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Improvement and Development of Technological Processes at Production Smoked Fish

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Abstract: The paper presents the results of experimental data obtained in brine, the coefficients of diffusion, the mathematical model and ambassador calculated optimal values of fish salting uniform layer of a certain thickness in brine. Studied modes production canned food smoked fish with a low-temperature heat treatment of semi-finished product. Developed are optimal modes for infrared smoke generators.

Key words: Smoked Fish · Technological Processes · Environmentally Friendly Products · Energy-Saving Technologies · PID Controller

INTRODUCTION

Before the fish processing enterprises the task of changing the product mix in favor of high-quality, environmentally friendly products, produced by energy-saving technologies [1-4, 15]. It is therefore necessary to carry out work to improve the techniques and technology of fish processing in the following areas:

- Study of salted fish to develop effective devices for salting fish.
- Creating smoking preparations for flavoring preserves and development on this basis of new products.
- Improving the technology of smoked fish.
- Creation of a smoke generator smoke with infrared heating.

Searchingfor new kinds of products at present, undoubtedly important, especially in connection with the use of raw materials, poor in their chemical composition and previously untapped [5-7]. Currently, created in the future will create a series of new equipment and modern technology to develop and production competitive products [8, 13].

Research of Laws Salted Fish: One of the determining factors of preparing delicatessen products is to provide semi-finished or finished product with a given salinity. This is possible on the basis of knowledge of the laws of diffusion of salt in fish salting. The solution of the mathematical model of the process of salting in brine is as follows:

$$S_{(0,t)} = S_{ecm} + S_0 \{1 - \exp [- 2.4706 (D\tau / l^2 - 0.0843)]\},$$

where,
$S_{(0,\tau)}$, S_0 – salinity fish in center of the specimen and on the boundary section solid and liquid phases, *%*;
$S_{åCò}$ – Natural the salinity of fish, *%*;
D – Coefficient salt diffusion in fish, m^2/s;
l – Half the thickness fish, *m*.

This formula is valid for of time salting $\tau > \tau'$,

where,
τ' – time, after the lapse whose begins to change the salinity of in the center of the sample:

$$\tau' = 0.0843\ l^2 / D.$$

The diffusion coefficients were determined for eels, capelin, blue whiting, saithe, redfish and mackerel. They depend on the chemical composition (fish fat (F)) and the temperature (t) of saline, which calculated by the formula:

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Table 1: Values of coefficient α for various types of fish

Name of the fish salting	Mass fraction of fat, %	Temperature of brine, °C	Coefficient α
Saithe (Fillet)	1.3	18	0.66
Perch (Fresh)	7.0	18	0.41
Capelin (Defrosted)	9.7	18	0.3
Mackerel (Fillet)	13.4	18	0.32
Eel (Defrosted)	15.0	18	0.38
Blue whiting (Fresh)	2.0	9	0.67
Blue whiting (Fresh)	2.0	18	0.68
Blue whiting (Fresh)	2.0	25	0.88
Blue whiting (Fresh)	2.0	30	0.92

$D = 0.003F + 0.02t + 0.66$.

The diffusion coefficients in the given formula are valid for of salinity fish do not more than 9%.

Efficient the salinity of S_0 is determined by from the following expression:

$S_0 = a\, S_\partial$,

where,
α – Coefficient;
S_∂ – Salt concentration in saline, %.
Coefficient α has different values for each species fish and depends on its chemical composition, condition integument, body shapes and etc. (Table 1).

Using the following dependencies defined boundary layer thickness fish in brine at which salinity product in all sections of the layer should be uniform. It is suggested that increase the thickness of layer with a uniform salinity is possible, if increase the density of irrigation the surface of fish. Have been identified optimal density of irrigation the surface of fish and maximum thickness of the layers capelin and mackerel fillets, when fish salting.

For example, the layer thickness of capelin 170 mm fillet mackerel 150 mm and the time of salting 50 and 60 minutes, respectively, the reflux density reached 0.0252 dm^3/ (min cm^2) and the density of brine 1.18-1.2 g/cm^3. The temperature of brine when salting must be 15 °C. When salting capelin and mackerel fillets in such conditions was obtained semi-finished product with a salinity of 4.6-5.43% and 4.65-5.30%. Such semi-finished product suitable for the preparation of smoked and low-salted products, as well given above modes are recommended for of introduction in mechanized baths for the salting fish.

Improving the Technology of Canned Smoked Fish: One of the basic kinds of processing of fish is a smoking: hot and cold. The quality of the final product depends on the preliminary preparation of fish, of smoke density and observance of required temperature regime [9, 10]. For different kindsof fish (depending on its size, cultivar, fat content and etc.), are used modes of processing, which differ respect to temperature, humidity and duration.

Process hot smoked fish happens, as a rule, two-stage: initial fish dried warm air at a temperature 50-90 °C for 30 minutes, then smoking of hot smoke when 80-120 °C from 0.5 to 3 hours. To obtain a quality product at all stages of the technological cycle is necessary to observe is strictly a certain temperature and humidity in the smoking chamber.

Canned fish smoked traditionally in great demand among the population.However, their production is connected with significant costs of raw materials and energy. At the present time, thereis a work conducted on the transition from high-temperature processing semi-finished product to the low-temperature processing. Constructed samples of canned food with application of low-temperature thermal influence differed high flavoring virtues. At the present time worked out modes receipt of canned from of smoked herring and researchingthe optimal modes of the production canned from cod.

Development Generator Smoke Fume: Improving the quality of smoked productis depending on its safety for human health [11], decrease in expenses of energy and fuel can be carried out, applying new ways of getting smoke fume taking into account the harmonization of supplying heat to fuel and kinetics of its of heating. To solve this problem, was designed the generator of smoke and infrared heating.

Fig. 1: PID controller OVEN TRM151

The main factors affecting the smoke generation process; the specific surface of the wood (X_1, m^2/kg), the initial moisture content of the sawdust (X_2, %) and the amount added to the cell generator smoke fume water (X_3, %). A number of factors: the distance of the radiator to the timber, the temperature of the radiation wavelength-were assumed constant. Duration of heating period (Y_1) and the period of formation of smoke fume (Y_2) depends on the major influencing factors as follows:

$$Y_1 = 104.4X_1 + 1.66X_2 + 4.82X_3 - 0.13X_1X_2 + 0.0003X_2X_3 - 0.258X_1X_3 - 4.19X_1^2 - 0.014X_3^2 - 704.5.$$

$$Y_2 = 10.5X_1 - 0.384X_2 + 0.0541X_3 + 0.0568X_1X_2 + 0.0151X_1X_3 + 0.023X_2X_3 - 0.715X_1^2 - 58.67.$$

Search of optimal values of influencing factors was fought in such a way, to at observance of boundary conditions most fully are met requirements optimization criteria for both periods: heating and of Education smoke fume. Were obtained the following optimal values influencing factors: for high-performance installations $X_1 = 11.8\ m^2/kg$, $X_2 = 45\%$, $X_3 = 50\%$; for small installations $X_1 = 11.0\ m^2/kg$, $X_2 = 70\%$, $X_3 = 70\%$. Thus, the generating parameters smoke fume allowsgetting quality smoker environment in the simple generators device.

Automating the Process of Smoking Fish: To automate the process of smoking chambers manufacture of smoked fish is widely used universal two-channel program PID controller [12, 14] OVEN TRM151 (Fig. 1).

PID controller allows you to periodically include ventilation shutters and regulate heating systems and supply of smoke (Fig 2).

TRM151 has two universal inputs, to which can be connected sensors are of different type: thermal converters resistance, thermocouple, sensors with the output signal current, voltage or position sensors latche. PID-the regulator TRM151 the standard configuration has two output of software module-regulator, each of which works according to on-off (ON / OFF) or at PID-to the law regulation.

In regulator TRM151 is provided the possibility of creating up to twelve independent programs (of so-called programs technologist) according to ten steps each.

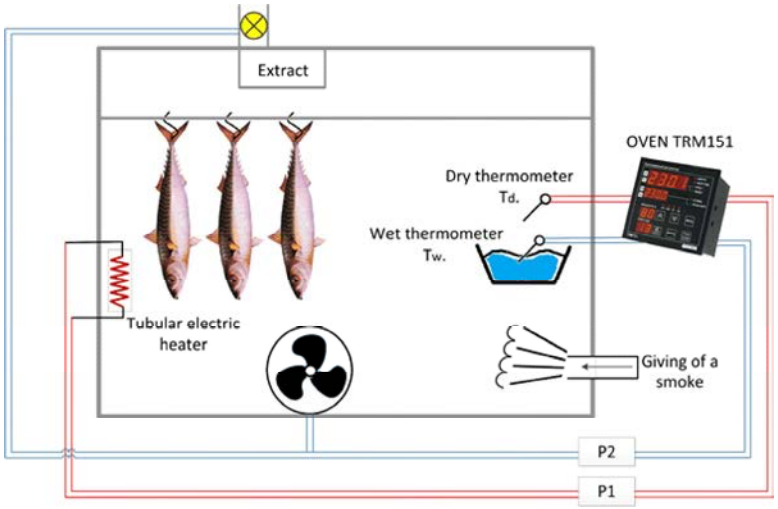

Fig. 2: Scheme of regulate heating systems and supply of smoke with the use of OVEN TRM151 (P1, P2 – motor starters)

For each step program are specified the corresponding setpoint, the parameters of regulation and conditions for the transition onto the next step. With the help of program technologist the regulator TRM151:

- Carries out automatic launch of and disabling of executive mechanisms;
- Maintains the temperature of at all stages of processing (a smooth heating of, the shutter speed and smooth cooling of);
- Establishes in the chamber the necessary values humidity by managing extractor fan;
- Controls the filing of smoke.

TRM151 ensures the safety and continuity of the process smoking of fish, controlling the working capacity of measuring techniques (checking on breakage,-circuiting and the like). When this TRM151 analyzes criticality state entire automation system: in case, if occurred sensor malfunction, not involved directly in current step, device is not halts program execution, but only signals about malfunction. If same is happening breakage of the necessary at the given stage measuring instrument of, then TRM151 stops the current a program technologist, at the same time, to avoid more serious breakages, all weekend device are disabled.

When the fault is turns out to be fixing: continue the process of is possible from any out of ten of steps used program.

Automation of smoking of fish with application of regulator TRM151 allows the user to as much as possible to stabilize the whole production process, minimizing the influence of “human factor” and the risk of release of defective products. Strict observance of all conditions of technological process with the help of devices OVEN TRM151 leads to a noticeable improve the quality of let out production. Profit from production smoked fish is obvious.

In addition to the smoking of fish, a universal dual-channel PID-controller OVEN TRM151 finds wide application atproduction of various food products, which are used different kinds of heat treatment: drying, cooking and smoking.

CONCLUSION

Results of the present research was developed automated control system for producing smoked canned fish with the original properties. The optimal decisions to generate smoke using infrared generators. Based on these dependencies, you can create small-sized high-smoke generators, characterized by simple design and low weight. Optimum modes salting of small fish and fillets in brine layer several rows. The main parameters for the construction of baths mechanized salting fish: the length of salting, the thickness of the fish, the density and temperature of the solution, the density of irrigation.

Thus, research and study how to contribute to the creation of new types of products and the improvement of equipment and technology.

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