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Heating Energy Requirement in Broiler Fattening

With rising energy costs the interest in energy savings in broiler fattening is increasing. Farmers can influence their energy costs their choice of a heating system and by adapting the ventilation to the heating conditions. If heating systems with flue gas evacuation are used, the ventilation rate can be reduced in the first days of the fattening period. The consequence is a decline of thermal loss through ventilation. In comparison to conventional hot air blowers with no flue gas evacuation, systems with flue gas evacuation were shown to provide an energy savings of about 15%.

Due to rising energy prices, the share of heating energy costs in the total production costs of broiler fattening are increasing. Farmers can influence the heating energy consumption by choosing between different heating systems and sources of energy. The heating energy required in the first days of broiler fattening accounts for the largest part of the total heating energy demand throughout the fattening period because during the fattening period (max. until day 20) the birds do not produce enough heat to balance their high heat demand with the heat losses by ventilation and through building components. In *Figure 1* the heat production by the birds is compared to the heat losses by ventilation and through building components, based on a calculation of the heat flows according to [1] for a broiler house with 30 000 birds. From day 16 onwards, the heat deficit is balanced by a decreasing temperature demand and by the increasing heat production by the animals. Up until fatting day 16, the heat deficit is usually compensated for by means of a heating system.

Generally speaking, two kinds of heating systems are suitable for use in broiler production. They differ considerably with regard to their effects on the energy situation in the broiler house. The differences are in the mode of flue gas evacuation. On the one hand, there are systems which emit the flue gases directly into the indoor air; examples of such systems are hot air blowers or infrared radiators, both of which use an open flame. On the other hand, there are systems with closed combustion chambers so that flue gases can be evacuated directly to the outside of the house. Infrared tube heaters and hot air blowers with flue gas evacuation are examples of such systems which are used in broiler fattening.

Another systematic difference between these heating systems is the mode of heat transfer. While hot air blowers use the air as transport medium by heating the indoor air, infrared radiators and infrared tube heaters operate on the radiation principle, and most of the heat is emitted by radiation energy. Rather than heating all the indoor air, it is possible to heat individual objects directly by radiation.

In this way, the birds are provided with heating energy directly from the radiation and indirectly from heated objects (e.g. floor plate). The indoor air temperature can be set lower if radiation heating is employed [2].

For an evaluation of heating systems, it is necessary to take the whole climate control system into consideration. Climate control measures must be adapted to the different conditions resulting from the use of different

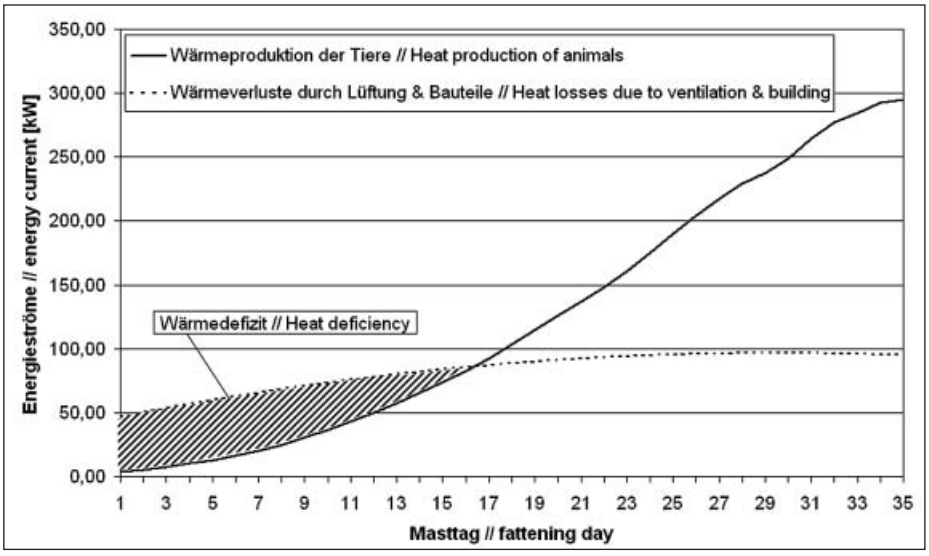

Fig. 1: Balance of thermal currents in broiler fattening

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Keywords

Heating energy, broiler fattening, carbon dioxide

Literature

Literature references can be called up under LT 06410 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

heating systems in order to observe the limiting value for CO_2 of 3000 ppm (animal welfare) and to avoid heat losses, caused by excessive ventilation [1].

The aim of this study was to compare the heating energy requirements of different heating systems with adapted climate control.

Material and methods

For comparing heating energy consumption, three farms with two identical broiler houses per farm using different heating systems were examined. In this way, possible influences of farm management and building design were minimized. The broiler houses were typical houses with 30000 to 44000 birds.

In addition to the acquisition of climate and animal production data, which were recorded by the control computers, the farmers logged the counter readings of the gas meters on a daily basis. Thus, a profile of the natural gas consumption during the fattening period was drawn up. The study spanned eight fattening periods on farms 1 and 2 and six fattening periods on farm 3.

Results and discussion

The results show that the heating systems with flue gas evacuation consumed less gas than those without. With a climate control system, which takes into account the effect of gas flue evacuation on the indoor carbon dioxide concentration, it is possible to reduce the gas consumption by about 15%. The lower ventilation requirement leads to decreased gas consumption especially during the first days, when the demand for heat is highest (*Fig. 1*).

The energy savings can only be achieved by adapting the climate control measures to the heating system. The use of alternative heating systems alone does not lead to energy savings. If flue gas and steam are evacuated directly to the outside of the building, it is possible to reduce the ventilation rate without exceeding the limiting value for CO_2 of 3000 ppm [1]. The result is lower heat losses by ventilation. Accordingly the averaged gas consumption was 0.09 m^3/bird for the heating systems with flue gas evacuation and 0.11 m^3/bird for the hot air blowers [3]. This equals a heating energy requirement of 0.75 compared to 0.98 kWh/bird. Apart from the effects of an adaptation of the climate control to the flue gas evacuation, the use of infrared tube heaters did not lead to energy savings that could be attributed to the radiation principle of heat transfer. The gas consumption of the infrared tube heaters did not differ from the other systems with flue gas evacuation.

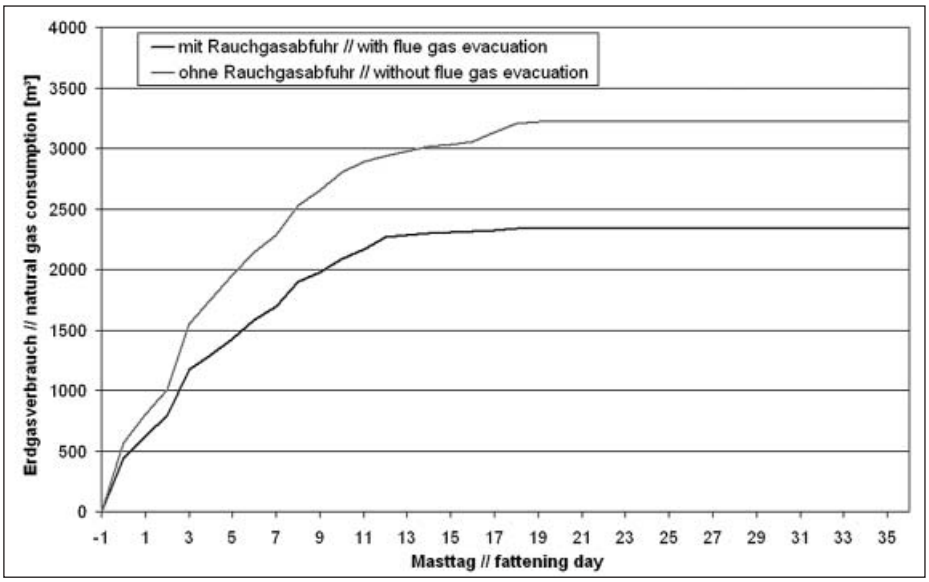

Fig. 2: Cumulative natural gas consumption of heating systems with flue gas evacuation and without flue gas evacuation in a poultry fattening house of Farm 3

Around 15 to 25% of the gas consumption occurs during the pre-heating of the broiler houses. After cleaning, the broiler houses are heated up to over 30°C for several hours in order to ensure that optimal temperatures are achieved when the birds are brought in (*Fig. 2*: day -1 to day 1). Around 70 to 80% of the energy requirements occurs during the first 20 days of the fattening period. In this phase, the animals do not produce enough heat to reach the high temperatures required at the beginning of the fattening period. After 20 days, another 5% of the energy is consumed in dealing with management factor, e.g. to compensate for day-night fluctuations. *Fig. 2* shows that the heating balance is balanced more quickly by heating systems with flue gas evacuation than by hot air blowers with an open flame. From day 13 on, the gas consumption of the systems with flue gas evacuation rises only slowly until the end of the fattening period. For the systems with an unshielded flame, this "slow-rise" period starts not until day 17.

Table 1: Researched farms

	Farm 1	Farm 2	Farm 3
Number of animals	30000	30000	44000
Heating systems	Infrared tube heater	Space heater with flue gas evac.	Space heater with flue gas evac.
Installed heat power	(5 x 28 kW)	(2 x 100 kW)	(2 x 100 kW)
	Space heater without flue gas evac.	Space heater without flue gas evac.	Space heater without flue gas evac.
	(2 x 95 kW)	(2 x 95 kW)	(2x120 kW)

Conclusion and outlook

The use of heating systems with flue gas evacuation combined with a simultaneous reduction of the ventilation rate leads to a decrease of heating energy consumption of ~15 % in comparison with heating systems with an unshielded flame. Advantages of infrared tube heaters over other heating systems with flue gas evacuation could not be found. The decline of heat losses caused by ventilation is one possibility to decrease energy costs. A reduced ventilation rate causes a temperature increase, but it also increases the concentrations of water vapour and gases – such as CO_2 - in the indoor air. It is important that the increased gas concentrations must not exceed the limit value. CO_2 sensors can be useful in this context, but at present such sensors are usually not employed in the climate control of poultry houses. If the carbon dioxide concentration in the indoor air is used as an additional climate control parameter, it is possible to keep the ventilation rate to a minimum, while still meeting the relevant animal welfare requirements [4].