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ECOSIGN

Ecodesign for food packaging

UNIT 11: Packaging with modified ambient

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Content Unit 11, Ecodesign for food packaging

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After learning this unit, the student will be able to:

- Objective 1: Know the main types of food packaging with modified atmosphere and the materials used;
- Objective 2: Know the principles underpinning the technologies for obtaining food packaging with modified atmosphere;
- Objective 3: Know the applications of modified atmosphere food packaging

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11.1 Definitions, generalities

- Modified Atmosphere Packaging (MAP) can provide superior quality and a longer life of food, while preserving the original taste, texture and appearance of the food.
- MAP gas mixtures usually consist of the gases that make up the air: carbon dioxide (CO2), nitrogen (N2) and oxygen (O2).
- Nitrogen is an inert gas that does not react with food. When used without other gas, its function is to remove oxygen from the food.
- Carbon dioxide (CO2) reacts easily with food, creating carbonic acid. It is soluble in water and lipids and has bacteriostatic and fungistatic properties. It can be used in small amounts (10% -30%) together with nitrogen to protect oxygen and to inhibit the growth of bacteria and molds. For maximum antimicrobial effect, the storage temperature of MAP should be kept as low as CO2 solubility decreases much with temperature rise. The absorption of CO2 depends largely on the moisture and fat content of the product.
- Carbon monoxide (CO) is very effective in maintaining red color in fresh meat due to carboxy-hemoglobin formation (a stable combination of carbon monoxide and hemoglobin that forms during carbon dioxide poisoning). It is a highly toxic gas and is not approved by regulators due to the possible danger to packing machine operators.
- **Argon (Ar)** is inert, colorless, odorless and tasteless. Due to its similarity to nitrogen properties, argon can replace nitrogen in some applications.

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11.1 Definitions, generalities II

- **Oxygen (O_2)** is highly reactive with food, causing both oil oxidation (grubbing) and food for aerobic microorganisms; is usually excluded in food preservation. For certain foods, there is reason to keep an amount of oxygen in their packaging. Thus, one of the major functions of O_2 in MAP meat is the maintenance of myoglobin (Mb) (a protein present in skeletal and cardiac muscle fibers, which plays a role in oxygen binding in its stable oxygenated form). This is the form responsible for the red color, which most consumers associate with fresh red meat. A similar effect is also obtained when using NO.
- **Hydrogen (H_2)** and **helium (He)** appear in modified atmospheres in some applications. However, these gases are not used to extend the shelf life. They are used as leak detection gases. Since these gases are expensive and not easy to handle, their use is rare. The most common method for leakage testing is CO_2 detection, which is the basic component in many MAP processes.
- The gases used for MAP must be indicated on the label. In addition, according to EU Regulation 95/2 / EC, the gases used should be listed with their corresponding E number (Table A.1 in Annex 1 of the course)

MAP pasive

- Usually, the change process aims to decrease the amount of oxygen (O_2) by moving it from 20.9% in air to 0% to slow aerobic growth and prevent oxidation reactions. This is the technique used mainly for meat, chicken, bakery and similar products.
- For fresh fruit and vegetables, O_2 has to get into the packaging and CO_2 comes out of the packaging, because the fresh look requires the "brewing" of fruits and vegetables. In order to diminish ethylene production of food, atmospheres that do not contain O_2 and / or CO_2-rich are generally used.

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11.1 Definitions, generalities III

MAP active

- The active MAP concept (which uses active materials and objects) has been developed to address passive MAP deficiencies. For example, when a film is a good barrier to moisture, but not to oxygen, the film can still be used with an oxygen absorber to exclude oxygen from the packaging. Similarly, carbon dioxide absorbers / emitters, ethanol emitters and ethylene absorbers can be used to control the oxygen levels inside the MAP.
- Thus, the MAP system is an active system in which the breathing of the packaged product and the passage of gas through the packaging film take place simultaneously. Therefore, the oxygen consumed during breathing is replaced simultaneously by the oxygen intake. Also, an equal amount of carbon dioxide that is produced by the packaged product is removed from the packaging. As a result, the air composition remains constant. This state is known as a state of equilibrium.

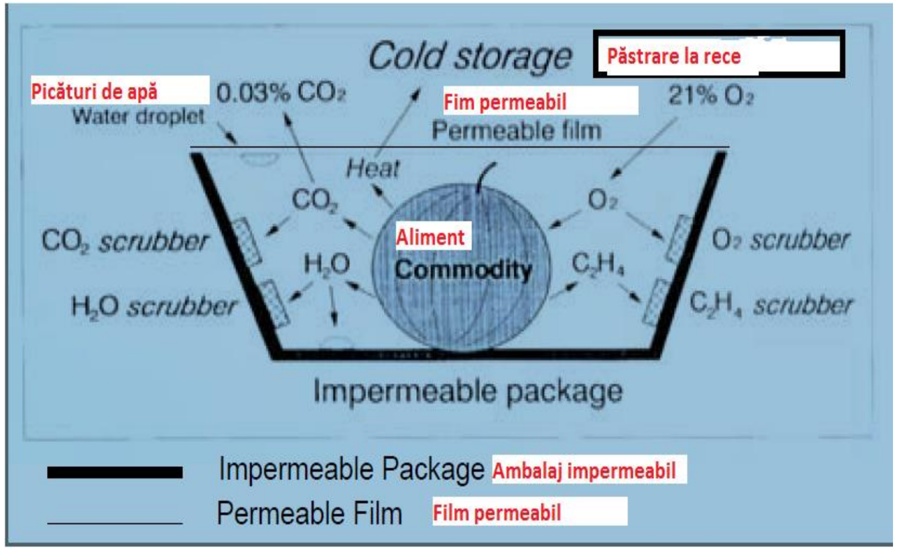

Fig 1. Active MAP packaging-Scruber
După: Amita Venkatesh, MODIFIED ATMOSPHERE PACKAGING (MAP), (The Half Guide), www.packagingconnections.com

Fig. 2 MAP pasiv

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11.3 Benefits and disadvantages MAP I

- **Benefits :**

1. Longer / superior storage time.
2. Less waste due to longer durability of packaged food.
3. More sales opportunities (perishable goods can be transported over longer distances).
4. Fewer preservatives (consumers get products containing few artificial additives or not at all).
5. Designing attractive packages (MAP is well suited for designing and presenting the most appealing packaging and for presenting the food).

- **Disadvantages:**

1. High complexity (Possible failures: Incorrect gas composition or leakage due to defective temperature or pressure distribution, contaminated or worn instruments, sealing contamination or imperfect materials).
2. Relatively high cost (In addition to high-quality films, gas consumption and staff costs for quality control are particularly expensive).
3. Influence on product quality (For example, an excessive concentration of CO_2 can be absorbed by the food and makes it more acidic / acre).

11.4 Gas mixtures:

There are three types of gas mixtures used in modified atmosphere packaging:

1) Inert gases (N_2, Ar)
2) Semi-reactive gas mixtures (CO_2 / N_2 or O_2 / CO_2 / N_2)
3) Reactive gas mixtures (CO_2 or CO_2 / O_2)

In Annex 1, Tab. A1 course, the recommended food blends are presented.

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11.3 Benefits and disadvantages MAPII

Extension of shelf life using MAP		
Product	Shelf life (days)	
	Air	MAP
Beef	4	12
Bread	7	21
Cake	14	180
Chicken	6	18
Coffee	3	548
Cooked meat	7	28
Fish	2	10
Fresh pasta	2	28
Fresh pizza	6	21
Pork	4	9
Sandwiches	2	21

11.5 Materials for MAP

Main features to consider when selecting MAP materials:

1) Breakthrough resistance
2) Reliability of tightness
3) Anti-Steam Properties
4) Permeability of carbon dioxide
5) Oxygen permeability
6) Water transmission rate

The CO_2 permeability should be 3 to 5 times the O_2 permeability. Many polymers used to make MAP films are in this area. (Annex 1, table A.5 course). The gas permeability of the polymers is $CO_2 > O_2 > N_2$, and the CO_2 / O_2 and O_2 / N_2 ratios are usually approx. 5. It is therefore often possible to estimate the permeability of the material to CO_2 or N_2 when O_2 permeability is known.

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- **Ethylene vinyl alcohol (EVOH) - ethylene copolymerized vinyl alcohol - Good gas barrier and low moisture sensitivity,** good mechanical strength and oil and organic solvents.
- **Polyamide PE (Nylon) -** Relatively high strength and hardness make it ideal for vacuum pouches for fresh meat, where bones can perforate other plastics. The nylon is generally laminated with PE which provides the hot seal properties.
- PET is a good barrier to gas and water vapor, it is resistant, provides good clarity and is temperature resistant. Crystalline PET (CPET) is weaker in optical properties but has an improved heat resistance melting above 270 ° C. Flexible PET film is used for barrier bags and cover covers for tray trays. CPET is used for pre-formed double trays for microwave ovens and convection ovens for food.
- **PP foam** and also PS and **PVC foam** are used to provide structural properties for laminates for MAP when combined with an EVOH barrier and PE as a hot-seal sealant.

Commercial use of MAP:

- Bags (made of several layers of metallic plastic) in a cardboard box or laminated cardboard boxes;
- Polypropylene oriented films (OPP);
- Cling films see Fig. 2;
- Films that react to temperature;
- Micro perforated films;
- Active clay films (a variety of alumino silicates in fine powder form) embedded;
- PLA (polylactic acid) films.

Fig. 2 Cling films

11.6 MAP technologies

- There are two different techniques for removing air from the packaging:

1) **Gas scrubbing - In the gas scrubbing process**, replacing the air inside the MAP is carried out by a continuous gas stream. This gas stream dilutes the air from the atmosphere surrounding the food product. The packaging is then sealed. Typical residual oxygen levels in gas-scrubbed packages are 2-5% O2. The speed of the process can be very high.
2) **Compensated vacuum -** Removes indoor air by causing a depression of the atmosphere inside the packaging and then filling the package with the desired gas mixture with this depression. Since air replacement is carried out in two stages, the speed of operation of the equipment is slower than that given by gas-washing technology. As the air is removed by vacuum and is not simply diluted, the efficiency of the waste air technology is better.

- **Sealing - Film features** (thickness and surface treatments) and plastic composition (resin type, molecular weight distribution, and presence of additives) determine the machine settings for the sealing operation. The correct combination of time, temperature and closing pressure parameters is essential to produce a good seal.

11.6.1 Packaging machines with modified atmosphere

- **Packing machines by thermoforming (see also heading 8, point 8.3.2, course).**
- **Vacuum chamber machines**
- **Filling, filling and closing machines for gas washing (form, fill, seal machine, or FFS machine).**

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a) Packing machines for thermoforming

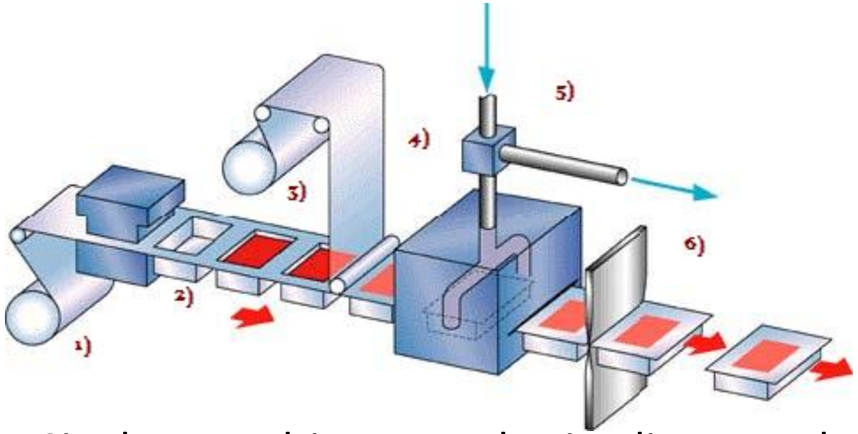


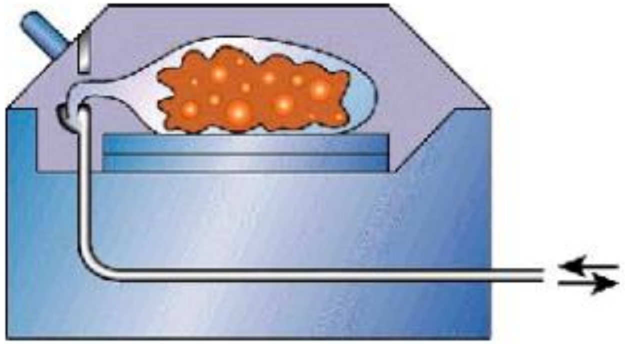
Fig. 3. (A2.5 Course outline 2) Blueprint of the thermoforming machine with compensated vacuum, fed by two film coils. A thermoformable inner film (1) is formed in a die (2). The food product is placed in this tray and covered by a superior film (3). A vacuum (5) is created in the tray and thanks to it comes the gas mixture (even before the upper film is closed by hot welding).
WITT manual, Modified Atmosphere Packaging (MAP) in the food industry - LMMappe_UK_30722

Single or multi-step packaging lines reach 4-20 strokes per minute depending on the size of the packaging and the product. The typical gas mixture demand is about 20-100 grams and is also dependent on the size of the pack and the number of races. Larger systems operate with gas capacities up to 200 slm.
(slm - liters standard per minute)

b) Vacuum chamber machines

These machines use preformed trays and use compensated vacuum technology to replace the air. In the machine of FIG. 4, the preformed plastic trays are manually introduced into the chamber prior to the air outlet, followed by washing with the desired gas mixture and hot sealing.

fig.4



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Filling, filling and closing machines for gas washing (form, fill, seal machine, or FFS machine).

They can be Vertical (VFFS) or Horizontal (HFFS). (See also 8.3.1 and Annex 1.5 of Unit 8)
VFFS machines produce a wide range of products that can be divided into four main groups:

- bulk goods ranging from peanuts and cakes to bolts and bolts,
- powders, ex. ground coffee and dehydrated milk, - granules, e.g. detergents;
- liquids: ex. ketchup, mayonnaise, salad dressing - They are able to produce the order of 120 packs per minute (depending on the size of the packaging).

Unlike thermoforming, the air is not initially exhausted but is constantly flushed with gas mixture before sealing. Consumption of the gas mixture in this case is much higher than for the packaged exhaust, as part of the gas mixture is lost. Consumption of gas mixture is 30-300 slm. Such a machine is shown in Figure 5 of the following slide (A2.6 Annex 2 course).

Production of bags (sacks).

In theory, all vertical packaging machines work the same way. A flat film layer, coming from a large roll of film at the entrance of the machine, is formed into a tube. This tube is closed at the bottom: this is the bottom of the new bag. Once the product is distributed in the bag, the top is also closed.

The gas tube.

The gas is introduced into the bag through a gas tube which is mounted in the forming tube and connected to a gas tank or **gas mixer**. A flowmeter regulates the amount of gas pumped into the packaging. The diameter and shape (round, rectangular or oval) of the gas tube depends on the amount of gas desired and the space the tube is provided with.

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Forming, filling and closing machines with gas flushing

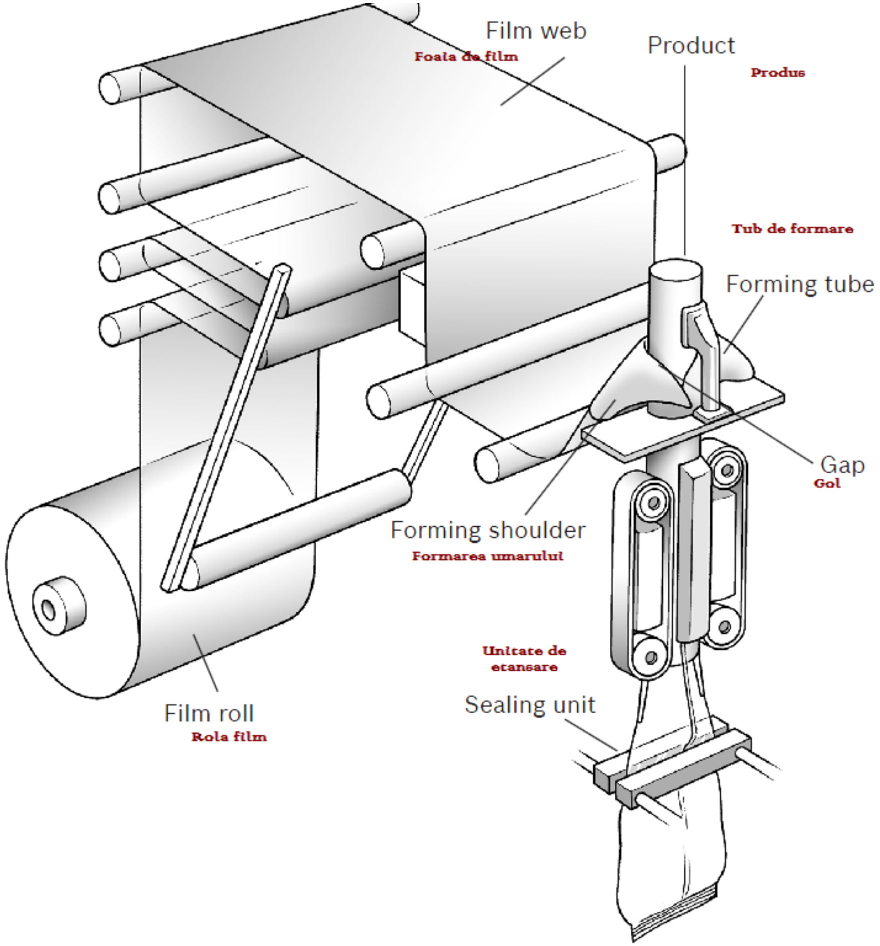
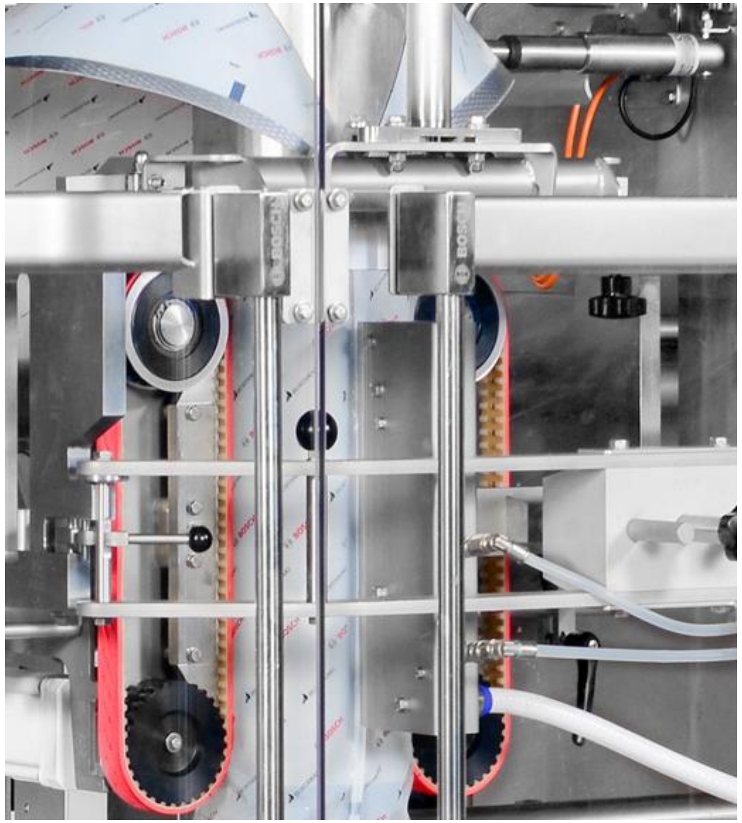


Fig 5 (A2.6 from the course) VFFS machine



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Regulations UE

Links:

European Regulation on "principles and requirements of food law" - including traceability requirements - Regulation No 178/2002

http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:031:0001:0024:EN:PDF

DIRECTIVE No 95/2/EC of 20 February 1995 on food additives other than colours and sweeteners

https://www.fsai.ie/uploadedFiles/95_2_EC.pdf

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