Ways of saving energy in heat treatment of sausage products

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The problem of saving and of rational use of fuel and energy resources at meat-preserving factories requires development and implementation of a wide range of energy-saving measures. The implementation of some of these measures does not require capital outlays and boils down to resolving some tasks of organizational and technological character. Yet the implementation of such energy-saving measures as the modernization of the existing termal equipment, the automation of the processes of heat treatment of products, the use of high efficiency thermal insulation, the use of facilities utilizing secondary energy resources and others requires considerable capital out lays.

Sausage making is one of the energy-consuming processes in the meat industry. In order to substantiate the effectiveness of the energy-saving measures we carried out an industrial research of processes of heat treatment of sausage products in the most widely used thermal chambers. In the course of the research we determined useful heat abstraction values as well as the losses the value of which were predetermined by the conditions of use of thermal chambers of different designs. On the basis of this research we compiled experimental and analytical heat balances of the thermal chambers used for roasting and boiling sausage products. It was determined that the items of the balance of the chambers are influenced by the mode of operation, the particularities of the design of the chambers, the parameters of the steam, the loading factor as well as the quality of termal insulation.

The analysis of some components of the heat balance made it possible to substantiate the possibility to lower the cost of those items, which are predetermined by the mode of operation of the chambers(the losses due to idle time and to the use of waste heat-transfer agents). Thanks to that we obtained optimum heat balances in which the losses connected with the mode of operation are minimal.

The degree of thermal and technological perfection of the heat treatment process as well as that of the equipment were assessed by determining the effective heat use factors. We obtained dependences of these factors for boiling sausage products in three-frame and five-frame boiling chambers on the diameter of the sausage sticks as well as on the loading of the equipment. It was determined that in three-frame chambers the effective heat use factors grow with an increase in the diameter of the sausage products. For example, for sausage products of 16 mm in diameter the effective heat use factor is around 32 per cent in the conditions corresponding to the standard parameters of the operation of the chambers. If the diameter of the sausage sticks is increased up to 100 mm the factor grows 1.5 times over. It was proved that in order to optimize the heat balance of the boiling chambers of this design it is necessary to pay a particular attention to lowering losses connected with the mode of operation. To this end it is necessary to comprehensively lower the idle time of the chambers between operations thus increasing the degree of their loading.

Also of great influence on the improvement of the structure of heat balance of the chambers is the observance of the standard temperature conditions of operation. The implementation of these measures makes it possible to lower the losses connected with the mode of operation by 39.5 per cent and to increase the efficiency of the use of heat energy.

Heat and technological tests of five-frame chambers showed that effective heat use factor grows as the diameter of sausage sticks increases up to 40 mm, while when it surpasses this figure the factor decreases. For example, for sausage sticks of 40 mm in diameter it is of 30.9 per cent while for sticks of 120 mm in diameter it is only 26.3 per cent.

The analysis of the heat balance of the chambers without taking into account the losses connected with the mode of operation showed that in a technological process the effective heat use factor decreases with an increase in diameter of sausage sticks. If the diameter of sticks is increased from 24 mm to 120 mm it decreases 1.33 times over. The main factor for increasing effective heat use efficiency in the improvement of the thermal insulation of the chamber since a longer heat treatment process results in an almost 2.5 increase in heat losses which amount to 46 per cent of the total heat consumed in the process.

In order to assess the heat effectiveness and to substantiate the standards of heat consumption we studied specific heat consumption per operation for roasting and boiling sausage products. Specific heat consumption depends to a great extent on the operating parameters of the equipment. The method of multifactor correlation analysis makes it possible to assess changes in specific heat consumption and in other energy indices due to the influence of different factors. These are such factors as the parameters of steam, the loading coefficient for chambers, the idle time between operations, the diameter of sausage sticks and others. With the help of the multiple correlation method we obtained an empirical dependence of the specific heat consumption on determining factors which influence its value. This helps us to work out a multifactor correlation model, to assess the reliability of the correlation coefficients and to study the influence of the change of determining factors on the value of specific deflection of heat consumption. It was found out that the dependence of the specific heat consumption in heat treatment of sausage products on the diameter of the sticks is hyperbolic in character. Of considerable influence on the value of specific heat consumption is the duration of idle time between operations due to the unloading of ready-to-serve products and the loading of raw material. The reserve for decreasing specific heat consumption due to shorter idle time between operations can be as high as 12 per cent. Reserve of heat saving due to maintaining standard temperature conditions for the heat treatment process in sausage making were also determined.

The correlation analysis made it possible to determine with a sufficient degree of accuracy (± 3.8 per cent) the values of specific heat consumption in heat treatment of sausage products as well as find out the ways of saving energy by optimizing the parameters of the use of thermal chambers. Thus the diameter of sausage sticks has a determining influence on the value of specific heat consumption which is conditioned both by the value of frame

loading and by the duration of the heat treatment process. Given all this the optimum diameter of the sausage sticks from the point of view of energy-saving is of 40 mm. With an increase of the diameter from 40 mm to 120 mm the specific heat consumption grows sharply surpassing the optimum value by 17.4 per cent. Thus the expediency of producing sausage products of 80 mm in diameter is proven. In this case less energy-consuming equipment and technology are needed.

Heat technological tests made it also possible to determine the influence of the parameters of steam on the specific heat consumption. In order to optimize the thermal balance of the heat chambers used for boiling sausage products it is recommended to maintain the pressure of the heating steam at 0.4 MPa level. The carried out research made it possible to compile alignment charts for determining specific heat consumption necessary for heat treatment of sausage products in thermal chambers under different operating models. These alignment charts constitute the basis for the operational checking of the consumption balance of sausage making shops of meat-preserving factories as well as for substantiating heat-saving reserves capable of being used for these purposes.