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THAWING OF FISH BLOCKS IN THE AIR

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The article presents a comparative study of fish block thawing in the air. Thawing was carried out by three methods: in the standing air, in the standing air saturated with water vapor and in the air saturated with water vapor with fan forced convection. For each of these methods the paper presents defrosting temperature curves at three different points of the block: the surface, the geometric center and the central part between the surface and the geometric center. Specified defrosting time and weight loss of thawed blocks and sensory evaluation of thawed fish was performed.

thawing, air, steam, forced convection, fish, herring

INTRODUCTION

In fish processing industry, in most cases, fish is supplied in frozen form. Larger fish are frozen individually and smaller in the form of blocks. In most cases, it is necessary to thaw the frozen material for further processing. One of the simplest ways of achieving this is to thaw it in air [Bykowski i in. 1986]. Often, this process is carried out in a simple natural convection chambers or in uncontrolled conditions prevailing in the production halls [Gruda i in. 1999]. The time of this thaw is long. For defrosting in the steam chamber it has to be heated from 10 to 12 hours. When thawing in the air on the production halls the time is extended to 48 hours. Issues intensification of thawing in the air are still the subject of many scientific papers [Góral i in.2003], [Li i in. 2002]. Intentional research of factors intensifying thaw in the air is still reasonable. Such factors may include: the maximum saturation of air with water vapor and in addition the introduction of forced convection.

AIM OF THE STUDY

The aim of this study was to compare selected methods of thawing blocks of fish in the air. Thawing was carried out by three methods: in the standing air (atmospheric), in the standing air saturated with water vapor and in the air saturated with water vapor with forced convection. For each of these methods are presented defrosting temperature curves at three different points of the block: the surface, the geometric center and the central part between the surface and the geometric center. Specified defrosting time and weight loss of thawed blocks and sensory evaluation of thawed fish was performed.

RESEARCH MATERIAL AND METHODOLOGY

The research material were gutted carcasses of Baltic herring (Clupea harengus L. membras) without head. Herring were frozen in blocks (6x12x16 cm), in the refrigeration chamber, in a natural convection, to -25°C and stored at this temperature for a period of one month. Each of frozen block consisted of 12 carcasses of four pieces arranged in three layers. Weight of each frozen block was 800g ± 10g. It is assumed that the block is finally thawed when the track carcass can be separated from each other without causing damage. Blocks were thawed in three ways: in atmospheric standing air (moist, unsaturated with water steam) in standing air saturated with water vapor and in the air saturated with steam with forced convection. Thawing was performed in thermally insulated chamber with dimensions H 38, W 44, D. 31 cm. The scheme of a stand for thawing in the air saturated with water steam forced convection is presented in Fig. 2. The cold steam is produced by the piezoelectric steam generator. In order to force the air traffic uses the fan. Air velocity over the block was 2 m/s. Temperature measurements were made with a thermocouple type K (NiCr-NiAl) with a thickness of 0.5 mm braided with fiber (Tmax = 400˚C). Arrangement of thermocouples in thawed is shown in Fig. 1. The signal from the thermocouple was passed PCI data acquisition 1710HG installed in a PC. Data measurement was supported by the program Lab-viev to record the measured temperature. Visualization of the results was performed using Matlab.

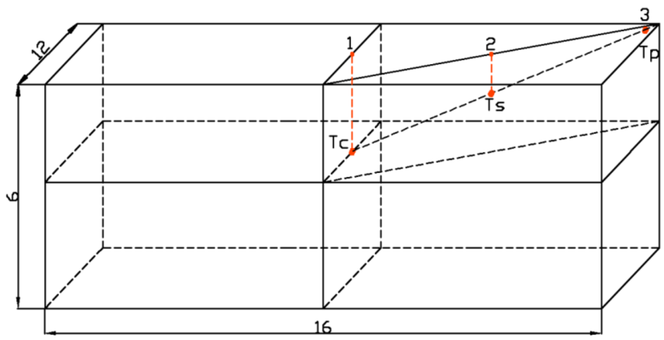

Fig. 1. Arrangement of thermocouples in the thawed block
Рис. 1. Устройство термопары в блоке дефростации

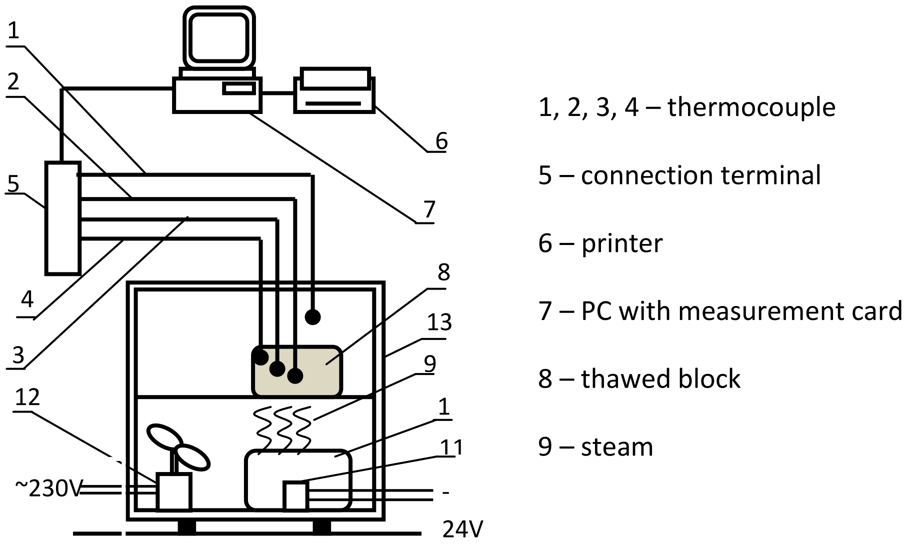

Fig. 2. The scheme of a stand for thawing in the air saturated with water steam with fan forced convection
Рис. 2. Схема стенда для разморозки рыбы в воздухе, насыщенном водяными парами с принудительной конвекцией

The weight loss was defined as the difference in mass of the block before and after thawing. Sensory evaluation was performed based on PN-92/A-88758. Each test of thawing was repeated three times. The precision of measuring the mean weight loss and mean time to defrost determined on the basis of the theory of interval estimation.

RESULTS AND ITS ANALYSIS

Figures 3, 4 and 5 show the curves of temperature measurement in designated points of thawed blocks and defrosting medium temperature. The graphs show that the longest long was the process of defrostin upright in the air (natural convection), for which the average time of thaw was 396 ± 22 minutes. For thawing in still air saturated with water steam defrosting time was 266 ± 14 min. the shortest defrosting time (166 ± 11 min.) appeared to thaw in the air saturated with water steam with fan forced convection.

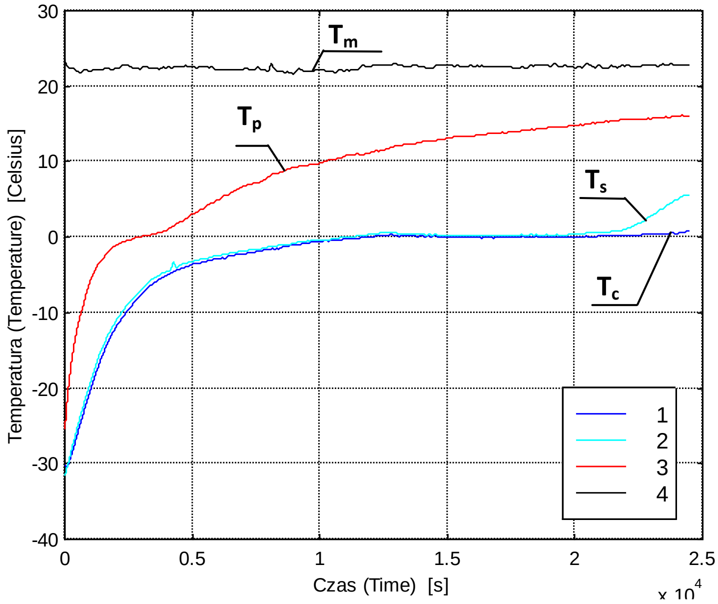

Fig. 3. Temperature changes in the block in the selected measurement points during the thaw in the standing air. T_m - thawing medium temperature; T_p - block surface temperature; T_s - temperature of the middle of the block; T_c - the temperature in the center of the block

Рис. 3. Изменение температуры в блоке в выбранных точках измерения во время размораживания в неподвижном воздухе: T_m – средняя температура размораживания; T_p – температура поверхности блока; T_s – температура в середине блока; T_c – температура в центре блока

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Figure 6 summarizes the curves of temperature change on the surface of the test block. Visible here is a brief but clear period to determine the resulting temperature phase transition of ice in the water. In the case of curve 2 and 3, the period is longer. For curve 1 and 2, the temperature at the surface reaches higher values, approaching the temperature of the thawing medium. The final temperature on the surface of the block thawed in the air (unsaturated steam), curve 3, is much lower than the temperature of the thawing medium. In this method is found the occurrence of the smaller temperature gradients inside thawed blocks.

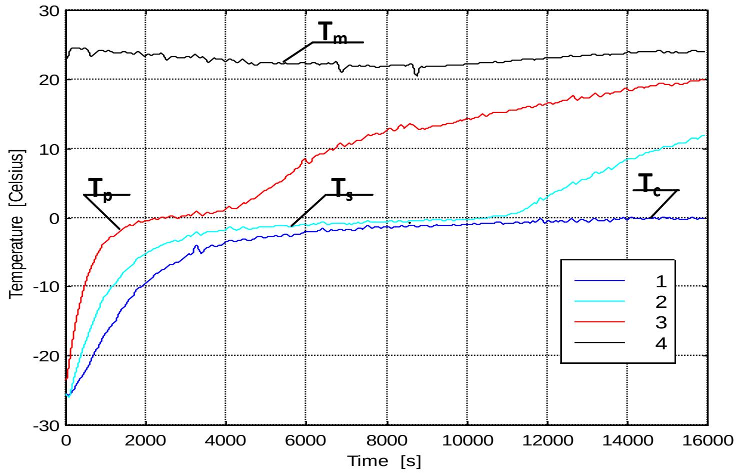

Fig. 4. Temperature changes in the block in the selected measurement points during the thaw in the air saturated with steam. T_m - thawing medium temperature; T_p - block surface temperature; T_s - temperature of the middle of the block; T_c - the temperature in the center of the block

Рис. 4. Изменение температуры в блоке в выбранных точках измерения во время размораживания в воздухе, насыщенном парами: T_m – средняя температура размораживания; T_p – температура поверхности блока; T_s – температура в середине блока; T_c – температура в центре блока

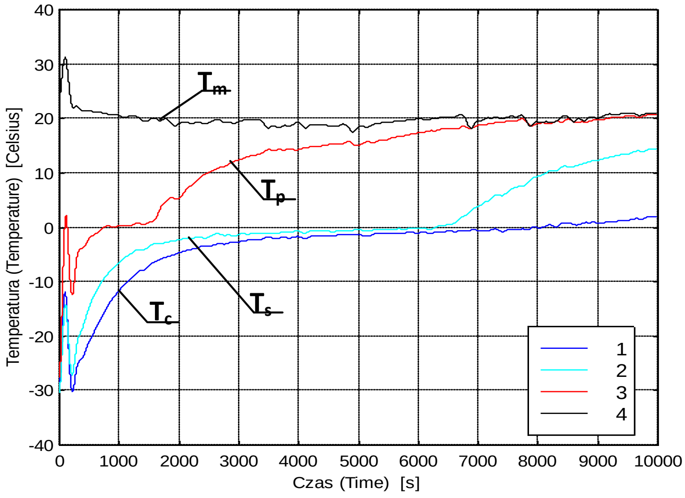

Fig. 5. Temperature changes in the block in the selected measurement points during the thaw-ting in the air saturated with water steam with fan forced convection. T_m - temperature of the thawing medium; T_p - block surface temperature; T_s - the middle of the block temperature; T_c - the temperature in the center of the block

Рис. 5. Изменение температуры в блоке в выбранных точках измерения во время размораживания в воздухе, насыщенном парами с принудительной конвекцией: T_m – средняя температура размораживания; T_p – температура поверхности блока; T_s – температура в середине блока; T_c – температура в центре блока

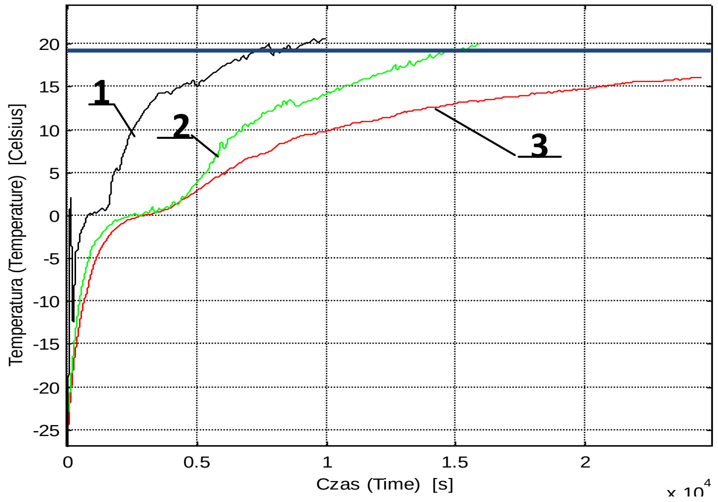

Fig. 6. Summary of curves of temperature change at the surface of thawed blocks: 1 - thawing in air saturated with water steam with fan forced convection; 2 - thawing in air saturated with water vapor, 3 - thawing in still ambient air
Рис. 6. Кривые температуры изменений на поверхности: 1 – размораживание в воздухе, насыщенном водяными парами с принудительной конвекцией; 2 – размораживание в воздухе, насыщенном водяными парами; 3 – размораживание в неподвижном воздухе

The curves of temperature changes in the middle of thawed blocks are presented in Fig. 7. Here we clearly see that the shortest period of phase transition (ice melting) is during thawing in the air saturated with water steam with fan forced convection (curve 1). In case of defrosting in the air saturated with water vapor phase transition time was two times longer (curve 2), for defrosting in the air not saturated with standing water is four times longer (curve 3).

By analyzing the curves of temperature in the center of thawed blocks shown in Figure 8, we see that phase transitions do not come to an end, which indicates not fully thawed carcasses located in the central part of the block.

The relative percentage mass loss of thawed blocks determined by dividing the difference in the mass of frozen and thawed block to frozen block mass multiplied by 100%. Curves presented in Fig. 9. shows that the greatest weight loss occurred for thawing in the air saturated with water steam with forced convection (2.3%), due to a much shorter time, thawing and washing out the block by the intensely condensed water vapor. Forced air movement in the chamber causing continuous condensation throughout the defrosting process.

The less weight loss (1.2%) occurred in the case of the air saturated with water steam. In this case, the intensity of the condensation of water vapor on the surface of the thawed block was much lower, and the defrosting time was longer. The smallest weight loss occurred during defrosting upright in moist air (0.9%). In this case, the defrosting time is the longest and the condensing steam lasted less (until they reach the surface of the dew point temperature of the block).

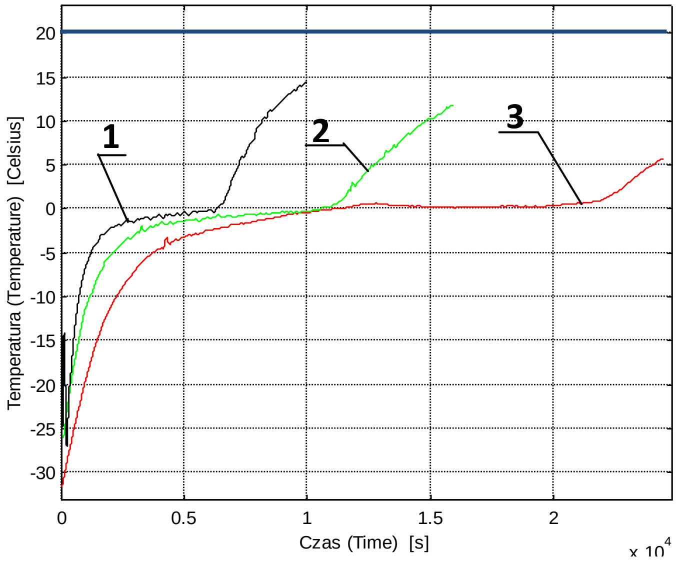

Fig. 7. Summary of curves of temperature change in the middle layer of thawed blocks: 1 - thawing in air saturated with water steam with fan forced convection, 2 - thawing in air saturated with water vapor, 3 - thawing in still ambient air

Рис. 7. Кривые температуры изменений в среднем слое размороженных блоков: 1 – размораживание в воздухе, насыщенном водяными парами с принудительной конвекцией, 2 – размораживание в воздухе, насыщенном водяными парами; 3 – размораживание в неподвижном воздухе

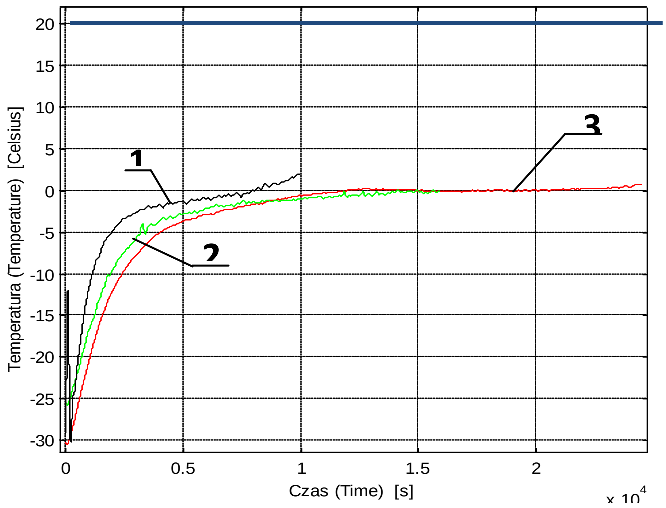

Fig. 8. Summary of curves of temperature change in the center of the thawed blocks 1 - thawing in air saturated with water steam with fan forced convection, 2 - thawing in air saturated with water vapor, 3 - thawing in still ambient air

Рис. 8. Кривые температуры изменений в центре блоков: 1 – размораживание в воздухе, насыщенном водяными парами с принудительной конвекцией, 2 – размораживание в воздухе, насыщенном водяными парами; 3 – размораживание в неподвижном воздухе

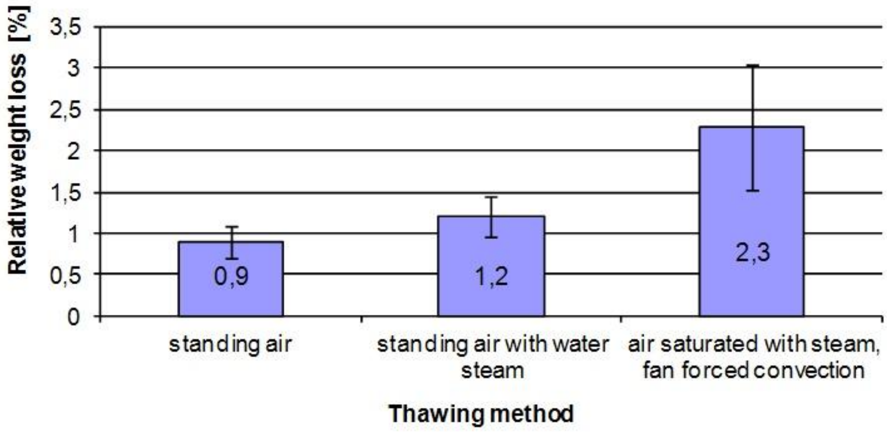

Fig. 9. The relative percentage loss of fish blocks depending on the method of thawing
Рис. 9. Относительный процент потерь массы в зависимости от метода

In terms of sensory evaluation all thawed fish carcasses were characterized by good quality, classifying them in class A.

SUMMARY

The results shows that the fish block thawing time in the air saturated with water vapor forced convection was shorter by 58%, and for the air saturated with water vapor by 33% with respect to time in the standing air thawing.

The method used for thawing effects on the weight loss of thawed blocks. The greatest weight loss occurred during thawing in water vapor in the environment of forced convection and the smallest in the standing air thawing.

The fish carcasses thawed by discussed methods were characterized by good quality. Thawing method did not affect significantly on the differences in sensory evaluation of thawed fish.

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РАЗМОРАЖИВАНИЕ БЛОКОВ РЫБЫ В ВОЗДУХЕ

А. Копец, Т. Рудковски, Д. Шишка

Статья посвящена сравнительному исследованию размораживания рыбных блоков на воздухе. Размораживание проводилось тремя методами: в неподвижном воздухе, в неподвижном воздухе, насыщенном водяными парами, и в воздухе, насыщенном парами с вынужденной конвекцией. Для каждого из методов статья дает температурные кривые дефростации в трех различных точках блока на поверхности, геометрическом центре и в центральной части между поверхностью и геометрическим центром. Были определены время дефростации, потеря массы дефростированных блоков и сенсорная оценка дефростированной рыбы.

размораживание, воздух, пар, вынужденная конвекция, рыба, сельдь