% carbon dioxide gas. ROP involves a reduction in the percent of oxygen in a package so that it is less than that of the Earth's atmosphere.

This can be accomplished in a number of ways, such as by removing the oxygen or by displacing the oxygen and replacing it with another gas. By clicking on the particles in the atmosphere below, additional details regarding that particle will be revealed. After exploring each of the particles in the current environment, use the buttons below to switch the atmosphere between normal and reduced oxygen.

ROP BASICS: Atmospheric Makeup -Oxygen Particle in Atmosphere

These oxygen particles make up about 21% of the Earth's atmosphere

ROP BASICS: Atmospheric Makeup -Nitrogen Particle in Atmosphere

These nitrogen particles make up about 78% of the Earth's atmosphere

ROP BASICS: Atmospheric Makeup -Carbon Dioxide Particle in Atmosphere

These carbon dioxide particles make up about 0.03% of the Earth's atmosphere

ROP BASICS: Atmospheric Makeup -Oxygen Particle in ROP Environment

These oxygen particles make up about 10% of this ROP package's environment

ROP BASICS: Atmospheric Makeup -Nitrogen Particle in ROP Environment

These nitrogen particles make up about 89% of this ROP package's environment

ROP BASICS: Atmospheric Makeup -Carbon Dioxide Particle in ROP Environment

These carbon dioxide particles make up about 0.03% of this ROP package's environment

ROP BASICS: ROP Accomplished

Reduced oxygen packaging can be accomplished by doing one of the following:
Removing the oxygen from a package
Displacing the oxygen and replacing it with another gas or combination of gases
Controlling the oxygen content to a level below 21%.

ROP BASICS: ROP Accomplished -Removal of Oxygen from Package

In this package, the processor chose to remove oxygen from the package which resulted in an ROP environment

ROP BASICS: ROP ACCOMPLISHED -Displacement of Oxygen

In this package, the processor chose to displace the oxygen in the package with carbon dioxide. This resulted in an ROP environment.

ROP BASICS: ROP Accomplished-Controlling Oxygen Content

This package is representative of one that a processor has chosen to control the amount of oxygen content.

ROP BASICS: Control for Hazards

It is critical that ROP foods be managed, processed, transported and held in a manner that will control deadly pathogens, including *Clostridium botulinum* and *Listeria monocytogenes,* as well as protect public health. Click on each image to learn more.

ROP BASICS: Control for Hazards –ROP Package

Safe use of ROP technology demands that adequate refrigeration be maintained during the entire shelf life of potentially hazardous foods to ensure product safety.

ROP BASICS: Control for Hazards –Exp Date

Food manufacturers commonly use "Pull Dates" or "Expiration Dates" for controlling product quality throughout the full shelf- life of the food. When reduced oxygen packaging is used for potentially hazardous foods, an expiration date of 14-days is required for most products as a means for controlling *Clostridium botulinum* and *Listeria monocytogenes*. However, there are some potentially hazardous foods that require a 30-day expiration date to control these pathogens.

ROP BASICS: Types of ROP

There are five ROP packaging options:

- Cook Chill
- Controlled Atmosphere Packaging
- Modified Atmosphere Packaging
- Sous Vide
- Vacuum Packaging

ROP BASICS: Types of ROP -Cook Chill Package

Cook Chill uses the heat of pasteurization to help preserve the food product. This method is often used in institutional catering.

ROP BASICS: Types of ROP -Controlled Atmosphere Packaging (CAP)

Controlled Atmosphere Packaging or CAP is used in this package of beef jerky as evident by the desiccant package.

ROP BASICS: Types of ROP -Modified Atmosphere Packaging (MAP)

Modified Atmosphere Packaging or MAP is used in this package of sliced apples to prevent discoloration.

ROP BASICS: Types of ROP -Sous Vide

Sous vide is used to cook a food under a vacuum for an extended period of time at relatively low temperature.

ROP BASICS: Types of ROP -Vacuum Packaging

Vacuum packaging is often used with sausages like those pictured here.

Knowledge Check

How is oxygen removal accomplished in vacuum packaging a type of ROP?

- Oxygen is displaced with another gas or combination of gases.
- The amount of oxygen content is controlled.
- Oxygen is removed from the package.

Knowledge Check

Modified Atmosphere packaging is used in packages of _____ to prevent discoloration?

- Beef jerky
- Sliced apples
- Sausages
- Prepared spaghetti sauce

Knowledge Check

Which of the following oxygen percentages would be ROP?

- 19%
- 22%
- 24%
- 26%

Knowledge Check

Which pathogens have been discussed as an ROP hazard? Select all that apply.

- *Escherichia coli*
- *Salmonella*
- *Clostridium botulinum*
- *Listeria monocytogenes*

BENEFITS OF ROP

ROP has several benefits ranging from extending shelf-life to adding convenience to a cooking process. Click the objects below to explore more about each benefit.

BENEFITS OF ROP: Anaerobic Environment

ROP can create a significantly anaerobic environment that prevents the growth of aerobic spoilage organisms. These organisms are generally bacteria or aerobic yeast and molds. These organisms are responsible for off odors, slime, and texture changes, which are signs of spoilage.

BENEFITS OF ROP: Degradation or Oxidative Processes

ROP can be used to prevent degradation or oxidative processes in food products. Reducing the oxygen in and around a food retards the amount of oxidative rancidity in fats and oils, which results in undesirable tastes and odor.

ROP also prevents color deterioration in raw meats caused by oxygen, resulting in a better looking product.

BENEFITS OF ROP: Product Shrinkage

An additional effect of sealing food in ROP is the reduction of product shrinkage by preventing water loss.

BENEFITS OF ROP: Extended Shelf-life

The combined effect of all the ROP benefits is an extended shelf-life for vacuum packaged, modified atmosphere packaged, and controlled atmosphere packaged foods displayed for retail sale.

BENEFITS OF ROP: Benefits for sous vide and cook chill

Although cook chill and sous vide processed food at retail cannot be sold directly to other businesses and must be consumed on premises, the extended shelf-life and quality benefits internal service and use of the products.

The marketing of products that are “Fresh - Never Frozen” and ready-to-eat convenience foods are examples of economic and quality advantages of sous vide and cook chill products.

Knowledge Check (after benefits)

True or False. The combined effect of all the ROP benefits is an extended shelf-life for vacuum packaged, modified atmosphere packaged, and controlled atmosphere packaged foods displayed for retail sale.

- True
- False

JURISDICTIONS

Different legal authorities may apply to utilize ROP depending upon whether ROP occurs at retail or involves seafood or manufactured food processing. It is critical for food safety inspectors to understand what legal authorities apply to ROP in their jurisdiction.

JURISDICTIONS: State, Territorial, Tribal, And Local Food Authorities

ROP at retail is generally conducted under state, territorial, tribal, or local retail food authorities, which may or may not be based upon the US Food and Drug Administration Model Food Code.

The Food Code is a model code and reference document for state, city, county, and tribal agencies that regulate restaurants, retail food stores, vending operations and foodservice operations in institutions such as schools, hospitals, nursing homes, and child care centers.

The 2013 FDA Model Food Code addresses ROP in Section 3-502.12 and Annex 6, Food Processing Criteria. This section provides that retail food establishments may package potentially hazardous foods using ROP without a variance if the ROP method controls the growth and toxin formation of *Clostridium botulinum.* This is also true for frozen fish, specific cook chill and sous vide processes, and certain cheese products. In most cases, the establishment must have a HACCP plan for these packaging activities, and the plan must be provided to the regulatory authority. A HACCP plan is not required when a food establishment uses a ROP method to package a TCS (PHF) food that is always labeled with the production time and date, held at 5°C (41°F), and removed from its package within 48 hours. Any other potentially hazardous foods packaged using ROP would require a variance and HACCP plan pre-approved by the regulatory authority

At the state and local levels the model may be

Enacted as a legislative statute
Broadcast as a regulation or
Adopted as an ordinance

JURISDICTIONS: FDA

The FDA has jurisdiction over products that utilize ROP and contain less than 2% meat that are involved in interstate commerce or exportation from the US. Most states also have inspection authority in wholesale manufacturers whether their products are marketed intrastate and interstate.

JURISDICTIONS: FSIS

The USDA Food Safety and Inspection Service (FSIS) has jurisdiction over products that utilize ROP and contain greater than 2% meat that are involved in interstate commerce or exportation from the US. A number of states may have State Meat Inspection programs conducting these inspections for USDA/FSIS under a Cooperative Agreement.

MODULE SUMMARY

Congratulations!

You have just completed the first of four modules. In this module, reduced oxygen packaging was introduced. Three methods used to create an ROP environment were discussed: removing the oxygen, modifying the atmosphere and controlling the atmosphere

The five types of ROP were introduced. They include cook chill, Controlled Atmosphere Packaging (CAP), Modified Atmosphere Packaging (MAP), sous vide and vacuum packaging.

Module 2: PRINCIPLES OF ROP

PRINCIPLES OF ROP

Welcome to the module on the Reduced Oxygen Packaging of Food. This is the second module of a four part series on the Reduced Oxygen Packaging.

LEARNING OBJECTIVE

In this module of the course, two learning objectives will be addressed. After completing this module, you will be able to
Identify and describe the five major types of ROP and how each type is used for food
Describe characteristics and effects of the gases related to the use of ROP for foods.

TYPES OF ROP

There are five major types of reduced oxygen packaging:

- Vacuum Packaging
- Modified Atmosphere Packaging (MAP)
- Controlled Atmosphere Packaging (CAP)
- Cook-Chill
- Sous Vide

Each type of reduced oxygen packaging has unique benefits and drawbacks, however, all of the types have one thing in common: the final product will be in a sealed package in which there is little or no oxygen present. Interact with each example below to determine which type of reduced oxygen package it is.

TYPES OF ROP: Vacuum Packaging

In vacuum packaging all air is removed from a package of food and the package is hermetically sealed so that a near perfect vacuum remains inside the package.

Vacuum packaging can be conducted in stiff, non-flexible, and even hard packaging. A more familiar example is vacuum skin packaging, commonly called VSP. In VSP, highly flexible plastic packaging is used that allows the package to mold itself to the contours of the food being packaged.

TYPES OF ROP: Vacuum Packaging -Vacuum Packaging Equipment

There are 2 basic types of machines that are used for vacuum packing applications: external vacuum sealers and chamber vacuum sealers.

TYPES OF ROP: Vacuum Packaging –Vacuum Packaging Equipment: External Vacuum Sealers

External vacuum sealers use an external bag that is attached to a vacuum-sealing machine. External vacuum sealers remove the air from a bag and seal it. Some external bag machines also have an external vacuum port. External vacuum ports allow the processor to use the acrylic vacuum containers or stainless steel vacuum bowls that have removable lids. Acrylic vacuum containers and stainless steel bowls provide two advantages:

- They are reusable
- They are ideal for vacuum packaging products that would be crushed if packaged in a vacuum pouch

TYPES OF ROP: Vacuum Packaging –Vacuum Packaging Equipment: Chamber Sealers

Chamber sealers require the entire product to be placed within the machine. Once the product is placed in the machine, the lid is closed and the air is removed. The bag is then sealed and the atmosphere within the chamber is returned back to normal. In some cases, another gas or mixture of gases is added back into the bag. This is called back flushing. Chamber sealers are typically used for higher volume vacuum packing.

The size of chamber sealers varies depending on the type of product being packaged. For example, whole sides and quarters of beef require very large packaging machines.

TYPES OF ROP: Vacuum Packaging –Vacuum Packaging Meats

In the case of raw meat, which is a respiring product, oxygen is used and carbon dioxide is produced in about equal volumes. When there is no oxygen present, anaerobic fermentation occurs. The lack of oxygen in the package and the lowered pH resulting from the fermentation will inhibit any spoilage bacteria that may be present on the meat

TYPES OF ROP: Vacuum Packaging -Vacuum Packaging Video Script Summary

Vacuum packaging is a form of Reduced Oxygen Packaging used at the manufacturing and retail segment of the food industry. While the popularity of vacuum packaging at retail has dwindled in recent years, this practice continues to be used in widespread fashion with wholesale food manufacturers. While there are food safety risks associated with this type of packaging, it is clear that this practice will extend a product shelf life, reduce shrinkage, and limit spoilage of refrigerated products.

There are a number of different types of vacuum packaging machines. Some are external types and others are chamber type machines such as illustrated here. The function of this machine is to remove all of the air from within the package of food and then hermetically seal the package. A perfect vacuum will exist within the package.

Here some freshly made cheese curd is placed into the pouch package to be vacuumed packed.

The open end of the bag or pouch is placed on the sealer bar. Care should be taken to make sure no food debris or folds in the packaging material are present that could result in a faulty seal. The pouch or bag of product rests inside the vacuum sealer.

As you can see, as the air is removed the bag draws into the product as if to wrap around the food itself. The lack of oxygen in the package inhibits any spoilage bacteria that may be present on the product. As with all types of food processing and packaging systems, sanitation and proper employee hygiene is important.

Maintaining proper refrigeration temperatures for these products is critical during storage, transportation, and retail sale.

Knowledge Check

Chamber sealers require the entire product, in its pouch, to be placed within the machine.

- True
- False

TYPES OF ROP: Modified Atmospheric Packaging

Modified atmosphere packaging is commonly called MAP. In MAP, the atmosphere of a package of food is modified so that its composition is different from normal air. MAP includes a onetime reduction in the proportion of oxygen or a total or partial replacement of oxygen with other gasses such as carbon dioxide or nitrogen. The atmosphere inside the package may change over time due to three factors:

- respiration of the product
- solubility of the product
- permeability of the package used

Compared to vacuum packaging, MAP is a more complex process because the percentage of each gas used is dependent on the food that is being packaged. The MAP system has to be designed specifically for the food packaged. Because of this, MAP is seldom used at retail.

TYPES OF ROP: Modified Atmospheric Packaging -Use of MAP in Raw Meat and Poultry

MAP is widely used for meat and poultry. A major goal in using MAP for raw meat is to achieve red color stability while slowing the growth of spoilage organisms.

To the average consumer, the quality of a meat product is evident from its smell, general appearance, and color. Aside from price, color is the primary factor considered by the general public when purchasing raw meat. MAP is used to create an environment in which red color is maximized.

TYPES OF ROP: Modified Atmospheric Packaging -Use of MAP in Raw Meat and Poultry: Meat Discoloration

Physical, microbiological, and chemical deterioration are the main reasons meat discolors.

Physical degradation is primarily the result of freezing. Raw meat frozen for too long will degrade and turn a brownish color. Aerobic bacteria growth can cause the meat to turn brown, however, most spoilage type organisms do not survive in an anaerobic environment. Chemical changes in raw meat such as protein denaturation, oxidation of myoglobin, hydrolysis, changes in pH, and enzyme action are also significant factors affecting the color of raw meat.

The use of carbon dioxide gas lowers the pH of the meat with the production of carbonic acid which forms when the gas dissolves in water. The lowering of the pH subsequently retards microbial growth. This process is known as gas flushing. Gas flushing is usually executed utilizing a mixture of oxygen, nitrogen, and carbon dioxide. The oxidation of myoglobin in meat to form metmyoglobin causes brown coloring of the meat. By exposing the metmyoglobin to oxygen, the discoloring effects can be reversed by creating oxymyoglobin. This reversal is known as gradual blooming.

The packaging technologist has to maintain the desirable red color of the oxymyoglobin pigment by having an appropriate oxygen concentration in the pack atmosphere, and at the same time, minimize the growth of aerobic microorganisms. Aerobic spoilage bacteria, such as *Pseudomonas* species normally constitute the major flora on red meats. Since these bacteria are inhibited by carbon dioxide, it is possible to achieve both red color stability and microbial inhibition by using gas mixtures containing carbon dioxide and oxygen.

TYPES OF ROP: Modified Atmospheric Packaging -Use of MAP in Dairy Products

MAP has the potential to increase the shelf life of a number of dairy products. These include fat-filled milk powders, cheeses, and fat spreads.

TYPES OF ROP: Modified Atmospheric Packaging -Use of MAP in Dairy Products: Milk Powders

Fat-filled milk powders spoil due to the development of oxidative rancidity. Whole milk powder is highly susceptible to the development of off-flavors due to fat oxidation. In MAP, the air is removed under vacuum and replaced with either nitrogen or a nitrogen and carbon dioxide mix. The powder is hermetically sealed in metal cans.

TYPES OF ROP: Modified Atmospheric Packaging -Use of MAP in Dairy Products: Cheeses

Cheeses spoil due to the growth of microorganisms, particularly yeasts and molds. Cheddar cheeses have traditionally been vacuum packed, but MAP is increasingly being used with high carbon dioxide concentration in carbon dioxide and nitrogen gas mixes.

TYPES OF ROP: Modified Atmospheric Packaging -Use of MAP in Dairy Products: Fat Spreads

The use of nitrogen and carbon dioxide atmospheres has significant potential for extending the shelf life of cottage cheese. Cottage cheese is a high moisture, low fat product that is susceptible to a number of spoilage organisms including *Pseudomonas* species. Use of gas mixtures containing carbon dioxide, balanced with nitrogen, can increase the shelf life significantly.

TYPES OF ROP: Modified Atmospheric Packaging -Gas Components of MAP

Back flushing occurs when oxygen is removed from a package and is replaced with other gas or gases. The gases typically used for back flushing in reduced oxygen packaged products are carbon dioxide, nitrogen, oxygen, and carbon monoxide. Click on each of the gases to learn more.

TYPES OF ROP: Modified Atmospheric Packaging -Gas Components of MAP: Carbon Dioxide

Carbon dioxide is antimicrobial. Using as little as 5% to 10% will suppress the growth of aerobic spoilage organisms. However, anaerobic organisms are not affected by carbon dioxide.

TYPES OF ROP: Modified Atmospheric Packaging -Gas Components of MAP: Oxygen

Oxygen speeds the growth of microorganisms and is necessary for aerobic spoilage organisms to survive.

TYPES OF ROP: Modified Atmospheric Packaging -Gas Components of MAP: Nitrogen

Nitrogen is inert and is used as a filler gas although it may decrease rancidity in certain products.

TYPES OF ROP: Modified Atmospheric Packaging -Gas Components of MAP: Carbon Monoxide

Carbon monoxide protects color. The FDA considers carbon monoxide to be GRAS, or generally recognized as safe. No carbon monoxide remains after a package is opened.

TYPES OF ROP: Modified Atmospheric Packaging -MAP Process Video Summary

Another form of Reduced Oxygen Packaging is Modified Atmosphere Packaging. In Modified Atmosphere Packaging, the atmosphere of a package of food is changed so that its composition is different from the normal air that exists. Additionally, the atmosphere within the package may change over time due to the permeability of the packaging material or the respiration of the food that is packaged. Food such as raw meat, vegetables and fruit will actually breathe within the package and will reduce the level of oxygen that exists there. Modified Atmosphere packaging includes a one-time reduction in the proportion of oxygen or a total or partial replacement of oxygen with other gases such as carbon dioxide or nitrogen. This form of Reduced Oxygen Packaging is much more complex than vacuum packaging as it must be designed specifically for the food being packaged.

Because of this modified atmosphere, packaging is generally not conducted in retail food establishments.

One of the more popular products that is Modified Atmosphere Packaged are meats, particularly red meats, where consumers commonly look at redness of meat as an indication of freshness. The goal and packaging of raw red meats ~~s~~ is to achieve red color

stability and slowing the growth of spoilage organisms.

What causes discoloration of meat? Physical, microbiological and chemical deterioration are the main reasons.

Physical degradation is primarily the result of freezing. Aerobic bacteria growth causes meat to become brown and chemicals changes because of the de-neutralization of protein and oxidation of myoglobin will affect the color as well. By utilizing a mixture of gases such as oxygen, nitrogen, and carbon dioxide, the browning effect of red meat can be hindered. The process of mixing these gases known as gas flushing is commonly employed. As the myoglobin is oxidized it forms metmyoglobin, which causes brown coloring of the meat. By exposing metmyoglobin to oxygen within the package, the discoloring effects can be reversed and a compound called oxymyoglobin is formed.

Oxygen barrier packages are filled with the red meat. A combination of carbon dioxide and oxygen are flushed into the package and the packages are closed. Sometimes individual packages of meat will have yet another plastic covering on top of the other one. The top film is an oxygen barrier film and it keeps oxygen from entering or exiting the package.

Sometimes, when packed in large processing plants, the box in which the individual packages of meat are stored will be modified atmosphere packaged instead of the individual packages themselves. Because of the complexity of modified atmosphere packaging, manufacturers will generally rely on processing or packaging experts to guide them in the proper films to use and the appropriate gas mixtures to utilize.

Knowledge Check

Multiple Choice: Oxygen, nitrogen, and_____are commonly used for gas flushing.

- Hydrogen
- Carbon Dioxide
- Halogen
- Sulfur Dioxide

TYPES OF ROP: Controlled Atmosphere Packaging

Controlled atmosphere packaging is commonly referred to as CAP. In CAP the atmosphere in a package of food is modified so that its composition is different from air. The modified atmosphere of the package is maintained throughout the shelf life of the product until the package is opened. Different methods can be used to maintain the controlled atmosphere of the package.

For respiring products such as fresh meat or fresh vegetables that continue to metabolize after packaging, gas scavengers or gas generators can be used to maintain an unchanging or controlled environment in the package.

For non-respiring products such as sausages or cooked meats which do not actively change

after packaging, a total replacement of the air in an impermeable packaging material will maintain an unchanging or controlled environment.

TYPES OF ROP: Controlled Atmosphere Packaging -Scavengers

Scavengers, also known as absorbers, are easily oxidizable compounds that actively modify the oxygen level, ethylene level and moisture level of packaged foods to help extend shelf life. Scavengers can be delivered via sachets, which are small permeable pouches that are placed in product packages, or integrated into packaging labels or film. Scavengers are commonly used for packaged jerky products.

TYPES OF ROP: Controlled Atmosphere Packaging -Emitters

Emitters, also known as gas generators, are compounds that actively modify the oxygen level, ethylene level and moisture level of packaged foods to help extend shelf life. In opposition to scavengers, emitters produce or generate gases to prevent package collapse.

Knowledge Check

Multiple Choice: These modify the oxygen level, ethylene level and moisture level of a package by producing additional gases.

- Scavengers
- Emitters
- Producers
- Consumers

TYPES OF ROP: Cook -Chill

Cook-Chill is a processing system where food is cooked and then packaged while the product is still hot. The cooking of the food will destroy disease causing vegetative organisms, reduce spoilage microorganisms and inactivate natural enzymes. The cooked food is portioned into bags while still hot and any air that remains is removed. The bags are crimped and then rapidly chilled and refrigerated at temperatures that inhibit the growth of microorganisms that grow at low temperatures. The cook-chill process is popular with catering operations found in institutional settings.

The safety of the cook-chill process depends on cooking foods to proper temperatures and then quickly cooling the items.

If properly carried out, the result of a cook-chill system is safe food with consistent food quality such as optimal color, texture, moisture content and nutritional value. Additionally, it provides a cost and time-saving measure to preserve food with exceptional quality. Click on the images below to learn more.

TYPES OF ROP: Cook –Chill -Danger Zone

Foods must be kept out of the temperature danger zone which is between 41°F to 135°F. Food held in between these temperatures are more likely to grow pathogenic or disease-causing organisms. Monitoring cooking, cooling and holding temperatures is important to make sure food is kept out the temperature danger zone.

TYPES OF ROP: Cook –Chill; Cook –Chill Process

This is an example of the cook-chill operation in a national chain restaurant.

TYPES OF ROP: Cook –Chill; Cook –Chill Process: Step 1

Food, mostly pourable sauces and soups, are heated or cooked in a tilt pan or on the stove. As the food is cooked or heated, oxygen is driven off, creating an anaerobic environment in the product. The cooking also destroys many of the vegetative spoilage cells and any vegetative pathogens that might be present. No more than 5 gallons are made for each recipe in this particular establishment. The sauce is poured into barrier bags which are impermeable to oxygen and moisture transmission. A metal stand holds the two bags upright for ease in filling. Care must be taken to prevent cross-contamination at this point. For example, the pitcher should not be placed on an unclean surface and bare hand contact with the inside of the bag and product must also be avoided.

TYPES OF ROP: Cook –Chill; Cook –Chill Process: Step 2

The bags are double sealed with a home-style "seal-a-meal" machine. A small amount of head space is left in the bag which makes it more flexible, easier to mix, and to cool.

TYPES OF ROP: Cook –Chill; Cook -Cook –Chill Process: Step 3

Labeling is written with a permanent marker directly on the bag. It includes the product name and the date bagged.

Ice water in a wheeled tote is used to cool down the bags of hot product. Eight to ten 1-gallon bags can be cooled down to 41°F within 1 hour. Further cooling to 34°F is required for products held up to 30 days.

TYPES OF ROP: Cook –Chill; Cook –Chill Process: Step 4

Final products are placed on trays and stored in the walk-in cooler. Products held at 41°F may be held for no more than 7 days. Other important controls for retail processing include no direct sale of the bagged product to other businesses or to consumers, specific shelf life requirements and continuous electronic monitoring.

When doing an inspection and a large number of cook-chill products are observed on trays or racks in a cooler, ask if the establishment prepares and packages the bags on-site.

TYPES OF ROP: Cook –Chill; Cook –Chill Process: Step 5

The bags of food are re-thermalized or reheated in hot water and poured directly into steam table pans for use or hot holding.

TYPES OF ROP: Cook –Chill; Labeling

Proper packaging and labeling of cook-chill products is needed for product identification, rotation, and recall purposes. Labeling food products is very important for safety and may be required by the local code. The retail label should include the product name and date packaged.

TYPES OF ROP: Cook –Chill; Cook -Chill Process Video Summary

Cook chill is a process that uses a plastic bag or pouch that is filled with hot cooked food from which air is expelled and then closed with a plastic or metal crimp. This bagged food is rapidly chilled and refrigerated at temperatures that inhibit the growth of cold welding pathogens.

This process is now used in many institutions such as schools and hospitals and central Commissary operations.

Food, mostly pourable sauces and soups, are heated to at least pasteurization temperatures. The cooking will also destroy many of the vegetative spoilage cells including pathogens that might be present. The hot product is poured into barrier bags which are impermeable to oxygen and moisture transmission. A stand holds the two bags upright for ease in filling. Care must be taken to prevent cross contamination at this point. Although the heat from this product will naturally expel any air in the bag, the top of the bag is squeezed by the employee and sealed with a metal crimp. The cooking and packaging is now completed and the product will now be labeled.

Knowledge Check

Multiple Choice: The temperature danger zone is between_____and_____.

- 41°F, 150°F
- 40°F, 140°F
- 41°F, 135°F
- 40°F, 150°F

TYPES OF ROP: Sous Vide

Sous vide means “under vacuum”. The sous vide method involves packaging in which raw or partially cooked food is placed in a hermetically sealed, impermeable bag. The food is cooked in the bag and then rapidly chilled and refrigerated at temperatures that inhibit the growth of pathogens that grow at low temperatures. Sous vide maintains the integrity of ingredients by cooking under vacuum for an extended period of time at relatively low temperatures. Click on each of the images below to learn more.

TYPES OF ROP: Sous Vide –Methods: Cook –Hold

The Cook-hold method involves vacuum sealing the ingredients, pasteurizing them, and then holding them at 130°F or above until served. The holding prevents food pathogens from growing, but it can also make the food too soft. Tough cuts of meat can be held at 130°F for 24–48 hours, but most other foods can only be held for 8–10 hours before becoming too tender.

TYPES OF ROP: Sous Vide –Methods: Cook -Chill or Freeze Method

The Cook-chill/Cook-freeze method involves vacuum sealing the ingredients, pasteurizing them, and then rapidly chilling the ingredients to avoid the formulation of spores of *Clostridium perfringens*. *Clostridium perfringens* can cause food poisoning. Chilling usually

takes place in an ice water bath for a specified period of time. The food product is then kept cold or frozen until it is reheated right before serving.

TYPES OF ROP: Sous Vide -Equipment

Sous vide equipment include counter top food warmers, water baths, rice cookers, electric burners, slow cookers, roasters and immersion circulators.

Immersion circulators are very expensive. However, use of immersion circulators are important from a culinary perspective because they ensure a constant and uniform temperature around the bagged product. When another type of equipment is used, there is a risk that water near the heating elements will be hotter than others parts of the water bath. This results in different parts of the food product being cooked at different temperatures and should be avoided in sous vide processing.

TYPES OF ROP: Sous Vide -Sous Vide Process Video Summary

The video you are about to see is entitled "Introducing the Sous Vide Professional" produced by the Polyscience Corporation. The video shows a step-by-step illustration of the sous vide process including the precise temperature controls that are maintained to create the perfectly cooked food product.

I'm Phillip Preston, President of Polyscience and Creator of the Sous Vide Professional, a precise temperature system. For years Polyscience has supplied the world's best chefs with Sous Vide equipment, and now we are proud to introduce the Sous Vide Professional, our next generation system.

In this video, I'll demonstrate how to use the Sous Vide Professional, step-by-step. I'll discuss all the features and benefits and provide tips to insure instant success with your first Sous Vide cooking experience.

Sous Vide is a technique that achieves perfect, repeatable results every time. Instead of relying on precise timing, as in traditional cooking methods, Sous Vide relies on precise temperature control, ensuring exact doneness throughout. Eggs are one on the best ways to demonstrate, how much only 1 or 2° F impact the doneness of food. Sous Vide maintains the integrity of food by cooking it in a pouch, in a gentle precise and consistent water bath. The result, amazing flavor and moisture, without loss of nutritional value and with the Sous Vide Professional cooking system everyone can achieve professional results.

The Sous Vide Professional precisely controls temperature within 1/10° F. It provides improved temperature consistency through circulating the water, which is especially key for delicate foods. Circulating water is the best way to get consistency and temperature uniformity. The Sous Vide Professional is flexible for all your needs. It can be clamped to any reservoir, from a stockpot to a 30qt tank.

To set-up the Sous Vide Professional cooking system, you clamp the unit to the pot, then you fill the water between the minimum and maximum level as indicated on the front of the unit. Next, you plug the power cord in and switch the unit on. You can then press the menu button to switch between Centigrade and Fahrenheit. You can set the temperature you want with the up and down button.

The Sous Vide cooking technique can be used for a variety of foods, slow poached eggs, meat, seafood, artichokes, root vegetables, fruits and also for custards. I'll demonstrate the basic steps of Sous Vide cooking with beef tenderloin. First, you season the beef tenderloin and vacuum seal it. Place it into the water bath with the correct temperature, in this case 138° F, and let it cook for between 45 minutes and 1.5 hours. Once it is cooked, remove it from the bag and sear quickly on both sides to give it a crust, and when I cut it, you will see the perfect doneness and uniformity. There are no overcooked or undercooked parts. You can see the moist and tender texture.

To safely remove the circulator from the bath, unplug the power cord, and do not immerse the unit in water. Wipe and dry the unit before storing it away. The Sous Vide Professional is so compact it can store in a typical kitchen drawer.

The Sous Vide Professional is designed with the input of many of the world's greatest chefs to give you professional results every time. Inside the box, you will find an easy to follow user's guide with important instructions on functionality as well as a quick-step guide with ten Sous Vide recipes. These simple yet delicious recipes are the perfect introduction to the art of Sous Vide cooking, and, as an added bonus, we've included Chef Thomas Keller's exclusive guide to Sous Vide. In it, Chef Keller discusses various aspects of Sous Vide cooking and provides 19 detailed recipes. There's also a comprehensive safety section, essential reading to those new to the art of Sous Vide cooking.

Knowledge Check

True or False: Sous Vide cooks a product under a vacuum.

- True
- False

MODULE SUMMARY

Congratulations!

You have just completed the second of four modules. In this module, the 5 types of reduced oxygen packaging have been covered. These 5 types include vacuum packaging, modified atmosphere packaging, controlled atmosphere packaging, cook-chill and sous vide.

Although each of the ROP types are accomplished in a different manner, the resulting packages all result in an anaerobic environment.

Module 3: HAZARDS OF ROP

INTRODUCTION

Welcome to the module on the Hazards Associated with the Reduced Oxygen Packaging of Food. This is the third module of a four part series on the Reduced Oxygen Packaging.

Learning Objectives

In this module of the course, three learning objectives will be addressed. After completing this module, you will be able to

- Identify microbiological and other hazards associated with ROP of foods
- Describe the "Hurdle" concept and how it relates to the safety of ROP

Identify the consequences of the inappropriate use or the failure of ROP to keep packaged foods safe.

MICROBIAL GROWTH FACTORS

There are multiple factors that impact microbial growth in reduced oxygen packaging. These factors include the available oxygen, temperature, acidity and alkalinity, water activity, the type of food and competitive microflora. Please click on each factor to learn more.

MICROBIAL GROWTH FACTORS: Oxygen

Bacteria fit into one of three categories with respect to oxygen: aerobic bacteria are dependent on oxygen whereas anaerobic bacteria are intolerant of oxygen. Facultative bacteria can grow under either aerobic or anaerobic conditions. Generally facultative bacteria are able to grow much faster if oxygen is present.

Oxygen availability in ROP foods is affected by the types of packaging used and bacterial growth. For example, aerobic bacteria can use oxygen and create an environment where anaerobic bacteria take over.

MICROBIAL GROWTH FACTORS: Temperatures

Bacteria have different tolerances for temperature. Adequate temperature must be reached based on the product being packaged.

MICROBIAL GROWTH FACTORS Acidity and Alkalinity (pH)

pH is a term used to describe the acidity or alkalinity of a solution. A pH of 7 is considered neutral. pH values below 7 are acidic, while those above 7 are alkaline. Most bacteria grow best at about pH 7 and grow poorly or not at all below pH 4.

MICROBIAL GROWTH FACTORS: Water Activity

Water activity (a_w) is a term used to describe the availability of water to microorganisms. Generally, the lower the water activity, the lower the growth rate of organisms.

MICROBIAL GROWTH FACTORS: Types of Foods

TCS (PHF) foods are foods that that requires time/temperature control for safety to limit pathogen growth or toxin formation.

MICROBIAL GROWTH FACTORS: Competitive Microflora

Food may become contaminated with a wide variety of microorganisms as a result of harvesting, processing and handling activities. These organisms can continue to grow during food storage and distribution. The development of these microorganisms and their resulting biochemical and chemical reactions is dependent upon the food. Common spoilage bacteria in ROP foods are facultative. They are live competing organisms and can grow faster than pathogens and out compete them for nutrients.

Knowledge Check

Multiple Choice: These are the microorganisms that are naturally occurring in food.

- Water Activity
- Competitive Microflora
- *Listeria botulinum*
- *Clostridium monocytogenes*

ROP HAZARDS

There are several hazards associated with reduced oxygen packaging.

ROP HAZARDS: Bacteria

Bacteria responsible for food borne illness can be categorized into two groups. One group multiplies in the intestinal tract and causes infections. Examples include bacteria such as *Salmonella* serotypes, *Campylobacter jejuni* and pathogenic *Escherichia coli.*

The second group produces toxins in the food or intestinal track and results in intoxication. Examples include bacteria such as *Bacillus cereus*, *Staphylococcus aureus*, C*lostridium botulinum* and *Listeria monocytogenes*. Click on each bacteria to learn more.

ROP HAZARDS: Bacteria -Clostridium Botulinum

Clostridium botulinum can be found everywhere. It produces a potent neurotoxin that causes botulism. Botulism is a severe food poisoning that is characterized by double vision, paralysis, and occasionally death.

Clostridium botulinum spores are relatively heat-resistant, and can survive most minimal heat treatments that destroy vegetative cells. The toxin can be present in the food, yet the food have no foul odor, off color or bad taste. *Clostridium botulinum* will not grow at a water activity of .94 or less. It can grow at pH values as low as 4.6.

ROP HAZARDS: Bacteria -Listeria Monocytogenes

Listeria monocytogenes causes a bacterial disease called Listeriosis which is particularly dangerous to highly susceptible populations which include infants and children, the elderly, pregnant women, and those with weakened immune systems.

Listeria monocytogenes is capable of surviving or thriving in cold temperatures. *Listeria* poses a high risk to refrigerated ROP foods because it is able to grow at temperatures as low

as 0°C.

Listeria is very persistent in the food processing environment. As a result, cross contamination of a product following a heating step and prior to packaging is a real possibility with this organism. Strict GMP controls must be followed. *Listeria* is also able to grow at a water activity level as low as 0.93 and at pH values as low as 4.5. Extended shelf-life refrigerated foods and temperature are common factors in outbreaks.

ROP HAZARDS: Parasites

There are three distinct groups of parasites: protozoa, flatworms and roundworms. Parasites may have one or more other animal hosts in their life cycle. Parasites do not proliferate in food, only in living organisms.

ROP HAZARDS: Natural Chemical Hazards and Toxins

The primary natural chemical hazard is scombrotoxin, which is a histamine formed by certain bacteria as a result of time and temperature abuse of certain fish species such as mahi-mahi, tuna, marlin and bluefish. Ingestion of scombrotoxin in sufficient doses results in scombrotoxin poisoning. Symptoms of scombrotoxin poisoning include headache, dizziness, tingling or burning in or around the mouth or throat, respiratory distress, and heart palpitation.

ROP HAZARDS: Radiological Agents

Radiological agents include radioactive elements or materials from industrial or medical processes or waste which include radioactive elements. Radioactive agents can be introduced into the food supply from intentional adulteration of food through criminal and terroristic acts, or contamination from radiation accidents.

ROP HAZARDS: Chemicals

Chemicals include environmental contaminants such as heavy metals and organic chemicals, including pesticides. Food may be adulterated through bioaccumulation of chemicals in their growing environment. Food may also be intentionally adulterated through criminal and terroristic attacks and unintentionally adulterated through contamination by chemicals in the processing environment or packaging

ROP HAZARDS: Allergens and Additives

Foods may contain allergenic proteins which pose a health risk to sensitive individuals. These major food allergens include milk, eggs, fish, crustacean shellfish, tree nuts, peanuts, wheat and soybeans. Exposure to these allergens may lead to symptoms which include a tingling sensation in the mouth, swelling of the tongue and throat, difficulty in breathing, hives, vomiting, abdominal cramps, diarrhea, drop in blood pressure, loss of consciousness, and, in severe cases death.

Certain food and color additives can also cause hypersensitive reactions or food intolerances in some individuals. Examples include sulfating agents and Yellow No. 5 food color.

ROP HAZARDS: General Physical Hazards

General physical hazards include glass or metal fragments which can cause damage to teeth, laceration of the mouth and throat and perforation of the intestine.

Knowledge Check

Multiple Choice: Which of the following bacterial hazards survives and thrives in cold temperatures?

- *Clostridium botulinum*
- *Listeria monocytogenes*
- *Salmonella*
- *Campylobacter*

HURDLE EFFECT

Use of ROP with some foods can markedly increase safety concerns. Unless TCS (PHF) foods are protected inherently, simply placing them in ROP without regard to microbial growth will increase the risk of food borne illnesses. Safe use of ROP requires adequate refrigeration to be maintained by processors and consumers. Because it is difficult to maintain sufficiently low temperatures throughout the production, distribution and storage of ROP foods, hurdle or barrier technology must be employed.

The hurdle concept means that multiple factors and technologies are combined to control microorganisms when single factors alone would not be able to do so. Refrigeration is the primary barrier used for ROP. Examples of other barriers and hurdles include, but are not limited to, high temperature during processing, water activity, short shelf life, acidity and competitive microflora.

Knowledge Check

True or False: The hurdle concept is used to promote the growth of microorganisms.

- True
- **False**

Knowledge Check

True or False: ROP inhibits pathogen growth.

- True
- **False**

Module Summary

Congratulations!

You have just completed the third of four modules. In this module, the hazards associated with reduced oxygen packaging have been discussed. Although there are many hazards possible, the most notable are pathogenic bacteria. These pathogenic hazards include *Listeria monocytogenes* and *Clostridium botulinum*. Failure to control these hazards present a significant public health risk.

Module 4: Controls for ROP

INTRODUCTION

Welcome to the module on the Controls for Reduced Oxygen Packaging of Food. This is the fourth module of a four part series on the Reduced Oxygen Packaging.

Learning Objectives Slide

In this module of the course, two learning objectives will be addressed. After completing this module, you will be able to

- Describe approved packaging films for food and the appropriate uses of each
- Identify general control measures required to maintain safety of food packaged under ROP

KEY TERMS: Good Manufacturing Practices

Good Manufacturing Practices, or GMPs, is a production and testing practice that helps to ensure a quality product. Many microbiological food safety problems can potentially be addressed by good manufacturing practices. Some examples include proper employee hygiene, adequate training and effective cleaning and sanitizing of manufacturing equipment and environment

KEY TERMS: Good Retail Practices (GRPs)

Good Retail Practices, or GRPs, are preventative measures to control the addition of pathogens, chemicals and physical objects into foods.

KEY TERMS: Standard Operating Procedures (SOPs)

Standard Operating Procedures, or SOPs, are written documents specifying the who, what, how, where and when of a task necessary for a prerequisite program.

KEY TERMS: Standard Sanitary Operating Procedures (SSOPs)

Standard Sanitary Operating Procedures or SSOPs are written documents specifying practices to address general hygiene and measures to prevent food from becoming contaminated.

KEY TERMS: Cold Chain

Cold chain is a term used to describe the series of interdependent operations in the production, distribution, storage and retailing of chilled and frozen foods. Control of the cold chain is vital to preserve the safety and quality of refrigerated foods.

KEY TERMS: HACCP

HACCP stands for Hazard Analysis and Critical Control Points. The HACCP concept is a means of implementing a systematic approach to food safety which helps to prevent foodborne outbreaks and food recalls. HACCP is based on the application of technical and scientific principles to identify, control and document the safe production of foods.

KEY TERMS: HURDLE Concept

Hurdle Concept - multiple factors and technologies are combined to control microorganisms when single factors alone would not be able to do so.

KEY TERMS: Head Space

Head space is the empty space between the packaging material and the product inside. It can continue to provide oxygen to a respiring product and for spoilage organisms for a period of time after sealing but shortly thereafter, an anaerobic environment will develop when the oxygen is used up in a bag with barrier properties.

KEY TERMS: Permeability

Permeability is the degree to which a package film allows the passage of a gas.

KEY TERMS: Oxygen Transmission Rate

Oxygen transmission rate or OTR is the steady rate at which oxygen gas permeates a film at specified conditions of temperature and relative humidity. The oxygen transmission rate is very relevant to reduced oxygen packaging as the intent is to maintain a less than normal oxygen concentration. Most of the chemical and biological reactions that create rancid oils, molds and flavor changes related to extended shelf-life with ROP require oxygen in order to occur.

Oxygen transmission rates through various plastic films are expressed in two different units depending on the country of manufacture or the manufacturer's choice. OTR in US standard units is cc/100 in^2/day at 77°F and 0% relative humidity. OTR in metric units is cc/m^2/day at 72°F and 0% relative humidity. A conversion between these two units of measure is OTR (in US Standards units) x 15.5 = OTR (in metric units).

The oxygen transmission rate is usually not printed on the packaging material but is available from the specification sheet of the manufacturer. An industry rule-of-thumb is that a material is considered a "high oxygen barrier" if its oxygen transmission rate is less than 1 cc/100 in^2/24 hrs (15.5 cc/ m^2/24 hrs).

There are packaging manufacturers that produce 10K OTR bags which comply with FDA guidelines for oxygen permeability for vacuum packaging fresh fish and have a guaranteed oxygen transmission rate (OTR) greater than 10,000 cc/m^2/24 hrs. Cryovac bags, for instance, have "Cryovac 10K OTR" printed on the back side of the bag to alert inspectors at any point in the retail or foodservice distribution system that the package permeability is within FDA compliance for fish. There are other manufacturers, however, not all of them print “10K OTR” on their bags.

A bag having an oxygen transmission rate of 10,000 cc O^2/ m^2/24 hrs or greater is not considered reduced oxygen packaging material for fish. To determine the OTR of plastic films that are not ROP for other foods, a challenge study must be conducted.

The films of sealed packages with an extremely low oxygen transmission rate can maintain a vacuum but other films with higher oxygen transmission rates will eventually reach

equilibrium with the air in time. The higher the oxygen transmission rate, the faster the internal atmosphere will reach an equilibrium with the atmosphere outside the package.

Knowledge Check

Multiple Choice: Which statement is TRUE concerning oxygen transmission rate?

- The oxygen transmission rate is very relevant in reduced oxygen packaging because pathogens in food require oxygen for growth.
- The oxygen transmission rate of a bag is easily found by looking on the packing label.
- A bag with an oxygen transmission rate of 10,000 cc O^2/ m^2/24 hrs or more is considered non-ROP for any food.
- The films of sealed packages with an extremely low oxygen transmission rate can maintain a vacuum but other films with higher oxygen transmission rates will eventually reach equilibrium with the air in time.

FILMS USED IN ROP

Plastic films or bags used for reduced oxygen packaging must meet federal standards for indirect food additives because components of the packaging materials may be absorbed by food. ROP films are generally multi-layered plastics because few if any polymers have all the necessary properties needed for a particular packaging job. Adding a layer of aluminum, a technique used in military MREs or Meals Ready to Eat, can extend the shelf life to several years.

Thicker packaging films, measured in millimeters or mils, can provide a greater gas gradient between the air and inside the package which slows the amount of gas that can move across the film in a given amount of time.

Plastic freezer bags do not maintain a complete anaerobic environment. They are intended to prevent moisture loss and reduce oxidation. The zipper or closure, even a double zipper, does not provide a hermetic seal because of openings at each end.

Corrugated boxes can have films laminated to the inside of the cardboard liner to reduce moisture or create a modified atmosphere. Strawberries and broccoli are often shipped this way.

FILMS USED IN ROP: High Density Polyethylene (HDPE)

High Density Polyethylene, or HDPE, is hard and opaque and can withstand high temperatures for short periods of time. HDPE is commonly used for milk jugs. HDPE oxygen transmission rate is 100-200.

FILMS USED IN ROP: Low Density Polyethylene (LDPE)

Low Density Polyethylene, or LDPE, can withstand high temperatures for a short time. It is made in translucent or opaque variations. It is quite flexible and tough but is still breakable. It is used for trays and other general purpose containers. LDPE is also used in combination with aluminum foil for juice and dairy products that are aseptically packaged. LDPE oxygen transmission rate is 500.

FILMS USED IN ROP: Linear Low Density Polyethylene (LLDP)

Linear Low Density Polyethylene, or LLDP or LLDPE, has higher tensile strength and puncture resistance than low density polyethylene. It is very flexible and elongates under stress. It is used to make thinner films and has good resistance to chemicals. LLDP is used for plastic bags, plastic wrap, stretch wrap, pouches, covers, lids, buckets and containers. LLDP oxygen transmission rate is 450-600.

FILMS USED IN ROP: Ethylene Vinyl Acetate (EVA)

Ethylene Vinyl Acetate, or EVA, is a soft and flexible polymer with good clarity and gloss, barrier properties and water proof properties. EVA has little or no odor and is used as an additive in plastic wraps to help create clinginess to the product being wrapped. EVA oxygen transmission rate is 700-900.

FILMS USED IN ROP: Ionomer

Ionomer is a strong choice for packaging applications where requirements include bonding to the product, seal integrity, and high packaging-line speeds. Ionomer is used in skin packaging. It is puncture resistant during processing and package handling. Ionomer is used with meat, poultry, and cheese. Ionomer oxygen transmission rate is 300-450.

FILMS USED IN ROP: Oriented Polypropylene

Oriented Polypropylene, or OPP, has become a popular film because of its unique combination of properties such as better shrinkage, stiffness, transparency, sealability, twist retention and barrier. OPP is used for vacuum bags due to its strong reliability, softness and flexibility. OPP It is widely used as a packaging material for sausages, cheeses, and fresh produce. OPP oxygen transmission rate is 100-160.

FILMS USED IN ROP: Polyethylene Terapthalate (PET)

PolyethyleneTerapthalate, or PET, is a film that has high tensile strength and has various properties which includes the ability to be manufactured clear. PET film is used to provide excellent product visibility with minimal exchange of gases between the package and its environment. PET oxygen transmission rate is 3-6.

FILMS USED IN ROP: Polyvinyl Chloride (PVC)

Polyvinyl Chloride, or PVC, is a film that is water proof and grease resistant. It has good low temperature flexibility, is not readily heat sealable and has good chemical resistance. Saran wrap is the trade name for this film. PVC oxygen transmission rate is 30-600.

FILMS USED IN ROP: Polyvinylidene Chloride (PVDC)

Polyvinylidene Chloride, or PVDC, is a film that has a remarkable barrier against water, oxygen and aromas. PVDC has superior chemical resistance to alkalis and acids and d is impervious to bacteria and mold. PVDC oxygen transmission rate is 0.1-1.

Interaction 10 - Oriented Polystyrene (OPS) 1-119

Oriented Polystyrene, or OPS, is produced by stretching extruded polystyrene film and improving visibility through the material by reducing haziness and increasing stiffness. This is often used in packaging where the manufacturer would like the consumer to see the

enclosed product. It is less expensive to produce than other clear plastics but will crack or tear easily. OPS is used to overwrap products. OPS oxygen transmission rate is 200-350.

FILMS USED IN ROP: Ethylene Vinyl Alcohol (EVOH)

Ethylene Vinyl Alcohol, or EVOH, is used to provide barrier properties, primarily as an oxygen barrier for improved food packaging shelf life. Due to their excellent barrier qualities, EVOH films are widely used with controlled atmosphere packaging, modified atmosphere packaging and vacuum packing. EVOH oxygen transmission rate is .01-.02.

Knowledge Check

Multiple Choice: This film is used for vacuum bags and has an OTR of 100-160.

- Ethylene Vinyl Acetate
- High Density Polyethylene
- Polyvinyl Chloride
- Oriented Polyethylene (Correct)

Knowledge Check

True or False: Plastic freezer bags maintain a complete anaerobic environment.

- True
- False

ROP Hazards and Controls Video

Click on each of the videos below to explore hazards and controls associated with reduced oxygen packaging.

ROP HAZARDS AND CONTROLS VIDEOS: ROP Hazards Video Summary

Reduced oxygen packaging is used to reduce the growth of spoilage organisms that discolor food and cause perishable foods to spoil. ROP can reduce product loss and shrinkage. However, industry and food protection officials must be aware that this special process also poses public health hazards.

There are a number of disease causing microorganisms that can grow in the absence of oxygen. Some of these microorganisms can grow in an environment that contains oxygen or one that does not. When spoilage organisms are inhibited from growing, these disease causing microbes will have little to no competition, and if temperatures are suitable for their growth, they will actually flourish. This can create a very serious public health concern. Two of the most prominently mentioned pathogens of concern are *Listeria monocytogenes* and *Clostridium botulinum*. The illnesses associated with these two pathogens can have serious health consequences including death.

ROP HAZARDS AND CONTROLS VIDEOS: Listeria Monocytogenes Video Summary

Listeria is a bacterium that, if consumed, can make people seriously ill, particularly those in vulnerable populations such as the sick, elderly, and pregnant women. *Listeria* has been found in soft cheeses made from unpasteurized milk, raw meat, unwashed vegetables, deli meats, and hot dogs or sausages that are not fully heated. In most cases, slight exposure to Listeria will not result in symptoms; however, those vulnerable populations

with lower immune systems are at greater risk for illness.

Listeriosis is the serious infection associated with this organism and is usually caused by eating food contaminated with the bacterium. The disease primarily affects older adults, pregnant women, newborns, and adults with weakened immune systems. However, persons without these risk factors can also be affected, although this is rare.

Listeria is ubiquitous - which simply means it can be found everywhere. It may be found in raw foods, on equipment, in the air we breathe, on the clothes we wear, and throughout our entire environment. It will also grow at refrigeration temperatures. 41°F will drastically slow its growth and is a key factor in controlling this organism. Another primary way to control *Listeria* is through sound sanitation and food handling practices. Reducing the incidence of cross contamination by keeping raw foods away from ready to eat foods is critical. Controlling *Listeria* in retail food establishments is difficult because of the nature of the business - customers coming in and leaving throughout the day can introduce this organism into the establishment. Keeping customers, vendors, and other individuals who are not directly involved in the preparation and packaging of food away from ready to eat food is critical.

The following are the three essential ways to control *Listeria monocytogenes* in retail establishments: prevent cross-contamination; practice proper sanitation; and control time and temperature.

ROP HAZARDS AND CONTROLS VIDEOS: Clostridium botulinum Video Summary

Clostridium botulinum is the organism which causes botulism. There are four types which affect humans. They are Types A, B, E and F. Types A and B are most commonly associated with the soil and with products grown in soil, such as vegetables. Type E is commonly associated with the Marine environment and products, such as fish and other types of seafood. All Types grow best where there is little or no oxygen.

Many cases of botulism are preventable. Foodborne botulism has often been from home-canned vegetables caused by failure to follow proper canning methods. However, seemingly unlikely or unusual sources are found every decade. Some examples are chopped garlic in oil, canned cheese sauce, chile peppers, tomatoes, carrot juice, and baked potatoes wrapped in foil.

To control *Clostridium botulinum* for reduced oxygen packaged foods at retail, the following controls are employed:

CONTROL MEASURES

There are several general control measures for ROP. They include temperature, hurdle technology, shelf life, sanitation, food safety management plans and training. Click each control measure to learn more.

CONTROL MEASURES: Temperature/Cold Chain Control

Temperature is the primary control for ROP. Safe use of ROP technology demands that

adequate refrigeration be maintained during the entire shelf life of potentially hazardous foods to ensure product safety. The cold chain should be maintained and monitored continuously if possible. This involves all aspects of food production, storage and distribution. Examples include but are not limited to refrigeration storage units, display cases and transport vehicles.

CONTROL MEASURES: Temperature - Product Differences of Fish

Smoked fish and other seafood can harbor *Clostridium botulinum* Type E which can grow at temperatures as low as 38° F. Several states have set temperature control storage requirements to be 38° F for these reduced oxygen packaged products. The FDA requires a HACCP plan for smoked fish because it is a high risk product for contamination with *Clostridium botulinum* and *Listeria monocytogenes*.

CONTROL MEASURES: HURDLE Technology

The hurdle concept was discussed in the previous unit. Temperature is the primary control for ROP. Adding one or more barriers, such as high temperature during processing, low water activity, short shelf life or high acidity will increase the minimum growth temperature for pathogenic microorganisms.

CONTROL MEASURES: Shelf Life - Use by Dates

Limiting the shelf life of ROP foods reduces the possibility of consumers eating a product that contains bacteria that have grown to a level that could make them ill. Although food packaging labels for ROP foods that require refrigeration must contain a refrigeration statement to maintain the product at 41°F or below, food manufacturers generally put a hold date or use by date on the products they market. This may not be required at the wholesale manufacturing level. Some states have specific requirements for manufacturers but these are generally restricted to dairy and seafood products.

Shelf-life allowed is usually longer for commercial food processing companies. Sanitation and food handling operations are considered to be under greater control in these types of operations.

The Food Code requires the shelf life for refrigeration of products that are vacuum packaged in a retail store to be limited to 30 days. Food manufacturing operations including USDA or state equal-to inspected meat plants are allowed an extended shelf life which is often 30 days or longer.

CONTROL MEASURES: Sanitation

Sanitation is a public health protection factor. Most of the food-related illnesses reported are due to food handling issues and sanitation issues. Manufacturing and retail establishments are legally required to maintain a safe, sanitary establishment. The term SSOP refers to Standard Sanitary Operation Procedures that should be written by the company to ensure employees know how to handle food in a sanitary manner and clean the facility properly. Good Manufacturing Practices and Good Retail Practices also address sanitation issues.

Food should be covered or packaged at all times to significantly reduce the possibility of being contaminated by other foods or the environment. Packaging materials can also be contaminated. They must meet sanitary standards and should be kept covered and stored off the floor.

CONTROL MEASURES: Food Safety Management Plan

The Food Safety Modernization Act requires food facilities to have a food safety management plan in place that evaluates the hazards in their operation, implements and monitors effective measures to prevent contamination and have a plan in place to take any corrective actions that are necessary.

All food manufacturing facilities must have a food safety management plan except those required by law to operate under a HACCP plan.

HACCP is a food safety management system in which food safety is addressed through the analysis and control of biological, chemical and physical hazards from raw material production, procurement and handling to manufacturing, distribution and consumption of the finished product.

The Food Code requires a HACCP plan to be developed and followed for foods packaged using a reduced oxygen method in retail establishments.

CONTROL MEASURES: Training

Training is the framework for helping employees develop their skills, knowledge and abilities. Standard Operating Procedures and Sanitary Standard Operating Procedures are written documents that specify tasks necessary for food safety and quality. They provide a foundation for an effective food safety management system. However, they can only be successful is they are communicated to employees who perform the tasks.

Employees that work in food production carry a public health burden. They must be adequately trained and educated so they are aware of the reasons why following proper food safety practices is important to prevent illnesses and death. This can only be achieved through employee training and development.

Knowledge check

Multiple Choice: Retail ROP foods that require refrigeration should be maintained at_____or below.

- 41°F
- 43°F
- 45°F
- 47°F

Module Summary

Congratulations!

You have just completed the fourth, and final, module. In the previous module hazards associated with the ROP process were discussed. In this module controls for those hazards have

been explained. Additionally, many types of films used in ROP were discussed. Each of these films has an intended use and are designed for a particular type of package as well as food.

The next step is to complete both the post-test and the course evaluation. You will then be able to print your course certificate of completion.