Determination of the required amount of carbon dioxide for the storage of compound feed in a soft sealed container

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Abstract. When the finished feed is stored in the air, various components are oxidized, resulting in deterioration of the feed, with the release of a rich unpleasant odor, taste and the formation of compounds of decomposition products: aldehydes, hydroxy acids, ketones and other substances. A method for packaging combined feeds in a carbon dioxide environment is proposed, which involves long-term storage. When carbon dioxide interacts with water, carbonic acid is formed, which has a positive effect on the safety of combined feed and prevents its spoilage.

1 Introduction

In the process of production of combined feed, the raw materials of grain, corn, oats and other components are crushed. The grinding process characterizes the destruction of the shells of the grain and the components of the feed. When the finished feed is stored in the air, various components are oxidized, resulting in deterioration of the feed, with the release of a rich unpleasant odor, taste and the formation of compounds of decomposition products: aldehydes, hydroxy acids, ketones and other substances. Therefore, from the very beginning of the storage of prepared compound feed, a number of parameters must be taken into account. The container in which it is stored affects the safety of compound feed. Industrial enterprises store compound feed in silos. In silos, the compound feed mass comes into contact with its walls made of metal, which contains: cobalt, copper, iron and other elements that oxidize the fats contained in the combined feed, thereby contributing to their progressive decomposition. The change in ambient temperature also has a significant impact on the safety of compound feed, with its active increase, the decomposition of compounds in the composition of combined feed occurs. To a large extent, the safety of the compound feed is affected by the recipe according to which the compound feed is prepared. Compound feeds, the recipe of which contains components of sunflower, corn, sesame and other oily crops, are also subject to active rancidity of fat with the formation of lipase and linoxygenase enzymes [1].

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Compound feed often contains additives of animal origin - meat and bone and fish meal, with an increase in humidity and temperature, it affects the quality of the compound feed. The use of conventional methods of compound feed storage does not give the desired results, since the storage modes of the grain part of the compound feed are not acceptable for meat and bone and fish meal, various types of meal, grass meal. This requires special storage techniques for combined feeds.

Storing loose feed at low temperatures slows down the rate of chemical reactions, so storing feed at low temperatures ensures a longer shelf life. Storage of combined feed in the conditions of the Far North increases the shelf life of compound feed up to 5 months, which is several times longer than in the middle lane. However, the use of low-temperature storage in the middle zone will lead to an increase in the cost of storing feed [2].

2 Results and discussion

One of the ways to increase the safety of loose feed is its storage in an airless environment. A decrease in oxygen concentration slows down the oxidative processes of macromolecular compounds, proteins, fats and carbohydrates. However, the lack of oxygen encourages the development of anaerobic bacteria that can cause product contamination. In addition, providing an airless environment by evacuation leads to additional energy costs.

A method for packaging combined feeds in a carbon dioxide environment is proposed, which involves long-term storage. To implement this process, a device for packaging agricultural products was developed (Figure 1).

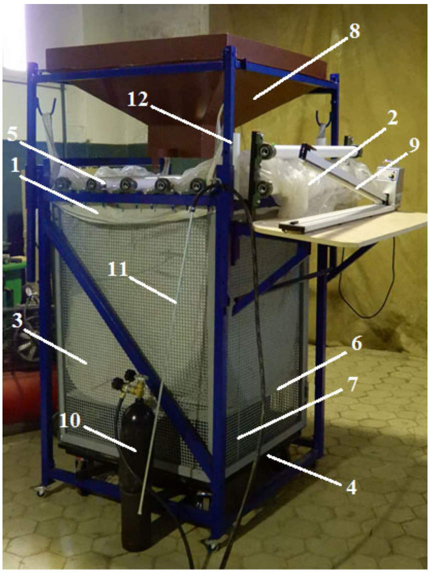

Fig. 1. Device for packaging compound feed in a carbon dioxide environment. 1 - soft container; 2 - insert; 3– cassette; 4 - mobile platform; 5 - rollers; 6 - movable bottom; 7 - pneumatic cylinders; 8 - loading hopper; 9 - sealing apparatus; 10 - cylinder with carbon dioxide; 11 - needle-injector; 12 - frame.

The cassette of the device is designed for a standard soft Big-Bag container with dimensions of 0.95x0.95x1.30 meters, with a volume of 1.173 m^3. The mass of loose mixed fodder when packed in a carbon dioxide environment is from 640 to 720 kg in one container. The average porosity of loose mixed fodder is 57%.

In the process of chemical interaction, the mass of a substance in a sealed soft container does not change. During storage of compound feed, oxidation of fatty acids is possible, while rancidity of fat leads to the oxidation of linoleic acid to linoleic acid hydroperoxide. It should be noted that during storage, only a part of the fats in direct contact with the oxygen of the gaseous medium is oxidized, and the volume of the gas mixture is limited, it is possible to reduce the intensity of the oxidative process by replacing oxygen with carbon dioxide. Saturated fatty acids contained in compound feed actively interact with carbon dioxide. In the process of interaction with high-molecular components of mixed feed, the content of carbon dioxide decreases, which leads to the formation of moisture, as well as during chemical reactions with carbon dioxide, other decomposition products and compounds based on carbon dioxide are formed [3].

When carbon dioxide and fat interact, oxidative reactions decrease, which positively affects the safety of the combined feed and prevents its spoilage. In the process of storage of compound feed, it is possible to infect it with microorganisms and pathogenic microflora, which contributes to the active decomposition of compound feed. The presence of carbon dioxide promotes the formation of carbonic acid when interacting with free water and water present in organic compounds, such as fats and proteins. The resulting carbonic acid inhibits the development of microorganisms and pathogenic microflora, so the storage of compound feed in a carbon dioxide environment contributes to the preservation of quality indicators [4].

It should be noted that part of the carbon dioxide can be dissolved in fatty acids without reducing their quality. Thus, it is possible to determine the initial and final mass of the gaseous medium inside the sealed flexible container. As a result of the calculation, it was found that at normal atmospheric pressure and a temperature of 20^o C, 0.86 kg of carbon dioxide is consumed per one soft container with mixed fodder [5].

When using soft containers, diffusion of carbon dioxide through the film of the soft container into the atmosphere is possible and vice versa. Diffusion of carbon dioxide through various materials of a polyethylene film will occur in different ways, and will depend on its thickness, material, physical and mechanical properties.

A study of the storage of feed in a carbon dioxide and air environment determined that when the feed is stored in a gaseous environment, where there was only carbon dioxide, the content of fat, protein, and carbohydrates decreases within the allowable reference values [6]. The storage of feed in the air showed that there was a significant percentage decrease in the content of protein, fat and carbohydrate relative to the reference value.

To assess the amount of carbon dioxide supplied when packing compound feed in a soft container, a cylinder with carbon dioxide was weighed on a VSP-30/5-3K balance (Figure 2).

Fig. 2. Weighing a carbon dioxide bottle.

The supply of carbon dioxide into the soft container with compound feed is carried out with the help of an injector needle during the filling process. As the feed is filled, the concentration of carbon dioxide in the upper part of the soft container is also monitored using a carbon dioxide concentration meter AQ 110 S. The concentration of carbon dioxide in the ambient air is 0.03–0.045 vol. % (300-450 ppm). Therefore, to estimate the amount of carbon dioxide in a flexible container, an AQ 110 S carbon dioxide concentration meter was installed in the upper part of the cassette with a flexible container, and an increase in the readings of the device above the nominal values indicated that the container was filled with carbon dioxide.

The study of the mass of carbon dioxide to fill the container was carried out with an error of about 10 g. Statistical analysis of the data obtained showed that the coefficient of variation for this series of experiments is 3.53%. The histogram of the distribution of the mass of carbon dioxide for filling the container is shown in Figure 3.

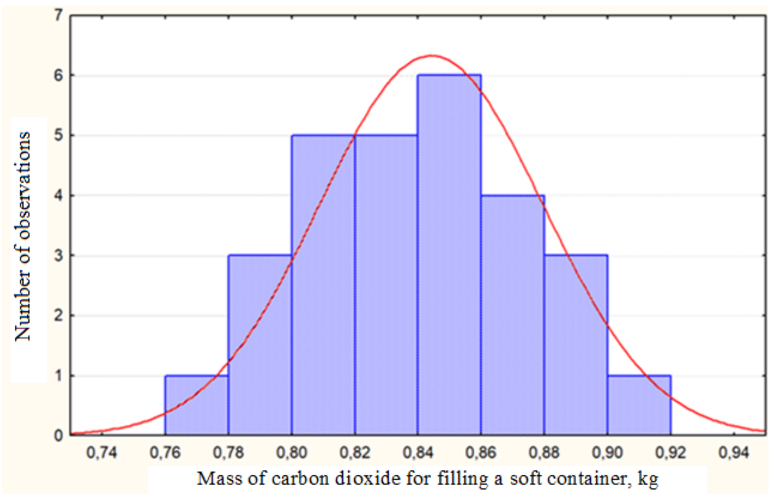

Fig. 3. Histogram of the distribution of the mass of carbon dioxide for filling a soft container with compound feed.

It has been established that to fill a soft container with a size of 0.95x0.95x1.30 meters and a volume of 1.173 m3 with compound feed, an average of 0.84 kg of carbon dioxide was required. The calculated value of the volume of carbon dioxide to fill the flexible container was 0.86 kg. Consequently, the discrepancy between theoretical and practical studies on filling the soft container with carbon dioxide was 2.3%.

3 Conclusion

Thus we can conclude that to fill a soft container with a size of 0.95x0.95x1.30 meters and a volume of 1.173 m3 with compound feed, an average of 0.84 kg of carbon dioxide was required. Comparison of mycological indicators of feed samples stored in a vacuum and in a carbon dioxide environment revealed the growth of fungi of the genus Penicillum spp stored in an airless environment (vacuum). Thus, the storage of compound feed for three months in a carbon dioxide environment makes it possible to avoid the development of microbiological and mycological contamination of compound feed with a slight decrease in feed value.

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