Intensification and higher energy efficiency in smoking processes

ZOTOV V.V., NOZDRIN S.I.
Moscow Institute of Dairy and Meat Industry, Moscow, USSR

The problem of developing high productivity energy-saving technological processes and equipment is of great importance for the enterprises processing the products of animal husbandry. This mostly concerns the processes of smoking and roasting sausage products which require a considerable fuel and thermal energy consumption. In order to improve the existing equipment optimum conditions for obtaining smoking media, ensuring high quality of products were worked out. A great attention was also attached to the problem of obtaining smoking media with given properties which would use as little energy as possible. The research showed that the physico-chemical properties of smoking media which ensure the intensity of heat and mass exchange in smoking as well as energy indices of the process are determined primarily by the temperature conditions of smoking media. In order to optimize the process of obtaining smoking media analytical models of temperature patterns in generators of different types were worked out. Mathematical models were obtained on the basis of the equation of thermal conductivity under various characteristic conditions. The analysis of the obtained results showed that in exothermic generators the temperature patterns in a layer of wood are determined by the temperature in the combustion zone which reaches 800-900°C. Because of this fact it is impossible to create optimum temperature conditions in the generators of this type. It was determined that the temperature conditions of the use of endothermal generators are determined by the intensity of energy supply. This allows to create optimum conditions for obtaining smoking medium. This results in a considerably higher quality of smoking medium. A design of endothermal generator based on heat=transfer agent ensuring uniform heat distribution in a layer of wood was proposed. Superheated steam was used as heat-transfer agent. The merit of this generator is its capability to quarantee an obtainment of a high quality conditioned smoking media with given properties. The design of the generator makes it possible to regulate the productivity in a wide range by changing the expenditure of the heat-transfer agent. Special devices designed to intensify the process of smoke generation were proposed. An analytical model of smoking process was worked out. Its validity was proven experimentally. It was determined that in order to intensify sorption processes it is necessary to increase the partial pressure of the main component of smoking medium. Method of obtaining a medium excluding formation of ballast gases was proposed. Limiting values of temperature at which the smoking media has an optimum moisture content were determined. It was also found out that at a temperature between 200-250°C the release of volatile matter from wood is 3.5 times higher than in the interval of 450-500°C. As a result 72 per cent of wood turn into volatile matter at a temperature lower than 380°C. The research showed that the maximum release of volatile matter is observed at 295°C. The expediency of a more comprehensive extraction of volatile matter from wood at a temperature of steam inferior to 390-400°C was proven. An optimum thickness of the layer of wood of between 40-50 mm as well as the value of energy supply of 500-680 kW/m^2 were determined.

The influence of the parameters of supertreated steam on its specific consumption was studied. Generation of smoking medium from 1 kilogram of sawdust was determined. It was found out that the concentration of the smoking medium is maximal at between 370-380°C and energy spent on its generation is minimal between 330-400°C. Thus the optimum temperature interval for generating smoking media is between 350-380°C.

In order to increase the energy efficiency of the process recommendations were worked out on how to use the remaining wood the heat of combustion of which is 1.31-2.82 times higher than the heat value needed for generating superheated steam.

The influence of steam-and-air mixture on the composition and concentration of the smoking medium was also studied. Experiments made it possible to determine the proportion of air in the steam-and-air mixture which constitute between 6 and 10 per cent by volume It was proven that the use of steam-and-air mixture decreases the quality of the heat-transfer agent by 20-30 per cent which is due to a high concentration of the medium. Such use also decreases the volume of heat capacity of the mixture by 3-5 per cent. The energy consumption in this process decreases by 25-35 per cent.

In order to control the process of smoking and the properties of the smoking media it was proposed to use ionometric method. Specific recommendations on the use of generators were worked out and ways of improving their energy indices were substantiated. Economical efficiency of applying these generators in industry was proven.

The results of the research, tested in industrial conditions, proved high quality of the ready-to-serve products.

Conclusions

1. On the basis of analytical and experimental research it was determined that the endothermal generators which use superheated steam as heat-transfer agent, are most efficient from the point of view of energy saving.
2. Principal directions of intensifying the processes of smoking media generation and of smoking were determined.
3. Laws of the process of smoking media generation were studied as well as optimum conditions for this process were determined.
4. A design of generators ensuring higher energy efficiency in smoking was developed.