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УДК 631.158

Analysis of modern ventilation systems to ensure the microclimate in livestock and poultry buildings

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This article analyzes modern air conditioning systems (ACS) to create a microclimate in livestock and poultry buildings. The creation and maintenance of a microclimate in livestock and poultry buildings is associated with the solution of a complex of engineering and technical problems and is one of the determining factors in ensuring the health of animals and birds. Traditional ventilation systems with the organization of air exchange according to the "top-down" scheme do not provide the required microclimate parameters in the habitat of animals and birds.

The indicators of the microclimate in rooms for animals and birds depend on external climatic conditions, technological regime, design features of buildings, quality of engineering and technical facilities, etc. It is considered optimal to consider such combinations of microclimate parameters (temperature, relative humidity, purity and air velocity) that ensure the highest productivity of animals [2].

The study of traditional schemes for organizing air exchange in livestock and poultry buildings was carried out by a number of authors [1; 2; 4; 5]. The most complete studies on models and in natural conditions were carried out by Bronfman L. I. [6], who concludes that natural ventilation is ineffective at high outdoor temperatures.

The system with mechanical draft induction allows for organized air exchange with the help of supply and exhaust systems. On fig. 1 shows the traditional scheme for organizing air exchange in the ventilation system of livestock and poultry buildings in a dry hot climate.

In the warm period of the year, the supply air is supplied through local supply units of direct evaporative cooling, which are suspended under the ceilings and connected by a shaft to the intake of the supply air, or mounted on the roof and connected to the supply units.

During the transitional period of the year, the same supply units are used, but the pumps that supply water for irrigation of wood chips in the unit cassettes can be turned off.

During the cold period of the year, the supply units of direct evaporative cooling are switched off and their intake openings are blocked (covered with polyethylene film), which makes it possible to exclude the infiltration of cold outside air through them.

The supply of heated supply air is carried out from the supply unit, which includes means for heating. Depending on the heat source used, the heating means in the second supply unit are designed accordingly. When hot water is used as a heat source, heaters are used to heat the supply air [6]. In the absence of boiler houses in livestock and poultry buildings, autonomous gas or liquid fuel air heaters are used.

A common feature for the traditional scheme of organizing air exchange in livestock and poultry buildings is the supply of fresh air from above with an inflow temperature t_{in}, which has a lower air temperature than in the animal habitat t_{an}, which is explained by the year-round presence of excess heat from animals in their habitat. The removal of gassed, humid and heated air occurs from the lower zone of the room with the help of axial fans with an adjustable number of revolutions of electric motors. The change in the number of revolutions of electric motors of axial fans is carried out according to the air temperature control sensor in the animal habitat [6].

From the diagram in fig. 1 it can be seen that the temperature of the removed air t_r can be equal to or even lower than the air temperature in the animal habitat t_{an}.

The latter is explained by the fact that part of the supply air can enter the axial exhaust fans along the shortest path, bypassing the animal habitat.

The air capacity of the supply systems is determined from the conditions for maintaining the concentration of harmful substances in the habitat of animals not higher than the MPC.

However, if part of the supply air passes, bypassing the habitats, the concentration of harmful substances in the outgoing air will be less than the concentration of harmful substances in the air in animals. Thus, the concentration of hazards in the animal habitat will be higher than the MPC. On fig. 2 shows the results of measuring the concentration of ammonia at a level of 0,5 m from the floor in a poultry house 18 m wide [1].

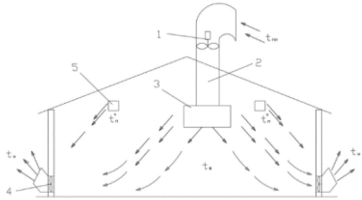

Fig. 1. The traditional scheme for organizing air exchange
in livestock poultry buildings:
1 – supply fan (1,1 kW); *2* – exhaust shafts; *3* – conditioner KIO-13; *4* – exhaust fan (1,1 kW); *5* – supply air ducts connected to two centrifugal fans (5,5 kW)

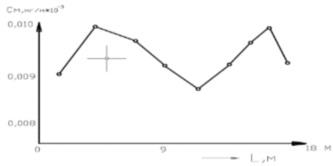

Fig. 2. Field measurements of ammonia concentrations in the air across the poultry house at a height of 0,5 m from the floor when supply air is supplied through a slotted supply air duct at a height of 3,5 m and gaseous air is extracted from the operation of axial fans mounted in longitudinal walls at a height of 0,3 m from gender

Outside air is supplied in the center of the poultry house through a slotted air duct at a height of 3,5 m. The exhaust air is carried out at a height of 0,3 m from the floor, from the operation of axial fans in the longitudinal walls.

From fig. 2 it can be seen that the lowest concentration of ammonia is typical for the middle part, in the aisle of the poultry house, where the supply air stream is directed from the slotted supply openings. The highest concentration of ammonia is observed in the zone of the last cages with birds along the supply air. It is quite characteristic that in the area near the longitudinal walls, where axial exhaust fans are installed, the concentration of ammonia is lower than in the cages with birds adjacent to the longitudinal walls. These field measurements confirm our assumptions that part of the supply air in the air exchange scheme according to fig. 2 passes, bypassing the habitat of animal birds. This indicates the low efficiency of traditional ventilation systems in livestock and poultry buildings with air movement according to the "top-down" scheme, which is confirmed by the results of foreign studies. In California (USA) an experimental study was carried out in 17 poultry houses during the flight period. In these poultry houses, the following ventilation systems were used with evaporative cooling of the supply air, fig. 3.

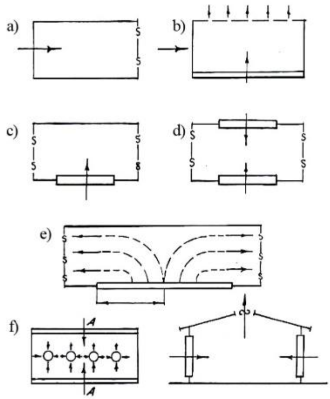

Fig. 3. Ventilation schemes with evaporative supply air cooling
used in poultry houses in the USA

1) irrigated layers are located in the end wall of the building, and exhaust fans – in the opposite side (fig. 3, *a*). With this system, in poultry houses up to 46 m long, it is possible to maintain a fairly uniform temperature. In long poultry houses, the cooled air descends to floor level and has an elevated temperature in the area where the fans are installed;

2) irrigated layers are located along the entire length in the longitudinal wall of the building (fig. 3, *b*), and exhaust fans – on the opposite. In this case, the distance covered by the air flow is reduced, and the house can be built to any length. In 27,4 m wide houses, oriented at an angle to the prevailing wind, the air quickly sinks to floor level below the chicken cages, and stagnant zones are observed in the house. In rooms with a width of 12–18 m, more uniform temperature fields are achieved than in wider poultry houses;

3) irrigated layers are located in one or both longitudinal walls of the poultry house (fig. 3, *c*, *d*, *e*), and exhaust fans – in the end walls. This scheme is used to shorten the path traveled by the air flow in the room. In order to avoid the formation of stagnant zones, it is recommended to organize air exchange in such a way that the speed before the turn is less and increases after the turn of the flow; for this, the width of the air flow path must be greater before the turn and less after it (see fig. 3, *e*);

4) irrigated layers are located in both longitudinal walls, and exhaust fans on the roof along the ridge (fig. 3, *f*).

With this ventilation scheme, the lowest content of ammonia and oxide, carbon in the bird habitat, the absence of stagnant zones and a more uniform temperature field are noted.

The results of studies [1; 3–7] showed that the ventilation scheme shown in fig. 3, *f* with air movement in the "bottom-up" direction turned out to be the most effective. The main equipment in the ventilation systems of livestock buildings are contact devices for evaporative air cooling.

Traditional ventilation systems for livestock and poultry buildings with the organization of air exchange according to the "top-down" scheme do not provide the required microclimate parameters in the habitat of animals and birds. In addition to uncomfortable conditions in terms of temperature and humidity in the habitat of animals, there is an increased content of ammonia and carbon monoxide, exceeding their maximum allowable concentrations.

The organization of air exchange according to the "bottom-up" scheme significantly improves the composition of the air environment and the microclimate in livestock and poultry buildings.

In order to identify the most optimal apparatus and devices for air cooling in livestock poultry buildings, a comparative analysis of these devices and methods for their calculation should be performed.

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УДК 66.061; 66.069.8

Analysis of organic solvents released during painting and drying of automobiles and household products

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The article presents the results of a study of the drying process of paints and varnishes based on organic solvents. and environmental problems. An analysis of the current scale of their use is carried out and an assessment is made of environmental problems associated with their evaporation. The issues of organizing the collection of the resulting solvent vapors and their further use, taking into account their use in specially equipped rooms, are considered.

Places where attention should be paid to the observance of precautionary measures in enterprises are warehouses where stocks of dyes and other chemical reagents are stored, stations for the preparation of feed and working solutions of dyes and various auxiliary substances. Organic dyes are flammable. Dust and dust-air mixtures of most of them are flammable and explosive. Paints related to nitro compounds are explosive. Diazo compounds, including diazoles, are highly explosive, especially at high temperatures. Therefore, these products should be stored and handled in conditions that exclude their overheating. The inclusion of inert additives in the final forms of paints reduces the risk of explosion and fire of settled dust and dust-air mixtures. Significant improvement of sanitary working conditions, reduction of dust emission is supported by the use of paints in special final forms – dust-free powders, granules, liquid form. Work rooms where paints are stored and work with them, related to the formation of dust, must have a strong supply and exhaust ventilation. It is necessary to constantly monitor the level of dust in these buildings. Electrical equipment must be assembled in an explosion-proof design. The preparation of concentrated and working solutions of paints should be carried out in closed equipment, if necessary, it should be equipped with local exhaust ventilation. Remember that many paints are toxic. Most of them irritate the skin and mucous membranes [1]. In particular, arylmethane-