Polymeric Consumer Containers PET (polyethylene terephthalate) In Food Production Technologies

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Abstract. *There are many different types of food packaging on the world market, including polymer packaging. However, when using plastic packaging, it is necessary to take into account various chemical, mechanical, physical, technological, marketing factors that can affect the quality of the final food and packaging. However, the packaging of food products into various types of polymeric containers, including PET containers, causes problems of vacuum deformation of the package, which can be solved using different technological methods and parameters.*

Keywords: *food technology; polymeric packaging; ways of canning; thermal sterilization; vacuum deformation.*

Subject of study. Various materials are currently used for packaging food products - from traditional cardboard and glass to innovative polypropylene with a barrier layer.

Glass jars - consumer products from this traditional packaging material for various food products are absolutely safe and environmentally friendly. The disadvantages of containers are its lack of mechanical strength (high fragility), significant weight (up to 30% gross) and the high cost of the container itself and its transportation.

Metal jars - containers made of tin, aluminum, other metals and their alloys are most widely used in the packaging of canned products. It reliably protects goods, products from mechanical stress and oxidation. Its cons: high cost, small assortment and insufficient safety for human health (in case of violation of production and use technologies).

As studies have shown, the buyer prefers polymer packaging and this packaging is in maximum demand among the population. This group includes products from polystyrene (cups for drinks, containers for various food products, regardless of consistency), polypropylene (cups for fermented milk products), polyvinyl chloride (containers, bottles), polyethylene terephthalate (containers for salads, bulk products) and other polymers. The advantages of such materials are affordable cost, ease of processing of returnable packaging and transportation, compatibility with the production of a wide range of various products. Therefore, plastic products are now used most widely. The main disadvantages of such consumer packaging are low environmental friendliness; transmission of plastic sunlight; quite high gas permeability.

Polymeric containers include containers made from combined materials. This group includes blisters, skin packs made of cardboard and plastic film, as well as tetra-packs of paper, foil and polyethylene used to store dairy products and drinks. This can also include packaging from multilayer polymeric materials. For example, polypropylene containers with a high barrier layer. Such packaging allows to provide products with a significantly higher degree of protection against the penetration of oxygen and pollutants from the outside, to preserve the aroma and freshness of products for a long time, it is distinguished by reliability, low weight and presentable appearance. Packaging materials largely determine its types and production technologies [1].

Depending on the materials used, and accordingly on the mechanical stability and degree of strength, packaging materials are divided into **hard, semi-rigid and soft**.

Rigid, semi-rigid packaging retains its original shape and size when filled with products. It is able to withstand mechanical stress during transportation and storage. Semi-rigid packaging retains its original shape only at light loads, while soft packaging changes shape and size when filled with products. Depending on the production technology, the packaging can be blown, injection molded and pressed, thermoformed and welded. The universal materials that can be used in the manufacture of containers using all these technologies are polymers. Wide possibilities of use make this material one of the most popular on the market.

Rigid packaging - this category includes metal products (cans, containers, tubes), wood (boxes, trays, baskets, barrels), glass (bottles, cans) and polymer (barrels, boxes). Such packaging for food products provides protection of the contents from mechanical influences, and in some cases also from the effects of oxygen, microflora, ultraviolet radiation. It should be remembered that a rigid container has a large weight (25-30% gross), as well as a significant cost.

Blown packaging - suitable for packaging liquid, pasty, solid and bulk products, carbonated drinks. It is made of various thermoplastics and represents preforms from which bottles can be blown when preforms are heated to 100 ° C.

Packing from gas-filled materials - such containers (trays, cans, containers) are made of polymers that can withstand high loads and temperature extremes. It is characterized by light weight, economy, provides protection of goods from both mechanical damage and moisture, exposure to microorganisms.

Soft packaging - this type includes polymeric (bags, sacks), paper (bags, wrapping paper) and fabric (twine, ribbons) materials. They are used for mechanically stable products, as they do not protect sufficiently from damage. The advantages of such containers are low costs for the acquisition and delivery, as well as the possibility of sealing, preventing the oxidation of packaged food.

Combined packaging - obtained by the joint use of polymers, paper or other materials (foil, cardboard). Such containers allow a long time to store products, preventing the loss of its consumer properties. This type includes the following types of food packaging.

Modern polymer packaging technologies include aseptic and vacuum packaging, as well as packaging in a gas-modified environment. For liquid products (juices, dairy and soy products), aseptic polymer combined packaging technology is most often used. Vacuum polymer combined packaging is suitable for meat and fish products, while polymer packaging technology using a gas-modified medium has been increasingly used for fruits and vegetables [2].

Currently, polymer packaging and packaging are used for the production of long-term food products - canned food.

The retort bags that appeared relatively recently in the practice of the food industry make it possible to combine the advantages of “soft” packaging with the advantages of sterilized food products, since the packaging material from which they are made not only occupies no more than 5% of the mass of the finished product, but also allows for final heat treatment - sterilization of products at high temperatures both in steam and in an aqueous medium [3,4,5].

The purpose of the study is the development of technological conditions and parameters for PET polymer containers. At the same time, different methods of canning food products were used, as well as their combination.

At food enterprises, for the packaging of alcoholic, non-alcoholic drinks, vegetable oils, polymeric consumer containers made of polyethylene terephthalate (PET) are very widely used.

A food manufacturer who uses even non-hot products for packaging this type of container has a problem with vacuum deformation of the container, which occurs when the technology is violated.

The presence of vacuum deformation in a polymer container with a product leads to its non-commercial appearance (the side surface of the container can be pulled in, the bottom of the bottle becomes convex and the container loses stability), the manufacturer also has problems with the sale of finished products, storage and transportation. Production studies were conducted, as a result of which technological methods were proposed for eliminating the phenomenon of vacuum deformation of polymer consumer packaging.

The vacuum deformation of a PET plastic container when packing liquid, not hot, homogeneous, calm products is caused by several reasons:

- use in the production of thin-walled polymer bottles (insufficient wall thickness of the bottles);

- mismatch of the topography of the container body to technological conditions (the required number of stiffeners on the surface of the bottles);

- temperature difference between the product and the conditions of its packaging;

- the absence of excess pressure or an uncritical amount of vacuum in a hermetically sealed bottle;

- insufficient value of the degree of filling of the container with the product.

Upon receipt of polymer packaging at the enterprise, it is necessary to control the wall thickness and the mass of bottles. The value of these indicators should correspond to the normative values in accordance with the current technological documentation. If an enterprise producing polymer containers from a preform, it is necessary to control the mass of the preform itself, the weight of the preform is determined mainly by the final capacity of the finished bottle to be made from this preform, as well as the wall thickness of the bottle. The wall thickness of the finished bottle should prevent the occurrence of vacuum deformation of the container [6].

The surface relief of the polymer bottle depends on the design of the mold for blowing the bottles in the appropriate equipment. Therefore, this issue must be monitored when purchasing this equipment.

When filling the product into this type of container, it is necessary to control the difference between the temperature of the product and the temperature conditions when packing (temperature in the technological workshop, bottle temperature, room

temperature for the product storage, product filling temperature. The temperature difference should not exceed the standard value; therefore, it is necessary technically control the required values of this parameter and use technological methods to maintain it (heating or cooling of the product, supported by ie the desired temperature in the workplace, etc.).

In order to prevent vacuum deformation, an inert gas can be introduced into the bottle with the product when corking and excessive pressure can be created inside the sealed package, which will not allow changing the negative shape of the container — the process of displacing oxygen from the container and replacing it with an inert gas (nitrogen). This technology reduces the level of oxygen in the container, thereby reducing the degree of oxidation of the product with atmospheric oxygen, which helps to improve its consumer properties (taste, color, consistency), extend the shelf life, and improve the presentation. Overpressure in the container contributes to:

- an increase in its rigidity, which makes it possible to form transport bags that are more overall in height, with products in PET bottles, without fear of deformation of the lower layer of the product;

- reduce logistics costs;

- prevent vacuum deformation of the PET packaging during packaging of products;

- a calm product is packed in a PET bottle and immediately sealed, while the pressure in the hermetically sealed bottle with the product is higher than atmospheric, which prevents vacuum deformation of the container, if the pressure in the container is much lower than atmospheric, then the side the surface of the bottle is retracted, the shape of the container becomes non-standard and vacuum deformation occurs.

Control of the degree of filling of the container with the product will prevent packaging deformation. This is the most effective factor in solving this problem. The degree of filling of the container with the product is the difference between the full volume of the bottle and the volume of empty space in the container. Calculations and studies have shown that the relationship between the degree of filling and the occurrence of deformation of the bottles is this: the higher the degree of filling of the container with the product, the smaller the volume of the space that is not filled with the product, the lower the vacuum and the less likely the vacuum deformation. But this indicator affects the net mass of the product in the container, so there should be a correlation between these indicators [7.8].

Conclusion. The target industrial consumers of this technology are food enterprises using PET polymer consumer packaging for filling homogeneous, non-hot products.

The vacuum deformation of PET plastic containers during packaging of liquid, not hot, homogeneous, calm products is determined by several factors that need to be controlled: the use of a thin-walled polymer bottle in production (insufficient bottle wall thickness), mismatch of the container body relief to technological conditions (required number of stiffeners per surface of bottles), the temperature difference between the product and the conditions of its packaging, the absence of excess pressure or uncritical vacuum in a sealed but clogged bottle, insufficient amount of filling of the container with the product.

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