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Tunnel ventilation in a broiler house

In a broiler Louisiana house without ridge-opening, tunnel ventilation was fitted with gable-end fans and air inlets in the opposite end of the house. Air temperature and flow velocity measurements showed that this cost-efficient method is suitable for minimising heat stress in broilers in windstill conditions.

Fig. 1: Fans built in the gable wall

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Keywords

House climate control, tunnel ventilation, broiler fattening

In a Louisiana house for broilers with cross-house ventilation without roof ridge opening, problems with the ventilation occurred during the very hot weather in summer 1998. Windstill and high exterior temperatures with simultaneous high air moisture content led to broiler losses. An investigation of tunnel ventilation was carried out to ascertain whether this system could offer increased heat transfer from the birds. Fans at the gable end of the house were to enable an additional airflow of 240 000 m^3/h through the building. The function of this ventilation in association with different variants of air inlet openings on the opposite side of the house was tested.

Broiler house

The insulated Louisiana house investigated is not identical with the one described above. It is 120 m long and 11 m wide. With a rood slope of 10°, the eaves are 3 m above floor level and the roof ridge 4.40 m. Positioned over the 1.25 m high continuous side-walling is a 1.10 m high continuous wire mesh window strip on both sides. Light-transparent plastic blinds closable from bottom to top, and activated by interior temperature, control the cross-house ventilation. The blinds on the house sides are split into three so that air inlets in each third of the house length can be opened to different degrees. The roof ridge has no openings.

House interior temperature is controlled by ventilation computer through continuous balancing of actual and desired conditions. The desired value is calculated from a predetermined curve giving optimum temperature based on bird liveweight. Bird weight was recorded by weighing equipment situated in the building and capable of carrying out several thousand weighings per day. Actual interior temperature was determined by six sensors. Air intake for each third of the house was controlled through measurements by two temperature sensors and the adjustable blinds. Additionally, the computer took account of wind direction and velocity. Outer temperature and relative air moisture content in the house were measured and recorded.

Tunnel ventilation

The five slowly revolving air extraction fans have a total maximum performance of 240 000 m^3/h: two of them each with 60 000 m^3/h with electricity demand of 1.5 kW. Each of the other three fans has a maximum performance of 40 000 m^3/h using 1.1 kW. All are equipped with self-closing shutter doors which open with the air flow. The fans were built by farm labour into the southern gable end on each side of the door (*fig. 1*). The fans are individually manually controlled. Possible speed settings are half and full performance. Automatic control through the ventilation computer is not installed. An emergency electricity supply is planned.

Air inlet variants

Five different air inlet variants, each realisable without rebuilding operations, were investigated:

- Variant 1: The plastic blinds of the cross-house ventilation on both sides along the total house length were opened 15 cm so that the cross section of the air intake ope-

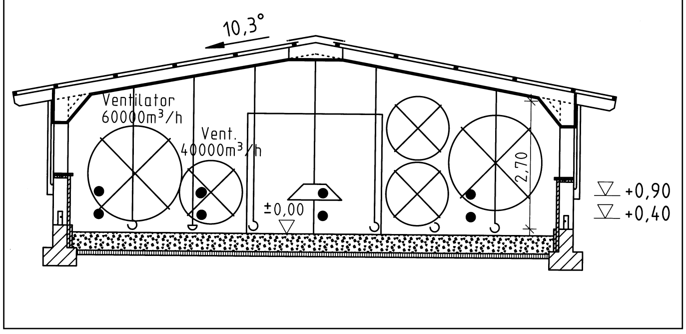

Fig. 2: Measuring cross section, position of heat wire-anemometer •

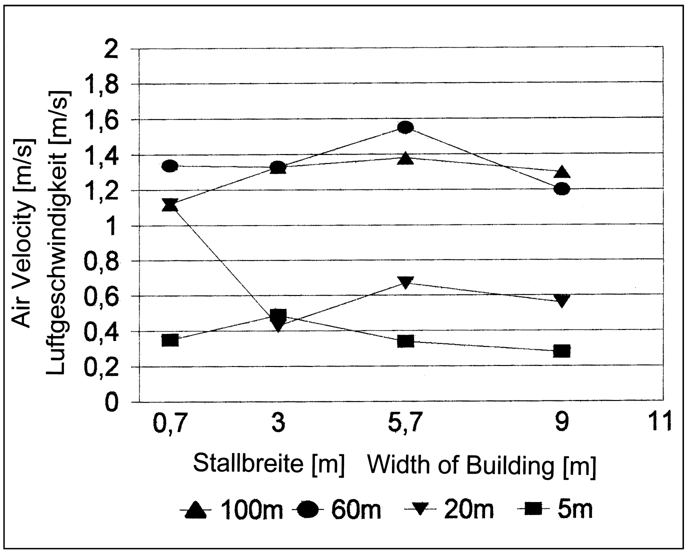

Fig. 3: Air velocity at measuring points of inlet air variant 3

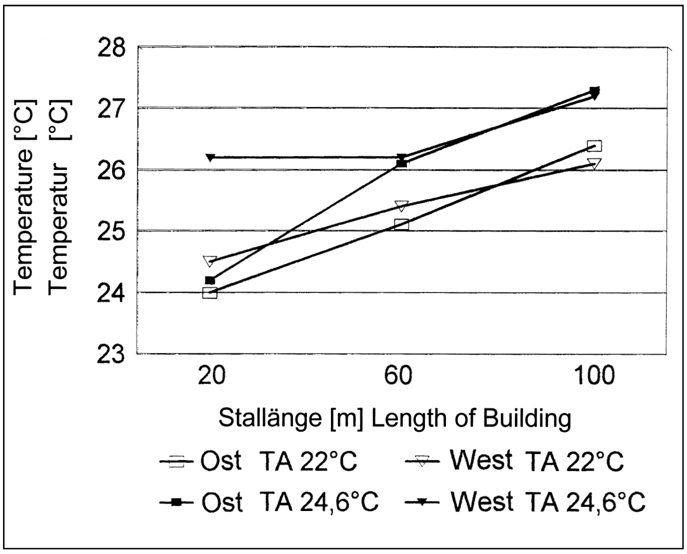

Fig.4: Distribution of temperatures in axial section

nings approximately represented the cross section of the house.

- Variant 2: the ventilation opens in the first third of the house, i.e. in the third furthest from the fans, were opened 50 cm on both sides. Additionally, the house door (10 m^2) in the gable wall opposite to the fans was opened.
- Variant 3: The ventilation openings in the first third of the house were opened 50 cm on both sides so that the cross section of the inlet air openings approximately represented that of the house.
- Variant 4: Only the house door opposite the fans was opened.
- Variant 5: The ventilation openings in the first third of the house were fully (1.10 m) opened.

Measuring instruments and set-up

Air velocity measuring

The air velocity measuring of the five tunnel ventilation variants took place in an unoccupied house with raised feeders, etc., in order not to disturb the feeding cycle. Recordings were carried out at half and full fan performance (33 and 67 m^3/s). Additionally, individual recording was carried out along the axis of the house in the vicinity of the doors. Fog tests were also done. Four hot wire anemometers were used for air velocity measurement. These were mounted onto a portable stand so that for each a measurement cross section through the house of 0.4 and 0.9 m height took place (*fig. 2*). There were three measurement cross sections, each in the middle of a house compartment, established 20 m, 60 m and 100 m from the house door. An additional cross section measurement at 5 m distance was set-up where the house door was open.

Measurement of air temperature and moisture content

was carried out during the feeding period with natural ventilation and ventilation variant 1. The temperature sensors were also placed in the cross sections 20, 60 and 100 m distance from the house door and, in each case, to the right and left at 1 m distance from the house side walls. Additionally, three sensors were positioned in the centre of the house as further cross section temperature recorders. As well as the house temperature, the exterior temperature was also continually measured and also recorded by computer. Originally, two sensors were available for moisture measurements. After one broke down, one sensor was available in the middle of the building.

Results

For judging the individual ventilation variants, the results of the air velocity measurements with hot wire anemometer, additional single measurements, and fog tests were drawn-up. Only the air inlet variant 3 showed a satisfactory result. Through the around 50 cm opening of the plastic blinds there occurred an opening with a cross section of 40 m^2 which was approximately equal to the house cross section of 37 m^2. Through this, there occurred no unnecessary counter pressure for the fans. At the individual measuring points a consistent airflow was recorded at maximum achievable air velocity. In general this was very even over the total house breadth and dropped only a little even right over by the sidewalls. In a measurement cross section at 5 m between 0.3 m/s and 0.5 m/s were measured. The high air velocity of over a metre per second at measuring point 0.7 m in the cross section 20 m was attributable to a short-time cross-ventilation effect through wind gusts (*fig. 3*).

Additional measurement at the air intakes showed that the velocity of the air along the 40 cm long opening in the direction of the rear gable only dropped a little and even at the most difficult ventilation points still was over 1 m/s. Fog tests made plain that this entry velocity is enough to make sure that fresh air from both sides of the house can force its way right to the middle of the building. Thus, the fresh air flow reaches all parts of the house.

Ventilation variant 3 was tested on specially chosen days with temperature measurements in a fully stocked house during the feeding period. In total cross section, the measurements showed a consistent distribution. With tunnel ventilation the temperatures at the five measurement points in cross section in the middle of the building varied a maximum 1.5 K from one another. The longitudinal distribution of temperature values with tunnel ventilation indicated an around 2 K warming of the air on its way to the exhaust fans.

Conclusions

The correct inlet air delivery is decisive for the functioning of tunnel ventilation in Louisiana-type broiler houses. With the air inlet variants described a good possibility was found of effectively applying tunnel ventilation without having to undertake extra rebuilding within the house. The required area of the air inlet openings depends on the house geometry and fan performance. So that the fans are able to work effectively, the cross section of the air inlet openings should roughly equal the cross section of the house. With the chosen air inlet variant the air velocity at the intake openings was sufficient for the fresh air to force its way into the middle of the house and thus to flow through the whole poultry occupation area.

With appropriate dimensioning of the fans, an air exchange rate of 4.5 m^3/kg liveweight and hour was easily achieved. The air inlet variant recommended here ensured that the airflow continued right into the poultry occupation area and was consistently distributed.