INVESTIGATION OF WORKING ENVIRONMENT PARAMETERS IN MEAT PROCESSING

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Abstract: The main working environment parameters such as microclimate, noise and light in meat processing pilot plant were investigated in this study. The pilot plant working conditions were identical like in most of small and medium meat processing enterprises in Bulgaria. Critical analysis was carried out and suitable measures for working environment parameters optimization and for decreasing of energy costs are presented. These measures can be used as a model to be implemented from meat processing SME.
Key words: meat, processing, working, environment, parameters, energy, efficiency, SME.

Introduction

Ensuring of occupational health and safety of the workers is constitutional right in Republic of Bulgaria. Providing of such conditions is done in accordance with specific activity carried out and the requirements for technical, technological and social development in order to protect life, health and employability of the workers. The question for ensuring of labour safety is of present interest for all branches of the industry including meat processing enterprises [7, 10, 14, 15].

Working conditions which have unfavourable effect on human health can occasion long-term and later occupational diseases and health problems. Effective control of the working conditions is of primary importance for increasing of the competitive power and productivity of enterprises and contributes to sustainability of social systems for protection by decreasing of accidents and diseases. The main parameters of working environment which are controlled are microclimate, noise and light [9, 12, 13].

Health hazards and risks for workers from meat processing industry in Bulgaria are relevant to insufficient light of the working places; insufficient or missing heating which causes formation of cooling microclimate during the cold period of the year; working equipments and technological processes which generate unfavourable microclimate conditions, for example cooling from the refrigerators, excessive heating from the boiling and from fats melting and etc.; elevated noise during work with meat grinder, cutter, mixer and etc., The overheating and overcooling are extraordinary irritant factors for human body. It is established that overcooling is direct or indirect relevant to cold factor. Considerably cooling can cause freeze, erythema perno (perniones), obliterans endarterit and etc. Occupational diseases as a result from continuous work in high temperature conditions are early atherosclerosis, cataract and retinitis [6, 14].

Noise is another unfavourable factor of working environment. Before provoking of visible changes of the hearing the elevated sound-levels lead to injury of the nervous and digestive human systems. Elevated workplace noise can cause hearing impairment, hypertension, ischemic heart disease, annoyance and sleep disturbance. Noise exposure has also been known to induce tinnitus, hypertension and cardiovascular impacts [4, 12].

Type and intensity of light have a great influence on workers health and contribute for right work organization. Rational light of the workplaces is in direct relation with work's hygiene and safety. Insufficient light, brilliance, stroboscopic effect, inadequate contrasts, irregular distribution of brightness in the range of vision and irregular design of the light lead to unfavourable influence on visual activity and the changes of visual system of the workers [2, 13, 16].

Measuring and control of the working environment parameters are compulsory measures [5].

The existing economic crisis and requirements for environmental protection by implementation of resources efficiency conception impose necessity of improving the architecture initiatives on the buildings, application of measures for limitation of the energy consumption and optimization of the production losses [3, 8, 11].

The aims of this research are to investigate the main working environment parameters (microclimate, noise and light) in meat processing industry and on this base to present suitable measures for optimization of these parameters and for decreasing of energy costs. This can be used as a model from meat processing small and medium enterprises.

Materials and methods

The object of this research was pilot plant for meat processing, situated in the University of Food Technologies-Plovdiv. Working conditions of this plant were identical like in most meat processing SME in Bulgaria.

For investigation of the microclimate was used portable thermo-hygro-areometer type HVACR Datalogger 2003 with measuring probes HP472AC and AP471S1, produced in Italy. The device measures passing, maximum, minimum and average values of the temperature, relative humidity and velocity of the air. Measuring ranges: 0÷40 m/s, 5÷98 % RH, -20÷+80 ^{0}C. Accuracy: ±0,05 m/s, ±2 % RH, ±0,3 ^{0}C.

For measuring of light was used portable lucimeter type SM 700 Milwaukee with measuring probe, produced in Italy. Measuring ranges: 0÷1999 lx, 2000÷19999 lx, 20000÷50000 lx. Accuracy: ±6 %. Resolutions: ±1 lx, ±10 lx, ±100 lx. Working temperature range: 0÷50 ^{0}C.

For noise measuring was used portable sound-level meter type HD 9102 with sound calibrator, produced in Italy. Measuring range: 30÷130 dB. Resolution: 0,1 dB. Accuracy: class 2. Working temperature range: -5±50 ^{0}C.

All measurements were carried out during cold period of the year and in accordance with valid standards [1, 2, 3, 4].

Results and discussion

As a result of investigation on microclimate in the meat processing hall measured air temperature was 11,9±0,1 ^{0}C and relative humidity was 75,0±1,5 %. Temperatures measured in the refrigerating and freezing chambers were 3,9±0,1 ^{0}C and -17,9±0,2 ^{0}C respectively. According to the standard optimal temperature for third category of work is 16-18 ^{0}C. But according technological requirements the temperature during meat processing in production hall has to be not more than 12 ^{0}C, air velocity not to exceed 0,3 m/s and relative humidity has to be in the range from 30 % to 75 % [1].

In table 1 are presented results from measuring of air velocity in meat processing hall. Air velocity in three different outlets of the aspiration system was measured too (table 1).

Table 1. Air velocity in meat processing hall

No	Air velocity in outlet of aspiration system, m/s	Air velocity in workplace, m/s
1	3,34±0,03	0,18±0,02
2	3,54±0 04	0,21±0,02
3	1,30±0,02	0,13±0 03
Average	-	0,17±0 04

The obtained results show that microclimate of meat processing hall is overcooling. Measured values of the temperature, relative humidity and velocity of the air in the workplace were in accordance with established standard. During some periods of the working time higher relative humidity of the air was observed especially in the thermal room.

The artificially light of meat processing hall was investigated. For this purpose the hall was divided to 21 elements with side size of 2,5 m. Illumination in the center of each element was measured and results are presented in table 2.

Table 2. Illumination (E_i, lx) in meat processing hall

Element number	E_i, lx	Element number	E_i, lx
1	123±2	12	192±3
2	115±3	13	117±3
3	140±3	14	182±3
4	140±3	15	190±3
5	190±2	16	175±2
6	275±2	17	170±2
7	199±3	18	182±3
8	204±2	19	176±3
9	143±3	20	168±2
10	170±2	21	185±2
11	174±3	-	-

The illumination in storehouses and freezing chambers was measured too. The results are presented in table 3.

Table 3. Illumination (E_i, lx) in storehouses and freezing chambers of meat processing enterprise

Element number	E_i, lx	
	Storehouses	Freezing chambers
1	66±3	103±2
2	117±3	37±3
3	68±3	26±3
4	100±2	-
5	120±2	-

Average illumination was calculated by the formula:

$$E_{av} = \frac{\sum_{i=1}^{n} E_i}{n}, \text{ lx}, \quad (1)$$

where: E_i – illumination of i-element, lx;

n – number of elements.

The coefficient of uniformity was calculated by the next formula:

$$g = \frac{E_{min}}{E_{av}}, \quad (2)$$

where: E_{min} – measured minimum value of illumination, lx;
E_{av} – calculated average illumination, lx.

Average illumination of meat processing hall was 162 lx and the coefficient of uniformity was 0,7. For the storehouses these values were 94,2 lx and 0,7 respectively and for the freezing chambers these were 55,3 lx and 0,5 respectively. The obtained results show that the illumination of the meat processing hall is insufficient in comparison with the standard which is 300 lx.

During noise investigation the sound-levels of three different outlets of the air conditioners in meat processing hall were measured. The obtained results were respectively 68,2±0,7 dB, 67,0±0,5 dB and 70,3±0,6 dB. Sound-levels during independent work of meat cutter, "wolfkind" grinder and mixer were measured also. The obtained values were 90,5±0,4 dB, 79,9±0,3 dB and 68,4±0,5 dB respectively. Total sound-level in meat processing hall was 90,0±0,5 dB. This total value corresponds to second class of noise (86-95 dB) according to the standard [4]. It is proved that this class of noise leads to auditory and extra aural problems [12, 13, 14].

On the base of investigation carried out the following measures can be proposed for optimization of working environment parameters and decreasing of energy costs in meat processing SME:

1. Optimization of light by installation of suitable energy savings lamps which can realized up to 30 % energy saving.
2. Improving of heat insulation of the building by confirmation with thermo-panels put inside of the working premises in accordance with requirements for energy efficiency, heat and energy savings. Applying of this measure will ensure decreasing of heating and cooling costs, easier cleaning, preventing of pollutant spreading on premises surfaces, higher production certification and tax concessions.
3. Installation of panels with light hues which will increase quality and uniformity of the artificially light in the working places. Behind it can be put installations for electricity and water supplying and the automation.
4. Installation of air screens on the exits of the main groups of premises in order to improve microclimate and to avoid infiltrations, odor spreading and draughts into the building.
5. Installation of energy saving lamps with white light in all service and administrative rooms which will provide psychological comfort of the habitation.
6. Implementation of measures related to using of renewable energy resources such as for example construction of tabular roof with surface of 800 m^2 which permits installation of solar panels with capacity that will cover the needs of hot water. Part of the hot water can be accumulated into boiler with capacity of 500 dm^3 and temperature up to 40 ^0C and subsequently to be heated for industrial needs. This will be the suitable way for optimization of production costs.
7. Applying of measures for reusing of t heat released from the freezing units for heating of water or air which subsequently are used for heating of the industrial building.

8. Noise limitations by application of rationale plans, construction and acoustic measures and use of personal protective equipments. Negative effect of the noise can be sharply decrease by implementation of suitable physiological regimes of work and rest.

Conclusion

Presented measures for optimization of the parameters of working environment and for decreasing of energy costs can be used as a model to be implemented by meat processing SME. Its application will leads to permanent and optimal microclimate, uniformly and rational light, easy cleaning of ceilings and walls, lack of air streams, decreasing of energy losses, certification of the industrial building and production with respectively alleviations and independence concerning hot water production for own needs. In case of installation of the photovoltage elements partial independence of the industry can be realized concerning electrical energy consumption and possibility for additional financial resources receiving by marketing of the surplus energy.

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