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Trends in livestock housing ventilation

To fully exploit livestock performance potential it is necessary that the animals feel comfortable in their environment with ventilation playing an important role here. In closed buildings a climate has to be created quite independent from outdoor conditions. Here, ventilating and climate equipment assure an air exchange according to the season of the year and thus withdrawal of heat, vapours and gases. In naturally ventilated housing the wind pressure and thermal currents are used in the creation of the inner climate.

Fig. 1: With tunnel ventilation, the foul air is extracted at the front side (Photo Fancom)

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Low pressure ventilation has established itself in practical farming for pig and poultry housing. Depending on building or environmental-specific requirements, central or decentral exhaust air ducting is applied. The development towards larger units and thus bigger housing compartments has caused a general movement towards decentral solutions in that regulation possibilities are easier to design into such systems. Central exhaust air withdrawal can, however, be desirable through emission pollution avoidance grounds or where heat exchange plants are applied. With central exhaust air withdrawal the dimensioning of the ducts is especially important.

Tunnel ventilation

For some time now tunnel ventilation has been successfully applied in poultry housing. This involves the withdrawal of all exhaust air through one of the gable sides of the housing, with air inlet through the eaves.

With forced ventilation the fans are the main aspects. These create the required air volume flow. In practice almost all fans are axial with the design having an important influence on electricity consumption. Depending on pressure stability and noise control requirements, fast or slow fans are installed. Energy-sparing fans have become established in many sectors. In controlled areas energy savings of up to 50% are possible allowing amortisation within three to five years despite higher purchase costs (see also DLG test reports)

Exhaust air ducting, diffusers, single flow jets and other accessories are also applied in exhaust air extraction. To avoid unnecessary turbulence in the exhaust air ducting, especially through sucking „false air“, the cross sectional area of the exhaust ducts have to be exactly matched to the fan performance. Here, integration of the fan beneath the exhaust shaft is advantageous. The application of diffusers and single flow jets can lead to pressure reduction of up to 30 Pa through the substantial easing of air inlet or exhaust. Installation of such components has increased in practice and has also led to energy savings.

Inlet

Independently from the type of building air intake design has to direct the air into the livestock accommodation without causing draughts and allow its passage through the building as uniformly as possible. Permitted air velocity in the livestock area is dependent on type and the size of animals, intake air temperature, and heat content of the interior air. In recent years displacement ventilation has established itself over radiation ventilation. Thus, above all, trickle ducts and passage/door ventilation have established themselves. The trickle duct side walls comprise mostly pressed foam panels with flooring of perforated panels or perforated plastic sheeting. The introduction and distribution of the inlet air in the housing functions well when the following points are observed:

- < 2.5 m/s inlet air velocity in ducts
- air throughflow between 200 and 300 m^3/h per m^2 trickle area
- not more than 15 m duct length with one-side air ingress
- no direct wall contact with the ducts (otherwise „quanta“ effect)

Such criteria usually feature a duct height of 30 to 50 cm and a fitting of the ducts directly over the pens (see also DLG test report).

A further established type of displacement ventilation via feeding passage. For feeding passage ventilation the amount of air volume flow per compartment is the limiting factor. The following criteria are of importance in this context.

- air intake velocity in feeding passage not over 2.5 m/s
- pen depth not over 4.5 m

- passage length not over 15 m
- feeding passage/pen separation walls must be at least as high as the air intake openings in the doors

The exhaust air extraction point should be as near as possible to the intake point within the building to guarantee a good throughflow degree.

As alternative to displacement ventilation, radiation ventilation is used in practice especially in poultry production and for larger sow units.

Planning factors to be observed in such cases are as follows:

- maximum inlet air velocity in summer 4 m/s
- minimum inlet air velocity in winter 1.0 m/s
- fitting of inlet air elements to be in the upper area of outer walls
- ratio of room height to breadth to be maximum 1:4.

A fundamental factor for all air intake systems is that air intake in summer should not come out of the ceiling space in that here temperatures of 70 to 80 degrees can be reached through intensive solar radiation. Air access into the inlet system should be on the north side of the livestock housing. If this is not possible, subsequently applied shadowing effect through tress, bushes or similar is practical.

Cooling

Reduction of interior temperatures can also be achieved through application of water evaporation equipment or by intake of air through perforated intake panels with trickle water systems. With such measures it must be observed however that in warm, high humidity weather the interior temperature will be reduced by the use of water but the saturation point will be quickly reached and through this the heat content in the interior air greatly increased so that substantial stress can result for the circulation of both animals and personnel.

Heating

Most systems used in practice need heating with the choice of system farm-specific. In compartments with relatively low temperature requirements and for the warming of compartments, e.g. after cleaning, gas cannons with their large performance range and relative cost-effectiveness remain useful. More precise systems should be applied for greater area requirements or for microclimates, e.g. for regulated temperatures in animal areas or low temperature variations in housing compartments. Depending on housing and livestock type, the following heating systems have proved themselves:

- Gas convectors; hereby the heated air is distributed uniformly in the compartments mostly via the „wickelfalz“ pipeline.
- Warm water heating; here heating of compartments is via delta or twin pipes. The regulating of warmth distribution is possible via conventional systems.
- Zone heating; especially in the piglet rearing areas warm water underfloor heating remains the trend, in some cases combined with infrared radiation lamps. To avoid heat losses lying areas should be insulated. Prefabricated heating panels of light concrete or plastic have been further developed.
- Radiation heating; here dark radiators have been used for some time, especially in poultry production. The radiation heat produced ensures a uniform temperature at ground level.

Regulating

Modern regulating equipment comes with lots of functions. Alongside the setting of desired temperatures there is the possibility of operating inlet and exhaust air flaps, heat contacts or alarm systems. By applying housing climate computers, the functions can be increased. Temperature curves can be applied according to animal liveweight, data can be recorded and called-up, consideration can be given to gas and moisture content, and much more. Additionally there is the possibility of networking with a central computer and other basic equipment, e.g. feeding computer.

Above all through the applicable animal protection statute and insurance contract, it is mandatory in intensive livestock production to protect the animals through acoustic and/or optic alarm systems should there be a power failure. For livestock steadings away from housing, power breakdowns or alarms must be notified per telephone or radio. In the meantime there are companies offering central monitoring services where breakdowns are first notified to the company which built the plant and from here the farmer is informed. Additionally monitoring through permanent video cameras is becoming established in livestock compartments. This system allows control from the farm office.

Outdoor climate housing

In cattle production, simple and cost-efficient buildings with outdoor or natural ventilation have proved themselves and become accepted. This applies to large-scale buildings with at least one open side. Eave heights are between 4 and 5 m with maximum roof slope of 20 degrees for better channelling of the exhaust air and (in exceptions) the condensation produced. A covering of the ridge is under some regulations not required over the feeding areas and traffic passages. But should the building design mean that the roof ridge is over the lying area a large-area transparent covering is a possibility. The sidewalls are of simple cladding, mostly wooden planks with adjustable air inlet elements or in general consisting of mechanically adjustable side elements such as roller windbreaks, curtains or windbreak netting. Where livestock is housed year-round, roof lining of insulated ceiling plates is practical to reduce the heat induction in summer. Whilst cows can put up very well with cold spells in winter in such housing in summer during longer lasting heat periods with windstill milk production is frequently reduced because the animals in such situations are unable to give off enough body heat and transpiration. In such exceptional situations it can be helpful to create artificial air movement within the housing in the form of support ventilation via fans. In the literature air volume flows of 500 to 2000 m^3/h and cow are recommended. A determination of the required site-specific air volume flow and a planning of the arrangement of fans should follow through specialists. Basically, however, the situation of the building in its surroundings must be considered. The best wind throughflow degree is achieved through positioning the housing sideways to the prevailing wind. Valley sites, tree shelters or other buildings can have an influence of air throughflow of the livestock housing and therefore greatly influence animal comfort.