

A STUDY INTO THE CONDITION OF FROZEN MEAT PRODUCTS DURING STORAGE AND TRANSPORTATION IN SPECIAL CONTAINERS

For transportation of meat products from processing centres to consumption zones there have been used isothermal wagons with mechanical refrigeration, designed for simultaneous convey of large batch of loads. However, it is expedient to transit small batches of load, for example endocrine raw materials, for preserving its biological activity, in special small-capacity containers with foam-thermal insulation. These containers feature excellent heat-insulating properties and allow to convey frozen raw materials to long distances.

Under laboratory conditions the state of frozen meat products during storage in special containers has been investigated by us.

The conditions and duration of storage of frozen meat can be expressed by a mathematical formula, like the problem concerning the heating of a set of bodies interacting with the environment. The solving of this problem is based on the equation of Ostrogradskiy with some assumptions, where:

$$\Delta \tau \iint_F \lambda \cdot n \cdot \text{grad} t \cdot dF = \Delta \tau \iiint_V c \cdot \rho \cdot \frac{\partial t}{\partial \tau} \cdot dV,$$

λ - heat conductivity;

c - thermal capacity;

ρ - density;

n - unit vector, directed along the external normal towards "F" surface to the side of heat flow;

$\text{grad} t$ - temperature gradient.

The right part of the equation determines heat, expended in increase of temperature of meat products, having volume "V", for the period of time $\Delta \tau$. The left part of the equation determines heat, coming into the volume "V", limited by the surface area "F" for the period of time $\Delta \tau$. The thermal capacity of the mass is not taken into consideration, for it is a small value.

The solving of this problem permits to determine the influence of separate factors upon the duration and conditions of storage of frozen raw materials.

The experiments showed the process of storage of frozen meat in a container made of foamed polystyrene. The container is a solid body with removable cover, and with external and internal

barriers from corrugated cardboard.

This container was charged with frozen meat in polyethylene film. Then the container was placed into the heating chamber with constant temperature of ambient air. The measurement of temperature of meat surface, as well as external and internal surfaces of the container was effected with the help of thermocouples.

Two variants of the experiments were carried out. The influence of initial temperature of frozen meat as well as the temperature of the ambient air upon the duration and conditions of storage of the product has been investigated. Meat was frozen up to 18°C below zero and 25°C below zero, the temperature of the ambient air in different experiments was 20°C , 30°C and 40°C respectively. In all these experiments the final temperature on meat surface reached 1°C below zero. These experiments showed, that the abovementioned equations describe the process of meat storage in container rather well.

The figure illustrates the changes of temperature on the surface of meat versus the duration of storage. As can be seen from this figure, the estimated data coordinate with experimental ones rather good.

The Table below shows the results of the experiments carried out on storage of meat in containers of different capacity under various conditions.

T a b l e

Weight of meat, kg	Initial temperature of the product, $^{\circ}\text{C}$		Temperature of ambient air, $^{\circ}\text{C}$	Duration of storage, hours
	on the surface	in the centre		
1	2	3	4	5
38,5	-9,2	-11,0	14	70
38,5	-15,2	-18,00	25	71
4,58	-18,0	-22,0	20	58
4,58	-18,6	-21,0	30	50
4,58	-18,6	-20,0	40	30
4,58	-25,0	-26,0	30	54
40,0	-23,0	-25,0	30	130
6,15	-17,6	-18,4	20	77
6,15	-20,0	-22,4	30	58

1	2	3	4	5
6,15	-18,4	-20,0	40	43
6,15	-26,0	-30,0	30	73

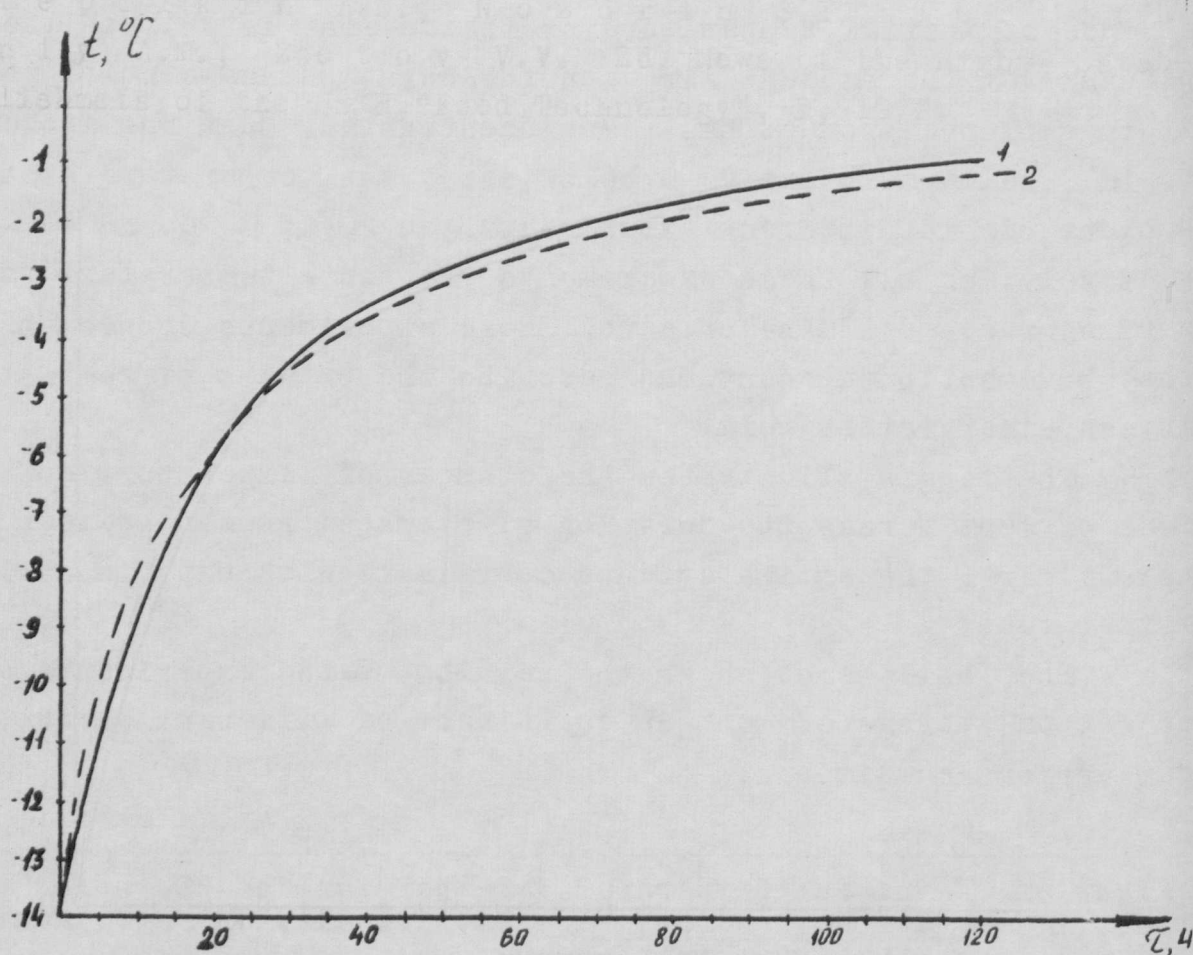


Fig. The changes of surface temperature of frozen meat versus the duration of storage

1 - According to the experimental data; 2 - data based on calculations

For the determination of the influence of conditions and duration of storage upon the quality of the product there have been carried out chemical, microbiological and organoleptical tests.

According to microbiological test there have been defined the following: the total number of bacteria, the presence of coliform bacteria, anaerobic bacteria and proteus.

The bacterial population in the sample amounted to: $8 \cdot 10^2$; $1,3 \cdot 10^3$; $8,0 \cdot 10^3$, and only in one sample it was $6,0 \cdot 10^4$.

The bacteria flora contained a great number of yeasts, Gram-negative bacteria, which were placed into the category of saprophytes during indication.

A small number of spore-forming bacteria from *Mesentericus subtilis* was revealed.

The abovementioned organoleptic and chemical tests (determination of volatile acids, reaction with copper sulphate, determination of amino-ammonia nitrogen) showed, that there were no signs of deterioration in the properties of meat. It was found out, that as the speed of air movement decreases by 8 times (from 4,1 up to 0,5 m/sec.), the duration of meat storage increases by 5%.

As a result of the above investigations, there have been found equations, enabling to estimate the duration and conditions of the storage of frozen meat products in the container; moreover, it was attained the possibility of long-term storage of small batches of meat products in special small-capacity containers, which enable to convey meat to long distances. In this case the products do not lose their initial properties, this is of particular importance for the preserving of the biological activity of endocrine raw materials.

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