CALCULATION OF THE ENERGY EFFICIENCY IMPROVING FOR THE BAKERY PRODUCTS COOLING PROCESS

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Currently, because of the increase in energy prices there is a need to create energy-saving technologies in the housing and utilities sector and in various industries. In the food industry this issue matures very serious. Baking industry also does not stand aside. Bakery products production requires the high energy consumption in the technological stages such as baking, proving and cooling.

The cooling process of just taken out from the oven bread is one of the final operations of manufacturing of bakery products. It was followed in the following sections of the technological chain by slicing and packaging of products. Actually They are these operations cause the need for cooling bread. The loaf cannot be neatly cut due to the adhesive properties of fresh bread crumb at high temperatures. High-quality cutting is only possible at temperatures lower than 37 $^{\circ}$C. Packaging of the hot products into the a film is also undesirable because it leads to the condensation of evaporated moisture on the inside of packaging and subsequent wetting of the crust, loss of identity, and the development of micro-organisms on the surface of the product.

Moreover, after the release from the oven bread begins to lose moisture rapidly and shrink (shrinkage of 4.5 ... 4.7%). This leads to economic losses of the enterprise. For large bakeries producing about 170,000 kg per day, shrinkage losses can be up to 9 tons. It is proved that in order to reduce the shrinkage it is necessary to rapidly cool the product, and then store it in slow-drying and slow-staling conditions. Currently, cooling and storage of freshly baked goods is conducted in a number of ways: in cooling chamber on fixed pallets, in vacuum systems, and using tunnel or spiral cooling conveyor system [1], which are now widely used. For large bakeries and plants, the department of cooling chambers requires considerable space; this in today's enterprise is a limiting factor due to the lack of space for the introduction of additional capacity. Furthermore, the cooling of bakery products in cooling chambers lasts several hours. This is unacceptable, since during the long-term cooling the quality of baked products deteriorates. Bakery products are staled and contaminated by microbes [2]. Vacuum systems do not require a large area, but at the moment they have a relatively low productivity and high operating costs, so now in the direction of increasing the performance of such devices, and vacuum cooling processes active research. Tunnel conveyor systems are a camera, conveyor, conveying the product along the tunnel, and air conditioning system. Such plants have a definite advantage over cooling chambers

with the natural cooling of the product - they occupy less space, and for this reason, such systems are widely used now.

The cooling process at such facilities is following: from the technological equipment product joins the spiral conveyor system. The conveyor moves smoothly without jerking at a constant speed, this ensures the proper location of the product on the belt during the passage of all levels - from the bottom to the top within 145 minutes. Fans conduct convectional cooling. The chilled products are poured into a hopper from the top.

After the series of experimental studies a mathematical model of bakery products cooling was developed. Model showed high convergence of the calculated values with experimental results [3]. The model allows to calculate various parameters related to cooling of bakery products of different variety.

Different types of products require different temperature and humidity conditions and the speed of air blowing products, hence their cooling requires different amount of energy.

Obviously, in order to increase the energy efficiency of the bakery products cooling processes it is necessary for each type of product to use cooling with parameters that take into account the thermal properties of the products, given that the belt speed is constant.