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The polymeric packaging in the food industry

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***Abstract*— The polymer packaging is firmly established in our lives, today it is difficult to imagine that at the beginning of the last century there have were no plastic products. The successful development of polymeric packaging materials for long-term storage of food in the food industry is happening due to the efficiency of the polymers and their production is a relatively inexpensive and practical one.**

With their minimum weight and cost, the polymeric packaging materials (films) while effectively retaining high quality of the food products in selling goods for a long time are to maximally facilitate opening, cooking and consuming the said products.

***Index Terms*— packaging, polymer, control, plastic, menegment.**

I. INTRODUCTION

One of the main features for the modern packaging is not now just to safeguarding the product from external influences, but also changing a nature of the product to interact with the environment through the mediation of the package. In practice, the interactive packaging is widely spread to changing their properties under external influence and control over the environment within the package that is enabling the purposeful physical, chemical or biological effect to the packaged product [1] .

The biochemical processes taking place inside the food, and its preservation is undoubtedly influenced by the composition of the gas environment within the package that defines the interaction between the environment (gas phase) within the package, the packaged product and the outside through the wall of the package. The conventional packing has the following composition of the gas atmosphere: oxygen (21%), nitrogen (78%), carbon dioxide (about 0.1%), noble gases and water vapor, the amount of which depends on temperature and humidity at a given time. The content of a various quantity of water vapor, oxygen, carbon dioxide, nitrogen, other inert gases within the gas phase inside the packaging prevents, slows down or accelerates certain processes occurring in the food product. Dynamics of changes in the gaseous environment of the film is determined by the primary packaging composition of the atmosphere, the permeability of packaging, release and absorption of gases inside the package [1] ,[2].

II. TYPES OF POLYMER PACKAGING

There are several varieties of packaging with a modified internal gas atmosphere (phase) due to the problems arosen in the course of the storage of certain foodstuffs [3], [5] :

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■ modified atmosphere packaging – MAP.

The air is removed from the package to replace with a gas or gas mixture. The gas mixture is selected depending on the product type. The gaseous atmosphere inside the packaging is constantly changing throughout the entire product shelf life due to factors such as the "breathing" of the packaged product (oxygen uptake and release of carbon dioxide), biochemical changes in the product and the associated discharge of vapors and gases, as well as the gradual penetration into the free space product of atmospheric gases and vapors through the package wall and through the microperforations in the welds;

■ vacuum packaging – VP.

The changes to occurring within the internal gaseous atmosphere. The product was placed in a package made of a film with low oxygen permeability and other gases, and air was removed. The pressure inside the evacuated package becomes subatmospheric. The film is compressed and fits the product before than the package is sealed. Under favorable conditions, the oxygen level within the vacuum package is reduced to less than 1% .;

■ isobaric packaging – IP.

inside of which is maintained close to the atmospheric pressure, it is a better solution than Evacuated packaging;

■ gas packaging – GP. often produced by mechanical replacement of air gas or gas mixture;

■ controlled atmosphere packaging – CAP.

a new generation of film packaging, inside which an artificial atmosphere is formed and maintained by passive or active means

Formation of the atmosphere in the package in a passive way is most often performed using a discharge of the product itself. For example, fruits and vegetables after the harvest continue to "breathe" by absorbing oxygen, releasing carbon dioxide and water vapor. If the product's ability to "breathe" exactly correlate with the permeability of the packaging film, it can be a passive way to create a favorable modified atmosphere inside the package by balancing the concentration of oxygen and carbon dioxide.

Formation of the atmosphere in the packaging is carried out in an active way by introducing certain additives in the packaging film or the package to change the composition of the gaseous phase of the product and increase its shelf life. Such additives include oxygen scavengers, absorbers / carbon dioxide highlighters, ethanol, ethylene absorbers, etc .;

■ self-control gas atmosphere packaging – SGAP

used for fresh products: herbs, flowers, vegetables and fruits. SGA can be established by the metabolism of "fresh" (raw) product and selective use of film materials, selectively skipping certain gases and vapors. At the same time within the package a certain balance O2 / CO2 / H2O establishes to depending on selective characteristics of the film, the amount of absorbed and emissions of gases and vapors. When storing horticultural products using packaging from single- and multilayer films based hydro chlorinated rubber, styrene plastics, elastomers, cellulose acetate, cellophane, and other ethylene copolymers. These materials have well passed

through CO_2, O_2 and H_2O. For products with a high physiological activity, a high level of absorption and excretion (asparagus, spinach, celery, green beans and peas, spinach, mushrooms and berries) used a microfilm in 20–100 μм;

■ actively-control gas atmosphere packaging – AGAP.

capable to regulating the composition of the gas medium inside itself using supplements that are in multiples, or injected directly into the matrix of polymeric material from which the film is made or applied to the inner surface of the package. Active gas phase modification of the product increases its shelf life and minimizes the migration of additives into the food product. For supplements, creating a protective environment within the package are:

- Moisture scavengers (dryers)
- Oxygen scavengers, and other gases (ethylene, carbon dioxide and others.)
- Highlighters for carbon dioxide,
- Ethanol,
- PH-controllers,
- Absorbers and controls odors,
- Absorbents, cleaners,
- Antimicrobial additives,
- Absorbers of the active part of the solar spectrum, and others.

The determining factor for the choice of packaging material and the gas environment inside the package, of course, is the packaged product.

Thus, polymer packaging materials have to possess the greatest barrier properties, i.e. have the ability to prevent the penetration of gases (such as oxygen, carbon dioxide), water vapor and foreign odors. A stable atmosphere inside the package is able to prevent the development of harmful microorganisms and keep the product safe for future use. Especially if the package is used as a package from a multilayer barrier film sealingly brewed under vacuum. In this case, most of the bacteria are removed the package atmosphere. Also, if the package is still further pasteurized or sterilized, the product shelf life will be extended considerably.

Taken individually polymeric materials do not possess universal properties capable of providing the entire palette consumer properties. Since some of them have excellent barrier properties to oxygen, but at the same time well permeable to water vapor. In addition, not all of them can be used as material well-welded to the material of the packaging substrate. Therefore, generally as a packaging material with good barrier properties to multilayer film is used. They are able to provide the necessary range of consumer packaging properties that preserve the product without loss of quality for a long time.

Among the most common types of films can be named with the number of layers from 2 to 5, if necessary the film with high barrier properties to make it 11 or more layers

There are 2 methods of production of such films: lamination and extrusion.

The process of lamination (bonding) for the different types of films is carried out 2 methods:

cold lamination - using various types of adhesives;

hot lamination - one or both of the layers to be bonded melt slightly or the filled layer between the molten polymeric material (adhesive).

The most common widely spread method for producing the barrier films is blown or flat slit extrusion (squeezing) polymer that melt into a single film. Meanwhile, more polymers having the desired barrier properties have extruded in a single film, but if these polymers are poorly compatible, between them polymer melt extruded adhesive composition there.

For packaging products the polymer materials are typically in use to having predetermined barrier properties, i.e. prevent, or, conversely, enhance the penetration of water vapor and foreign odors. The barrier properties of polymeric materials are strongly influenced by:

- The polymer composition,
- The size of molecules, penetrating agents,
- Solubility of gaseous substances in the polymer,
- The chemical nature and structure of the polymer,
- The presence of functional groups in its structure,
- Lyophilic or lyophobic polymer material,
- The degree of crystallinity,
- The degree of orientation,
- Molecular packing density,
- And ambient temperature.

III. MARKING OF POLYMER PACKAGING

The polymeric materials used for packaging in the food industry should be marked by means of which identified the material from which the packaging is produced, and indicates the possibility of recycling.

The symbols related materials can be performed using abbreviations or symbols in the form prescribed by interstate standards [4].

Marking of packages and containers made of polymers:

The sign for the triangle of three arrows - "Mobius loop" means that the plastic from which packaging is made, can be successfully processed, or - the packaging is completely or partially made of recycled materials:

The sign for the recycled plastic (the sign of recycling) is put on all kinds of plastic packaging. The plastic packaging materials includes the plastics of 7 groups, each of which has its own character digital code that manufacturers are writing with a view to provide information about the type of material, its processing capabilities and to facilitate the sorting procedure before sending plastic recycled for reuse.

A number for the plastics group is designated number, located inside the triangle. Under the triangle is alphabetic abbreviation type of plastic:

PETE stands for polyethylene terephthalate that used for making the various packaging materials (bottles, boxes, etc.) for dispensing different beverages, juices, water, etc .. Also, this material can be found in packages for various kinds of powders, bulk foods, etc. . PET lends itself very well recycled and reused.

Recycling: carried out mechanically (grinding) and physico-chemically. Because of recycling very different products can produce, including recycled plastic bottles.

HDPE stands for high-density polyethylene that used for manufacturing the packing packages, packages for milk and water for foods, containers for bleaches bottles, shampoo, detergents. LDPE lends itself very well recycled and reused.

Recycling: HDPE-waste is ground in special mills, after which the granules are melted again in various products.

PVC stands for polyvinyl chloride, vinyl that used for the manufacture of cans for dry food and all sorts of dietary fat. Processing: injection molding, compression molding, extrusion, calendering.

LDPE stands for low-pressure polyethylene made from plastic bags, flexible plastic packaging and some plastic bottles.

Recycling: LDPE-milled product and subsequent granulation

PP stands for polypropylene. The polypropylene is made all kinds of buckets, plastic utensils for hot dishes, disposable syringes, bags for packing sugar, containers for frozen food, bottle caps, bottles of ketchup and syrup, yogurt cups, packaging films, etc ..

Processing: injection molding, compression molding, extrusion.

PS stands for polystyrene that used in the manufacture of disposable camp utensils, food containers, cups for packaging yogurt packaging trays for food products in supermarkets (for meat, salads, cold cuts, etc.), trays for meat and poultry, egg containers. The polystyrene is a styrene polymerization product that relates to carcinogens.

Processing: extruding with subsequent crushing and granulation

OTHER. A mixture of different plastics or polymers which are not mentioned above.

Packing that marked this digital code, can not be recycled after use and sent to a landfill or incinerator furnace.

Thus, using the plastic packaging in the food industry as a safety, transportation, loading and unloading, delivery and storage of raw materials and finished products obtained by the consumer, you need to be confident in the safeguarding to use of polymeric materials.

IV. ADVANTAGES OF POLYMER PACKAGING

One of the advantages for the plastic packaging, unlike the metallic and glass containers, is that they can be selectively permeable to gases and vapors, as well as to respond flexibly to a variety of external stimuli that lead to changes in the composition and properties of a food [6] :

− **the sunlight effect** triggers the unwanted photochemical reactions in products;

− **the moisture absorption** accelerates the growth of microorganisms, bacteria, fungi, degradation products (soaking, oxidation , dissolution, etc.), loss of product quality (crispy, caking, etc.);

− **the absorption of oxygen** leads to irreversible changes in the product: oxidation (rancidity) of fat, protein denaturation, destruction of vitamins, active substances, etc.;

− **the loss of oxygen** leads to a change in red meat, cheese ripening with disabilities, the development of bacteria, rot, etc.;

− **the absorption of aromatic substances** from the external environment leads to the acquisition of third-party smell;

− **the aromatics volatilization** causes deterioration of the food product.

V. IMPROVEMENT OF THE QUALITY OF POLYMER PACKAGING PRODUCTION PROCESS

Implementation of the International management systems to entity is one of the main condition for improvement of quality of polymer packaging goods production. These management systems have a great importance for each entity and implementation such as management systems is requiring huge financial support. In this regard, different methods are being developed to facilitate their implementation.

The management systems helps to entity to gain maximum benefit from its production process. Implementing such as management systems would allow to get more benefit without any additional payments and time consuming.

CONCLUSIVE

The primary purpose of food packaging must continue to be maintaining the safety, wholesomeness, and quality of food. The impact of packaging waste on the environment can be minimized by prudently selecting materials, following EPA guidelines, and reviewing expectations of packaging in terms of environmental impact. Knowledgeable efforts by industry, government, and consumers will promote continued improvement, and an understanding of the functional characteristics of packaging will prevent much of the well-intentioned but ill-advised solutions that do not adequately account for both preconsumer and postconsumer packaging factors.

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