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USING CFD SIMULATION IN POULTRY HOUSE WITH SIDE VENTILATION SYSTEM

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Abstract. Exposure and the outbreak of diseases result in significant losses in large scale poultry operation. New ventilation systems are necessary to provide safe and homogenous internal environment at large enterprises, especially under the changeable climatic conditions of global warming. Within the framework of this investigation, computational fluid dynamics (CFD) simulation of a side ventilation system in a poultry house during winter seasons has been conducted. As a results, 3D temperature fields, current lines and pressures in a poultry house have been found. It has been determined that fresh air valves arranged at a height of 200 mm from flooring work better than those traditionally arranged at a height of 400 mm. The erection of walls on the inside of a poultry house framework as well as the decrease in the height of flooring improve poultry house aerodynamics.

Key words: CFD, aerodynamics, poultry house, side ventilation system, fresh air valves

The authours of the paper [1] suggested a new cooling system to be applied in a poultry house with the use of heat-exchangers of a special design [2, 3] CFD simulation of air flows and heat-and-mass exchange in a poultry building is presented. Here, water from subterranean wells is used as a cooler. There are recommendations provided for choosing the design of ventilation systems in poultry houses. In their follow-up studies [4] the authours optimize the height of extractor-type fan arrangement. It is shown that it is to the point to arrange ventilation equipment at a height of 1.5 m. Here, the area of dead-air zones and the inequality of air velocity distribution close to poultry decreases.

Aimed at the decrease of energy cost and the increase of quality indices of air environment when providing the necessary conditions for poultry management [5], the authors conducted experimental research and numerical simulation. In the process of investigation, the decrease of energy expenditures for establishing microclimate during broiler management has been obtained. The quality of air environment in poultry houses has been increased. It makes it possible to decrease the disposal of feeding stuffs and the loss of poultry stock and, as a results, increase the economic efficiency of production and product quality.

The ventilation scheme was constructed in such a way that air flow reached the center of the building in winter season in order to normalize the aerodynamic parameters of a poultry house. Such a method made it possible to reduce the loss of fresh air pressure in the poultry building. Thus, the following structural alterations were made: the width of the building was increased from 21 m, which was typical in a traditional design, to 22.36 m in a new design (see fig. 1).

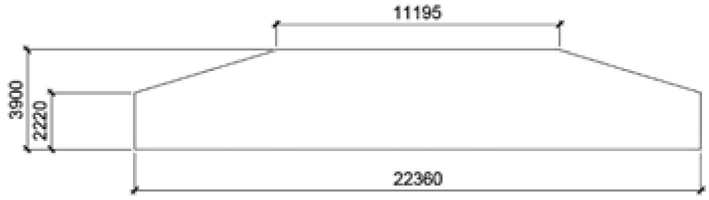
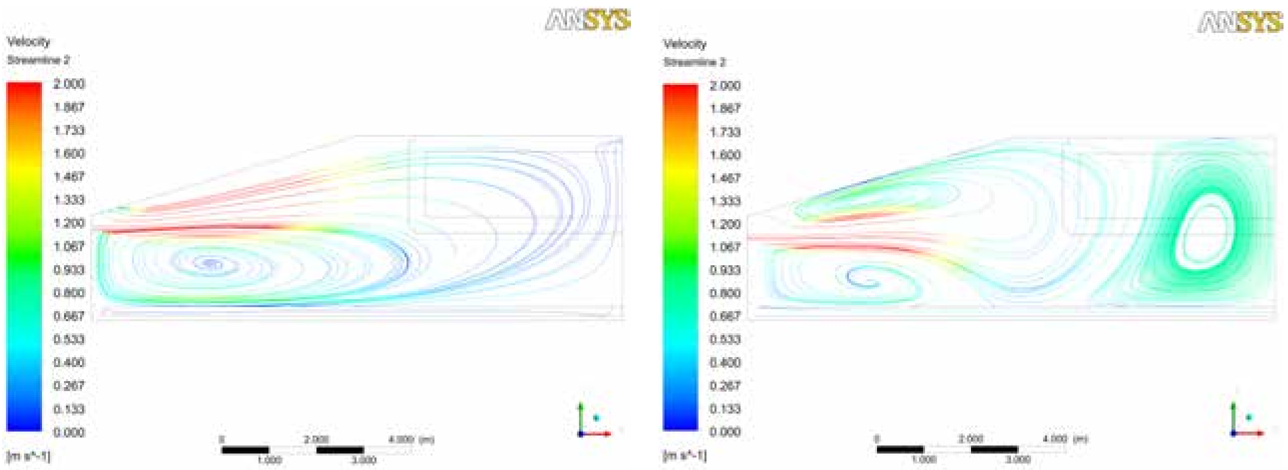


Fig. 1. Suggested cross sectional diagram of poultry house structural dimensions

Numerical simulation was conducted at valve opening being 0.1 m, 0.066 m and 0.049 m, respectively. Ventilation valves Wlotpowietrza 857x337 mm 3000-VFG Przepustowocs 2900 v^3/h were applied. They were arranged on the side walls being 79 pcs in total.

The results of CFD 3D simulation of a poultry house has made it possible to compare three modifications of valve opening in case of side poultry house ventilation system. Prior to conducting numerical simulation, 3D mesh has been generated applying the finite-element method in ANSYS Meshing.

Fig. 2 present air flow hydrodynamics in a poultry house. As it has been already mentioned, air flow is directed upwards by fresh air valves. However, due to low entry pressures and velocities, after passing the third of the building the air falls down. The valves are arranged at a height of 200 mm from the flooring (Fig, 2a). The air smoothly moves close to the flooring area and is directed to the center of the building. The valves, that are arranged at a height of 400 mm from flooring cannot provide the same impact. This can be caused by perturbation due to large building airspace. The average entry velocity at various air expenditures ranges from 6.39 m/s to 9.62 m/s.



a b

Fig. 2. Stream lines (m/s) in a poultry house at valve opening being 0.049 m at a distance from the front end wall of: a – 10.3 m; b – 52.3 m

Fig. 3 present pressure loss values in fresh air valves. The least pressure loss is shown to be 24.3 Pa at valve opening being 0.1 m and the greatest one – 55.68 Pa at 0.049 m, respectively.

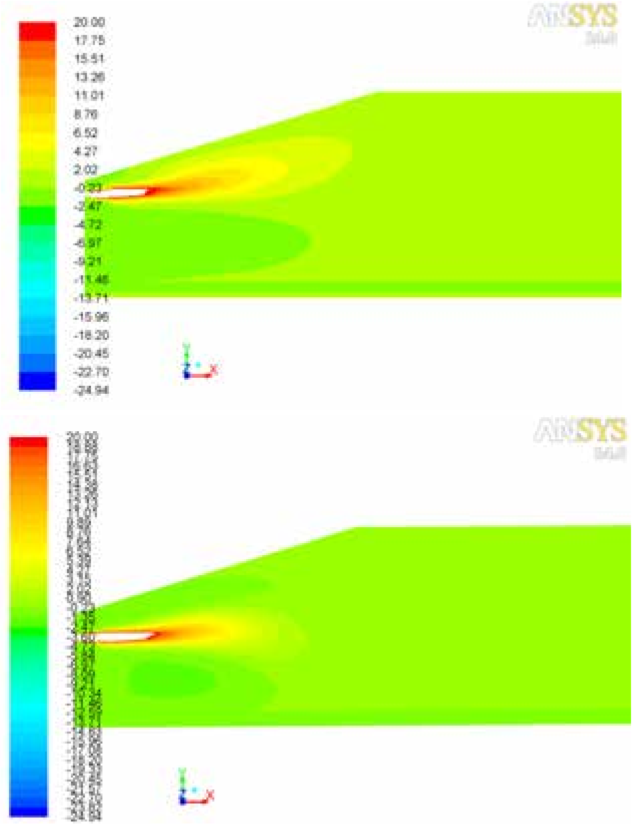


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Fig. 3. Pressure loss (Pa) in a fresh air valve of a poultry building at valve opening being 0.049 m at a distance from the front end wall of: a – 10.3 m; b – 52.3 m

Conclusions. The design of a poultry house has been improved. It has been suggested arranging spoilers above fresh air valves at an angle of 75o from a vertical line; mounting outside walls on the inside of a concrete framework; increasing the width of a poultry house up to 22.36 m; decreasing the height of flooring up to 3.9 m above the floor level.

Effective arrangement of fresh air valves and the improvement of aerodynamic characteristics in a poultry house building have been investigated applying CFD. It has been determined that the least pressure loss is 24.3 Pa at valve opening being 0.1 m and the greatest loss is 55.68 Pa at 0.049 m, respectively.

The conducted research shows that the valves, which are arranged at a height of 200 mm from flooring are much more effective. The valves, which are arranged at a height of 400 mm from flooring cannot provide the same impact.

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УДК 631

ДОСЛІДЖЕННЯ ПРОЦЕСУ ПЕРЕМІЩЕННЯ ЗЕРНОВОГО МАТЕРІАЛУ МІЖ ГВИНТОВИМИ СЕКЦІЯМИ ТРАНСПОРТЕРА

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Шнекові транспортери знайшли широке застосування при переміщенні різних сипких матеріалів, переважно сільськогосподарського виробництва, до яких відносяться: зернові, гранульовані насіннєві матеріали, дерть, полова, висівки, комбікорми, пластівці, гранули мінеральних добрив та ін.

Для підвищення надійності функціонування гнучкого гвинтового конвеєра пропонується його робочий орган виконувати з окремих гвинтових секцій, які шарнірно з‘єднані між собою.

Методика проведення експериментальних досліджень наступна За базу був прийнятий перевантажувальний патрубок, опис будови та принцип роботи якого наведено в роботі [1]. В якості сипкого матеріалу було вибране зерно із домішками гранул пластмасового матеріалу різного кольору. Безпосередньо під вивантажувальним патрубком був розташований лоток, на який вивантажували матеріал і за допомогою кінозйомки встановлювали дальність польоту сипкого матеріалу фіксуючи траєкторію різнокольорових гранул. Кут вильоту матеріалу