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# Research of thermal and hydrodynamic flows of heat exchangers for different air-cooling systems in poultry houses

**Abstract.** Increasing the productivity of poultry farms relates to the need to create an optimal, regulated microclimate in poultry houses. This issue becomes of primary importance due to the decrease in the productivity of poultry farming caused by the imperfection of the existing systems. The purpose of this study was to develop and numerically model a shell-and-tube heat exchanger of an innovative design for cooling supply air as an element of the air conditioning system used in ventilation systems of distinct types in the summer period. CFD modelling using ANSYS Fluent software was used to simulate hydrodynamic processes and heat exchange processes in channels with compactly arranged pipes in a bundle. Two types of ventilation systems were considered, namely tunnel and side. For them, heat exchangers designed to cool incoming air in summer were developed. A total of 80 automatic inlet valves measuring 0.3×0.85 m were installed in the side walls. Furthermore, evaporative cooling systems 5.3×1.1 m were located on the front-end walls. Numerical modelling of hydrodynamics and heat transfer was performed, as well as an analysis of the operation of heat exchangers of two distinctive designs for tunnel and side ventilation. Velocity, temperature, and pressure fields in the channels under study were obtained. The conditions of the hydrodynamic flow in the channels of the heat exchangers were analysed. In the case of the tunnel ventilation system, the pressure drop is 991 Pa, which is 3.3 times less compared to the side ventilation system. The outlet temperature is +23°C, which meets the design requirements. The main disadvantage is the financial costs for the purchase, cutting of pipes and their welding. To ensure standardized conditions of the air environment in the poultry house, considering all aspects of technical and economic analysis, it is proposed to choose a heat exchanger for the tunnel

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ventilation system. In practice, such heat exchange devices can be used not only in microclimate systems of poultry houses, but in the industrial, energy sector, and critical infrastructure facilitie

**Keywords**: automatic inlet valves; Computational Fluid Dynamics; poultry farm; tunnel ventilation; side ventilation

## INTRODUCTION

Increasing the productivity of poultry farms is associated with the need to create an optimal microclimate in the air environment in poultry houses. An important task here is the development of innovative approaches and principles for solving the problem of cooling and heating supply air in poultry houses in summer and winter. This issue is relevant due to the decrease in the productivity of poultry farming caused by the imperfection of the existing microclimate systems in the summer at elevated temperatures and humidity of the outdoor air. Current power supply systems in poultry houses require elevated energy consumption and costs to provide a controlled environment in poultry houses.

In the studies by V. Blanes-Vidal *et al.* (2008), E. Bustamante *et al.* (2017) presented modelling of air flows and heat and mass transfer using Computational Fluid Dynamics (CFD) in poultry houses equipped with a side ventilation system. The authors suggest that the method of side mechanical ventilation is more effective compared to other methods and can reduce thermal stress and increase the productivity of poultry keeping in the summer. The results of the mathematical modelling were compared with the data of experimental studies and the difference does not exceed 12%. M. Zajicek & P. Kic (2012) present CFD solutions for various improved enclosures for different flow configurations and broiler room shapes. The effects of transverse and longitudinal ventilation are combined with changes in the directions of incoming air flows, as well as with a different cross-sectional shape obtained using louvres.

According to the calculations presented by E. Bustamante *et al.* (2017), it was concluded that the insufficient speed of air movement, as well as the absence of a cooling system, increase the thermal stress of the poultry, which leads to a decrease in ventilation productivity. This is facilitated by the uneven flow of air in the area where the poultry is located and the area of stagnant air, which worsens the conditions for thermoregulation of the poultry. V.G. Gorobets *et al.* (2018), N. Biçer *et al.* (2020) considered an outdoor air-cooling system using a specially designed heat exchanger using water from artesian wells as a coolant. Mathematical modelling of heat and mass exchange processes during air ventilation in poultry houses with a highly adjusted arrangement of ventilation equipment was performed. As a result of numerical modelling, the fields of velocities, temperatures, and pressures in the poultry house were determined.

When developing new types of heat exchanger designs, such factors as their compact characteristics, efficiency of heat transfer through the surface separating heat carriers, pressure losses in the circuits of each heat carrier and other parameters characterizing heat exchange surfaces are considered. Another important analysis tool for determining the effectiveness of the developed design of the heat exchanger is detailed mathematical modelling of heat, mass, and energy exchange processes in the heat exchanger (Ambekar *et al.*, 2016; El Maakoul, 2016; Bayram & Sevilgen, 2017). Such modelling allows for the analysis of local hydraulic and thermal characteristics on heat exchange surfaces (Kim *et al.*, 2016; Leoni *et al.*, 2017; Ling *et al.*, 2017), to determine their thermal efficiency coefficient and to estimate the hydraulic losses that determine the power of the pumps, which are used to remove coolants (Pal *et al.*, 2016; Mellal *et al.*, 2017; Shahril *et al.*, 2017).

The most common designs of heat exchangers, which are mainly used in engineering, are recuperative ones. As a rule, shell-and-tube heat exchangers have a chequerboard or corridor arrangement of tube bundles, and the conditions of their hydrodynamic flow and heat exchange have been thoroughly investigated in several scientific works (Thakre & Pachghare, 2017; Abbasi *et al.*, 2020; Bahiraei *et al.*, 2021). However, hydrodynamics and heat transfer in the case of small-diameter tube bundles have been understudied. Z. Yang *et al.* (2020), A.C. Caputo *et al.* (2022) note that the use of such heat exchange surfaces in shell-and-tube heat exchangers allows improving their energy and economic characteristics compared to known designs.

The purpose of this study was to develop modern designs of shell-and-tube heat exchangers, as well as to conduct research on hydrodynamic flows and heat transfer in inter-tube channels to improve systems for maintaining a standardized microclimate of the air environment in poultry farms.

## MATERIALS AND METHODS

The study was conducted during 2020-2022 by the National University of Life and Environmental Sciences, Kyiv. The basic enterprise was a poultry farm located in the city of Ladyzhyn (LLC "Vinnytsia Poultry Farm"). In this enterprise, conventional type poultry houses with dimensions of 20×120×5.8 m for 50,000 heads were used for breeding poultry. The microclimate maintenance system used in poultry houses had two types of ventilation systems, namely tunnel and side. It had 18 exhaust fans of the type Munters EM50 1.5 HP (Sweden), which were located on the back-end wall of the poultry house with a total volumetric airflow of 1,036 thousand $m^3/h$. On the side walls of a separate poultry house according to the current technology to keep a normalized microclimate of the ventilation system, there are automatic inlet valves with a total number of 80 pieces measuring 0.3×0.85 m (Fig. 1). Furthermore, evaporative cooling systems of 5.3×1.1 m were located on the front-end walls of the poultry house. Notably, the existing microclimate maintenance system had several shortcomings, namely, insufficient cooling of heated outdoor air in the summer, high water consumption in evaporative cooling systems and high humidity levels in poultry houses. The study used a new system for cooling external heated air, which was cooled in shell-and-tube heat exchangers, where water from underground wells was used as a coolant. Therewith, heat exchangers were used instead of the evaporative cooling system and automatic supply valves. For these ventilation systems, a new design of heat exchangers was developed, which were designed to cool the incoming air in summer.

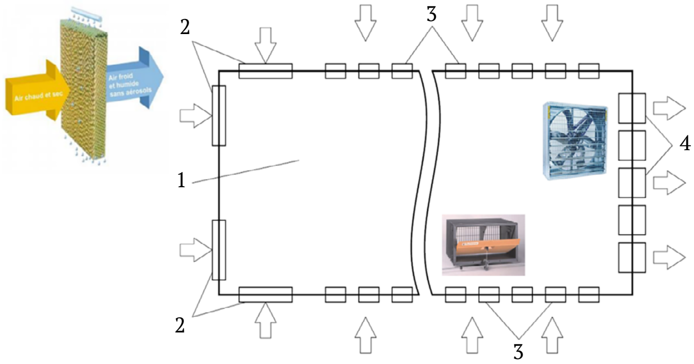



**Figure 1.** Scheme of the evaporative cooling system and side ventilation inlet valves in the poultry house
**Note:** 1 – poultry house; 2 – evaporative cooling cassettes; 3 – ventilation supply valves; 4 – exhaust fans
**Source:** developed by the authors

A heat exchanger with a case of rectangular cross-section with transverse flow around pipes with an inherent geometry of the arrangement of pipes with a diameter of d=10 mm was considered (Fig. 2). It differed from conventional chequered and corridor tubular bundles. The heat exchangers, which contain a transverse tube bundle, consisted of rows of tubes, where the adjacent tubes of each row were tangent to each other, and the adjacent tubes in each row were arranged with a sequential offset relative to the axis of the row. In this study, adjacent tubes were offset by 1 mm from each other. In both types of heat exchangers (HE), the width of the channel between adjacent rows of tubes was equal to 15 mm, the number of tubes along the depth of the channel in one collector was equal to 51 pcs.

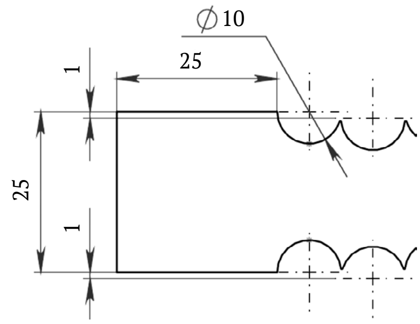



**Figure 2.** Location of tubes in the HE bundle, (top view)
**Source:** developed by the authors

All calculations were performed with an air consumption of 1,036 thousand m$^3$/h. The heat carrier was air +40°C at the entrance, which flows through the heating ducts in summer to cool the air in the poultry house. At the exit from the heat exchanger, the air temperature should have been close to +20°C. Groundwater from artesian wells was used as a coolant (Gorobets *et al.*, 2021). In turn, the temperature of cold water at the entrance to the thermal power plant was equal to +10°C. Since the problem was solved in 2D projection, to reduce the cost of computer resources, the boundary conditions for the temperature on the inner walls of the pipes were set differently for each collector. It was assumed that the water temperature in the pipes of each collector will change according to a linear characteristic. Thus, in the HE for the tunnel ventilation system, the average value of the temperature at the first collector was 19.87°C, while at the second – 13.29°C, assuming that the water temperature at the outlet was 23.16°C. With the side ventilation system, the temperature on the first collector is 21.625°C, on the second and third – 16.975°C and 12.325°C, respectively. The water temperature at the outlet of the thermal power plant is 23.95°C. Water consumption for all HEs is presented in Table 1.

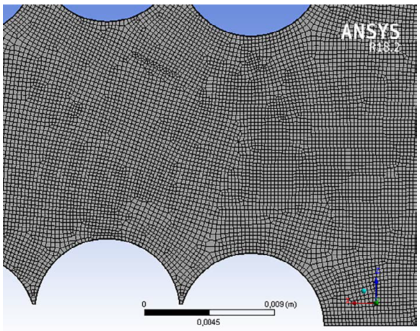
**Table 1.** Design parameters of HE for distinct types of ventilation systems

| Ventilation system | Water consumption for all HEs, $m^3/h$ | Air consumption for all HEs, $m^3/h$ | Air consumption for one HE, $m^3/h$ | Width of HE, m | Height of HE, m | Number of tubes in one HE, pcs | Number of collectors, pcs | Quantity of HE, pcs | Total length of pipes, m |
|---|---|---|---|---|---|---|---|---|---|
| Tunnel | 372.0 | 1,036,704 | 86,392 | 2.65 | 1.0 | 10,812 | 2 | 12 | 129,744 |
| Side | 382.4 | 1,036,880 | 12,961 | 0.85 | 0.3 | 5,202 | 3 | 80 | 124,848 |

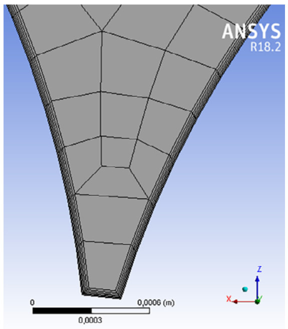
**Source:** developed by the authors

The system of movement of coolants in the channels and in the tubes was crossed. To obtain sufficient cooling of the supply air from +40°C to +20°C, the heat exchangers were designed according to the inlet dimensions of the valves and evaporative cooling cassettes. Due to the need for such a considerable air exchange (1,036 thousand $m^3/h$) and the necessary heat exchange between heat carriers, the number of collectors in heat exchange units for systems with tunnel and side ventilation was different. Table 1 presents the structural data of both designs of heat exchangers for distinct types of ventilation systems.

CFD modelling of hydrodynamic processes and heat exchange processes in channels with a compact arrangement of pipes in a bundle was carried out using the ANSYS Fluent software package (ANSYS..., 2017). The mathematical model was based on the Navier-Stokes equation (Khmelnik, 2021), the energy conservation equation for convective currents, and the continuity equation. The standard k-ε model of turbulence was used in the calculations. Mesh generation was performed in ANSYS Meshing based on the Workbench platform (Fig. 3).



a



b

**Figure 3.** Mesh generated in ANSYS Meshing

**Note:** a – full channel, b – boundary layer

**Source:** developed by the authors

When creating the grid for the heat exchanger of all designs, local grid control was used. The minimum associated size was $2.5 \cdot 10^{-4}$ m. The quadriside grid was generated using the construction of the boundary layer with the Total Thickness approach. For the first layer, the thickness was $5 \cdot 10^{-5}$ m, the number of layers was 6. The quality indicator of the grid, i.e., Orthogonal Quality, for both types of heat exchangers was within 0.561-0.564.

## RESULTS AND DISCUSSION

Studies indicate that the air velocity in the intertube channels for heat exchangers located in holes with a tunnel ventilation system will be lower compared to heat exchangers with a side ventilation system. Due to the considerably larger dimensions of the heat exchangers for the tunnel ventilation system, 2 collectors are provided for it, and 3 collectors for the second one. Accordingly, the number of pipes included in the collectors was chosen so that the outlet temperature was close to +20 °C. The incoming hot air enters the heat exchanger from the right side. Figures 4-5 show the variation of temperatures for distinct types of ventilation systems. As air passes through the inter-pipe channels of the bundles of pipes in which water flows from underground wells, the air temperature will decrease. For the tunnel ventilation system, the air approaching at the intersection between collectors 1 and 2 is cooled to a temperature of +30.1°C (Fig. 4). For the side ventilation system, for which the HE was designed for 3 collectors, the temperature between 1 and 2 collectors drops to +32.3°C, and between 2 and 3 – to +26.1°C (Fig. 5). Based on the conducted studies, when using the tunnel ventilation system, the temperature in the HE decreases from +40 to +22.5°C (Fig. 4), and with the side one – from +40 to +19.7°C (Fig. 5). Therewith, the number of pipes and the dimensions of the heat exchanger for the first case will be substantially smaller, which is conditioned upon the lower temperature pressure on the inner part of the pipes for heat exchangers with a tunnel ventilation system.

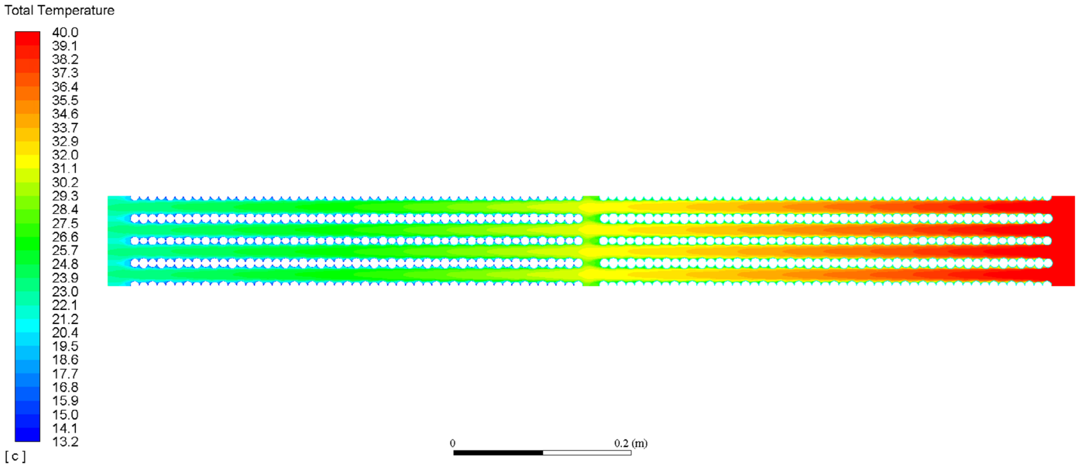



**Figure 4.** Field of temperatures in HE for the tunnel ventilation system, °C

**Source:** developed by the authors

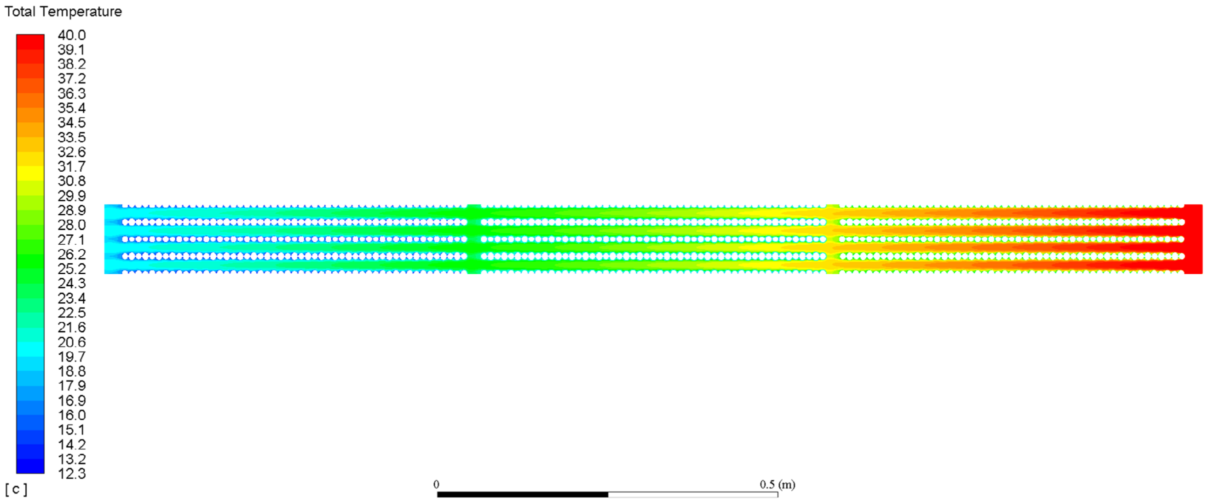



**Figure 5.** Field of temperatures in TE for the side ventilation system, °C

**Source:** developed by the authors

On Figure 6 presents the distribution of velocity vectors at the entrance to the HE channel for different types of ventilation systems. The analysis of the velocity field during the flow around the investigated bundle of pipes indicates their complex nature. On the part of the pipe surface adjacent to the flow in the inter-pipe channel, the velocity near the surface is maximum. Accordingly, a boundary layer is formed in these areas and the local values of the heat transfer coefficients will also be maximum. Separation currents are formed in the areas between adjacent pipes, close to the contact lines. The speed of the eddy flows in these areas is substantially lower, which leads to a decrease in the local values of the heat transfer coefficient on the surface of the pipes in the separation zones.

Therewith, the local values of the heat transfer coefficient for different flow zones can differ several times. To increase the areas where the local values of the heat transfer coefficient are maximum, the diameter of the pipes was chosen to be the minimum, since the size of the separation and stagnation zones increases with the increase in diameter.

In the case of the tunnel ventilation system (Fig. 7), the maximum air speed in individual points is 17.6 m/s, and the average speed in the narrowest passage of the channel is 15.1 m/s. In the case of the lateral ventilation system (Fig. 8), the maximum speed in certain sections of the flow is 27.2 m/s, and the average is 23.5 m/s.

Table 2 provides a more detailed overview of CFD simulation results for different types of ventilation systems. Notably, depending on the location of the heat exchanger in the end zone of the poultry house (tunnel ventilation), the flow rate in the heat exchanger channels increases, i.e., the heat transfer coefficient on the surface of the beam increases. This, in turn, leads to a decrease in the number of pipes in the heat exchanger, a decrease in its weight and manufacturing cost. Differences in local heat exchange characteristics for tunnel and side ventilation systems help pick a better hot air cooling system – in this case, preference is given to tunnel ventilation.

a

b

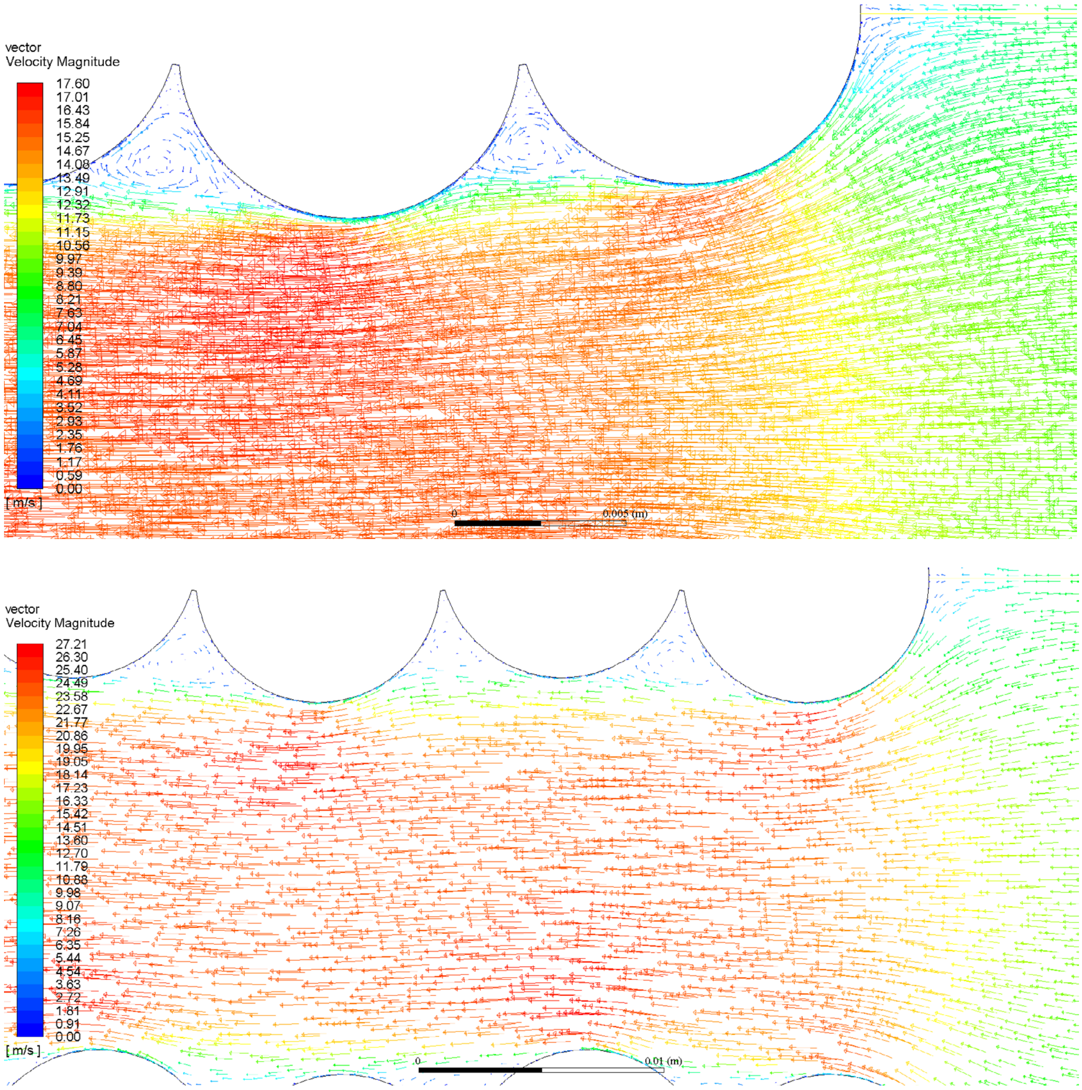



**Figure 6.** Airflow velocity vector at the entrance to the HE, m/s
**Note:** a – for the tunnel ventilation system, b – for the side ventilation system
**Source:** developed by the authors

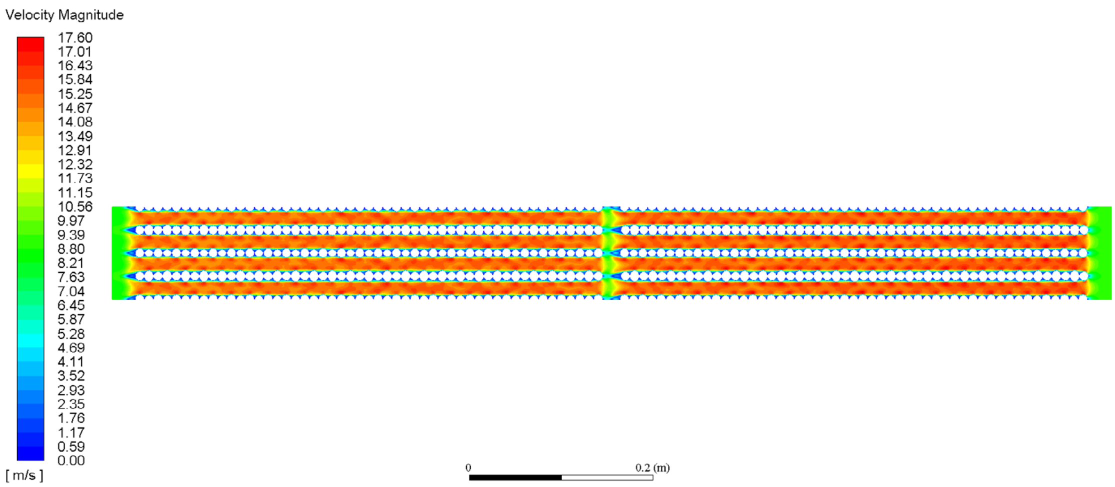



**Figure 7.** Air speed in the channel for the tunnel ventilation system, m/s
**Source:** developed by the authors

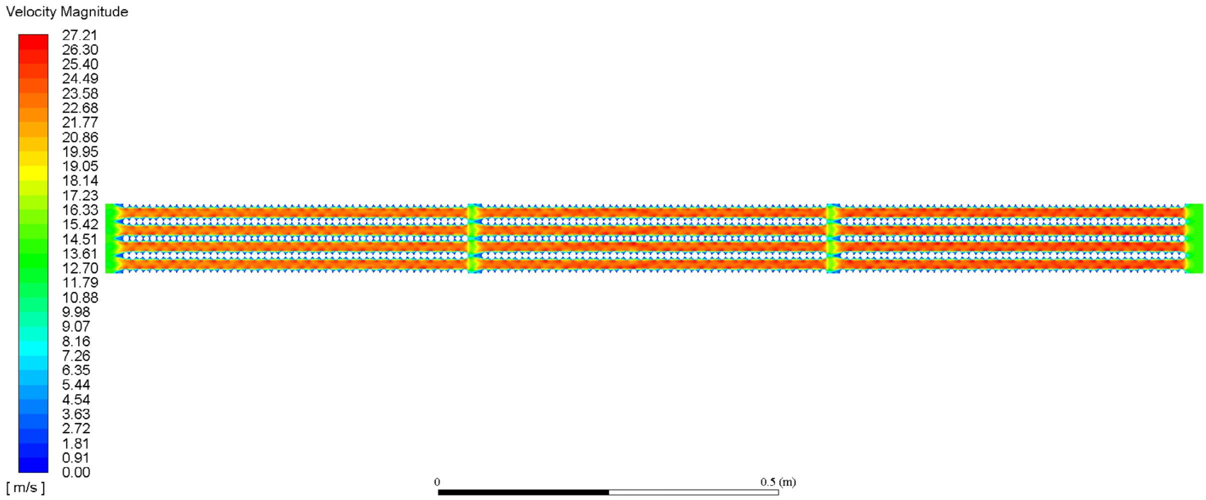



**Figure 8.** Air speed in the channel for the side ventilation system, m/s
**Source:** developed by the authors

**Table 2.** CFD simulation results of HE for different types of ventilation systems

| Ventilation systems | Temperature of water at the exit from the HE, °C | Temperature of the air at the outlet of the HE, °C | Pressure drop in the HE channel, Pa | Average air speed in the narrowest section of the HE channel, m/s | Maximum air speed in the HE channel, m/s | Thermal capacity of all HEs, kW | Thermal capacity of one HE, kW |
|---|---|---|---|---|---|---|---|
| Tunnel | 23.16 | 22.55 | 991 | 15.10 | 17.60 | 5,696.64 | 474.72 |
| Side | 23.95 | 19.66 | 3,286 | 23.53 | 27.21 | 6,204.00 | 77.550 |

**Source:** developed by the authors

From the comparison of heat exchangers according to the pressure drop in the channels (Fig. 9-10), developed for distinct types of systems, it can be observed that they differ by approximately 3.3 times. For the side ventilation system in the HE channels, the pressure drop is 3.3 kPa, the maximum pressure values in individual areas reach 3.44 kPa (Fig. 9). For the tunnel ventilation system, where the pressure drop is 0.99 kPa. At certain points of the channel, the pressure reaches 1.08 kPa (Fig. 7). Prominent pressure drops are accompanied by an increase in the power of exhaust fan motors. Thus, it will be more suitable to pick a HE for the tunnel ventilation system (Table 2).

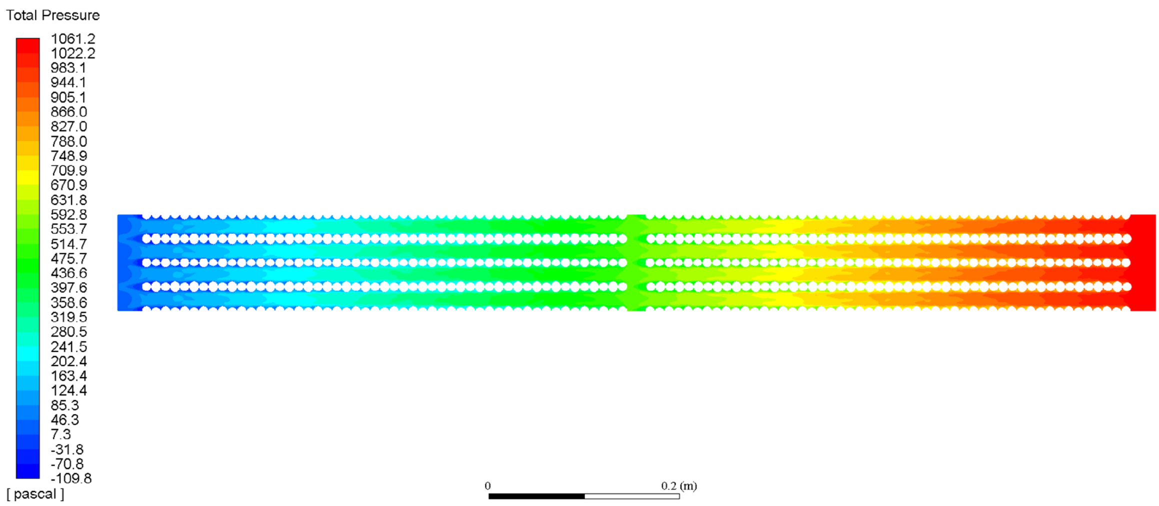



**Figure 9.** Pressure drop in the HE channel for the tunnel ventilation system, Pa
**Source:** developed by the authors

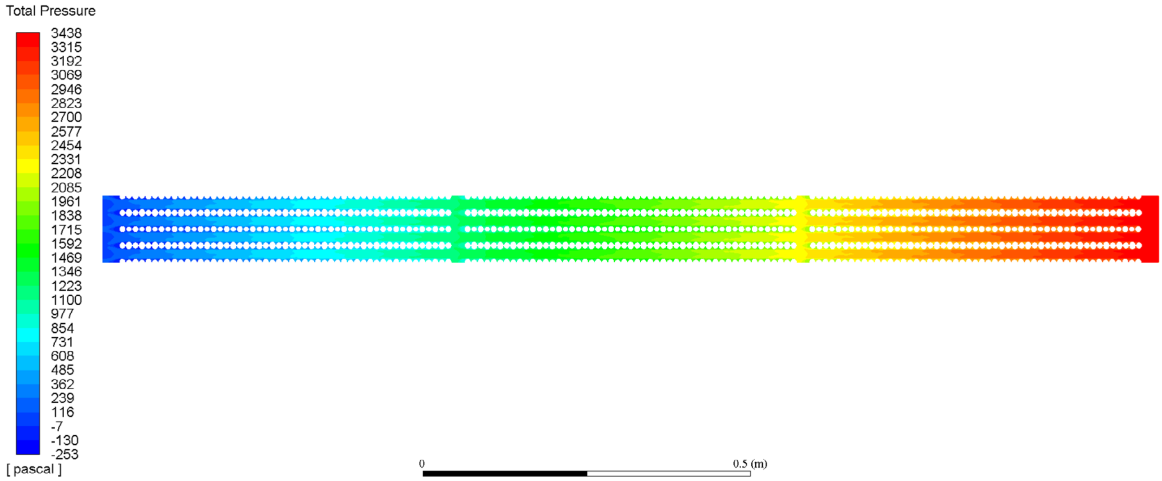



**Figure 10.** Pressure drop in the HE channel for the side ventilation system, Pa
**Source:** developed by the authors

When designing and manufacturing a heat exchanger for a microclimate control system in poultry houses, it is necessary to consider numerous parameters. These include the pressure drop in the heat exchanger channels, which affects the power and performance of ventilation systems; the temperature at the outlet of the HE, which enters the poultry house and cools the air in the room, etc. The basis of the project is the development of heating systems for two types of ventilation systems. In the case of the tunnel ventilation system, the pressure drop is 991 Pa, which is 3.3 times less compared to the side ventilation system. The outlet temperature is +23°C, which meets the design requirements. But the disadvantage is the financial costs of purchase, pipe cutting, and thermal welding. Both the tunnel and side ventilation systems are quite effective. When choosing a ventilation system, one should consider such factors as pressure losses in heat exchangers, the amount of metal, as well as the material costs required for their manufacture. When the pressure loss increases, the power consumption required to drive the fans increases. The production of many heat exchangers for the side ventilation system increases their mass and, accordingly, the cost of their production compared to tunnel ventilation, for which only two heat exchangers need to be produced. Thus, to ensure normalized conditions of the air environment in the poultry house, considering all aspects of the technical and economic analysis, it is suggested to pick a HE for the tunnel ventilation system. Such costs are justified since the improvement of microclimate parameters helps increase the weight of poultry and increase the productivity of the poultry farm in the summer. However, the reconstruction of the ventilation system requires considerable capital costs, and not all poultry farms can afford the installation and maintenance of the proposed system.

Side ventilation system, according to the studies of V. Blanes-Vidal *et al.* (2008), E. Bustamante *et al.* (2017) is more effective. However, when using HE and judging by the research conducted in this paper, it is necessary to pick a tunnel ventilation system. The article by N. Biçer *et al.* (2020) proved that the tunnel ventilation system is more effective in the hotter period of the year. The advantage of the tunnel ventilation system is that when the heat exchangers are placed on the end wall of the poultry house, the direction of air movement in the poultry house is straight and directed towards the end wall on which the exhaust fans are located. Therewith, in contrast to the lateral air supply, there is no change in the air direction by 90°, which, as is known, increases pressure losses due to an increase in local resistances. As a result, with the same mass flow of air, it is necessary to increase the power of exhaust fans. The second factor that improves the hydrodynamic pattern of the flow during tunnel ventilation is the smaller number of stagnant zones compared to the side ventilation system, which causes an uneven distribution of temperatures in the volume of the poultry house. The latter factor affects the conditions of the microclimate, under which chickens in some areas of the poultry house will be in worse conditions, which reduces the productivity of the poultry house as a whole.

In the studies of V.G. Gorobets *et al.* (2018), N. Biçer *et al.* (2020) it is assumed that the tunnel ventilation system is effective, compared to the rest of the known ones. The general conclusion of the conducted research is that the use of a cooling system using HE is an effective system for maintaining the microclimate. Notably, the conclusion made is confirmed by studies conducted by V.G. Gorobets *et al.* (2021), where HEs with different geometries of placement of small-diameter pipes in a pipe bundle were investigated. Therein, the displacement of adjacent pipes relative to each other was from 1 to 5 mm. Therewith, the excess pressure in such bundles reached up to 15 kPa. In this regard, in the present study, it is proposed to use a bundle of pipes with minimal displacement of neighbouring pipes. The maximum excess pressure is 3.3 kPa for the lateral ventilation system and up to 1 kPa for the tunnel ventilation system. The selected design solution with a minimum displacement of the pipes in the bundle reduces the pressure drop by 4.5 times compared to the maximum pressure losses obtained in the study by V.G. Gorobets *et al.* (2021) for individual pipe arrangement geometries, where the displacement between adjacent pipes was large.

In the proposed heat exchangers for cooling external heated air, the design of the selected heat exchanger is substantially different from conventional designs. The difference lies in the choice of compact bundles, where the chequerboard or corridor arrangement of pipes in the bundle changes – in compact bundles of pipes, the step size between adjacent pipes in the flow direction is minimal. With such an arrangement of pipes in bundles, channels for the flow of air coolant are formed, where pressure losses are substantially smaller. This helps reduce the required power of ventilation systems when using heat exchangers of the proposed design.

The second major difference of such heat exchangers is the use of small diameter pipes. When flowing around individual pipes in a bundle, a boundary layer is formed on their surface at the point of attachment of the external flow, which breaks off in the aft part of the pipe. When using small-diameter pipes, the boundary layer formation length is substantially shorter compared to large-diameter pipes. Since the local values of the heat transfer coefficients are maximal at the initial areas of boundary layer formation, the value of the average value of the heat transfer coefficient on the surface of small-diameter pipes will be 1.5-2 times larger. This helps reduce the size of the heat exchangers of the proposed design by 1.5-2 times and reduce their weight by 15-20%.

A specific feature of the proposed design of heat exchangers for cooling supply air is displacement of adjacent pipes relative to each other. The amount of displacement can be 1-5 mm. Therewith, curved channels are formed between adjacent rows of pipes in the bundle, which increases the value of the heat transfer coefficient for the bundle as a whole. However, with an increase in the amount of displacement, pressure losses increase considerably, so it is necessary to choose such a configuration where the increase in the heat transfer coefficient would not lead to significant pressure drops in the heat exchanger channels. In the proposed design of the heat exchanger, the value of the displacement was selected equal to 1 mm. With such a displacement, the pressure loss will not be significant, i.e., the power of the fans for pumping the air coolant in the heat exchangers will be insignificant with an increase in the total heat transfer coefficient. The selected design of the heat exchanger is the best for the developed microclimate maintenance system in poultry houses.

The conducted studies suggest that when developing new systems for cooling supply air in poultry houses using shell-and-tube heat exchangers with compact placement of small-diameter pipes and well water as a coolant, a tunnel ventilation system can be recommended. To improve the mass-dimensional characteristics and increase the efficiency of heat exchange equipment, it is necessary to use working surfaces with heat exchange intensifiers.

## CONCLUSIONS

A new system for maintaining the microclimate in poultry houses with tunnel and side ventilation is proposed, which is based on the use of water from underground wells to cool the outside air in shell-and-tube heat exchangers. An innovative design of the shell-and-tube heat exchanger with a compact arrangement of small-diameter pipes in pipe bundles for air cooling in the ventilation system has been developed. CFD modelling of hydrodynamics and heat transfer processes in pipe bundles of different geometries with their compact arrangement for various ventilation systems was carried out using the ANSYS Fluent software package. Fields of temperatures, pressures, and velocities in the channels of the HE under study were obtained. In the case of using a tunnel ventilation system, the average speed in the narrowest channel passage of such HEs is 15.1 m/s. The pressure drop is 991 Pa. And with a lateral ventilation system, the average speed of such HEs is 23.5 m/s, while the pressure is 3.3 kPa.

The conditions of hydrodynamics and heat exchange in the channels of the heat exchanger were analysed, and the factors affecting the intensity of heat exchange between the cold and hot coolant on the surface of the tube bundles were determined. The geometry of the pipe bundles and the flow regimes where the parameters of the cooled air meet the regulatory requirements were determined. Ventilation systems with tunnel and side ventilation were compared, and the advantages of tunnel ventilation for maintaining a normalized microclimate in poultry houses were proved. The design of the shell-and-tube heat exchanger, which is the most effective in the operation of ventilation systems, was determined. It was shown that the parameters of the selected heat exchanger using the tunnel ventilation system help reduce the pressure drop by 3.3 times compared to the heat exchanger for the side ventilation system and to reduce the material costs and funds for their manufacture. In the future, to increase the heat transfer coefficient, the authors recommend investigating the energy and mass-dimensional characteristics of the heat exchange equipment.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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## Дослідження теплових та гідродинамічних течій теплообмінників для різних систем охолодження повітря в пташниках

**Анотація.** Підвищення продуктивності птахофабрик пов'язане з необхідністю створення оптимального регульованого мікроклімату в пташниках. Ця проблема набуває першочергового значення у зв'язку зі зниженням продуктивності птахівництва через недосконалість існуючих систем. Метою дослідження була розробка та чисельне моделювання кожухотрубного теплообмінника нової конструкції для охолодження припливного повітря як елемента системи кондиціонування повітря, що використовується в системах вентиляції різних типів у літній період року. Для моделювання гідродинамічних процесів та процесів теплообміну в каналах з компактно розташованими трубами у пучку було застосоване CFD-моделювання з використанням програмного забезпечення ANSYS Fluent. Розглянуто два типи вентиляційних систем, а саме тунельну та бокову. Для них розроблені теплообмінники, призначені для охолодження повітря, що надходить у літню пору року. У бічних стінах були влаштовані автоматичні припливні клапани загальною кількістю 80 штук розміром 0,3×0,85 м. Крім того, на передніх торцевих стінках розташовувалися системи випарного охолодження 5,3×1,1 м. Проведено чисельне моделювання гідродинаміки і теплопереносу, а також аналіз роботи теплообмінників двох різних конструкцій для тунельної та бічної вентиляції. Отримано поля швидкостей, температур і тисків у досліджуваних каналах. Проаналізовано умови гідродинамічної течії в каналах теплообмінників. У випадку з тунельною системою вентиляції перепад тиску дорівнює 991 Па, що в 3,3 рази менше порівняно з системою бічної вентиляції. Температура на виході становить +23 °C, що відповідає вимогам проєктування. Основним недоліком є фінансові затрати для придбання, порізку труб і власне, їх зварювання. З метою забезпечення нормованих умов повітряного середовища в пташнику з урахуванням усіх аспектів техніко-економічного аналізу запропоновано вибрати теплообмінник для системи тунельної вентиляції. На практиці такі теплообмінні апарати можуть використовуватись не лише у системах мікроклімату пташників, але також і в промисловій, енергетичній галузі та об'єктах критичної інфраструктури

**Ключові слова**: автоматичні припливні клапани; Computational Fluid Dynamics; птахоферма, тунельна вентиляція; бокова вентиляція