MICROCLIMATIC EVALUATION OF TUNNEL VENTILATION IN PIG FATTENING HOUSE DURING HOT WEATHER

Ľubomír Botto[1], Jana Lendelová[2]

[1]Animal Production Research Centre Nitra, Hlohovecká 2, 951 41 Lužianky, Slovakia
[2]Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia

Abstract. The objective of this work was to evaluate microclimatic parameters of tunnel ventilation in pig fattening house during hot summer weather. The stable was longitudinal divided into 2 sections with 6 pens with total capacity 500 housed pigs. Basic microclimatic parameters (temperature, relative humidity and air velocity) were measured in each section in two marginal pens (1st and 6th) and in two middle pens (3rd and 4th) in animal zone by ALMEMO device during the day. In fattening house was registered lower average temperature (35.5 and 36.6 °C) than external air temperature (37.3 and 37.6 °C) during operating one and both front fans. Average internal air relative humidity 32.9 and 28.6 % was higher than external air humidity by 6.8 and 4.5 %. Air humidification or another system of cooling was not used in the stable. Average internal velocity of air presented 0.95 and 1.22 m/s in animal zone. Cooling effect for pigs was ensured by elevated air flow at presented temperature.

Introduction

Current modern types of pigs are demanding on conditions of stable environment. It is not possible to achieve good conditions for pigs breeding without effective ventilation system. Pigs are relatively sensitive to high environmental temperatures because they cannot sweat and are relatively poor at panting (Kemp, Verstegen, 1987). A lot of research has been done on the factors affecting heat production in pigs (Brown-Brandl et al, 2001). It was found that animals reduce feed intake progressively with increased temperature (5), with the consequence of reduced growth rate. Thus, the reduction in the associated thermal effect of feeding is an efficient mechanism to reduce heat load (Verstegen et al, 1998). Generally it is recommended to raise pigs at temperature 3 °C higher than lower critical temperature (Vansickle, 1998). In general, as the pig gets older and larger, its optimum temperature decreases. Thus, the effects of heat stress are more of a concern with older finishing swine (Myer, Bucklin, 2001).

Heat stress also alters pig behaviour. It was found out that pigs modify their posture in relation to ambient conditions, to either increase or decrease heat loss (Mount, 1979). Evaporative heat loss might occur either via respiratory evaporation or by evaporation from the wet body surface of pigs (Nienaber et al, 1999). Fattening pigs preferred to lie on slatted floor at high ambient temperature. Pigs also shifted their excreting area to the solid floor and daubed themselves with manure and urine to cool them by evaporative cooling (Aarnink et al, 2001).

Optimum parameters of temperatures, relative humidity and air velocity for finishing pigs in Slovakia presented Botto et al (1995). Air temperature as cardinal environmental factor is influenced by relative humidity and air flow velocity. Air humidity level is very important in cooling process. The higher humidity level in the air, the less effective is the process of evaporative cooling (Myer, Bucklin, 2001). On the basis of evaluation of microclimatic parameters in stables for fattening pigs with cross ventilation there have been noticed higher temperatures and lower relative humidity as optimum range in summer period (Harichová et al, 2000, Botto et al, 2000).

Utilization of enhanced air flow is one possible method of cooling during high ambient temperatures. In this system the sensational effect of temperature perception is applied. It means that at equal ambient temperature but higher air flow the ambient temperature is sensationally decreased. The cooling effect of air movement is typically expressed by effective temperature, the temperature that animals actually feel (Xin, McFadden, 1995).

System of tunnel ventilation is ranked among progressive systems of ventilation, which is the latest realised in Slovak conditions with combined air inlet for summer and winter period. In reconstruction of stables for fattening pigs it is necessary to ensure consistent design of ventilation and creation of suitable environment.

Data and methods

The objective of this work was to evaluate microclimatic parameters of tunnel ventilation in pig fattening house during hot summer weather. This system of tunnel ventilation makes use of combined air inlet for summer and winter period and it was not realized in Slovak conditions for piggery up to now.

The house for pig fattening was longitudinal divided into 2 sections with total capacity 500 housed pigs in 6 pens from 30 to 100 kg (Fig. 1). Pigs were fed by multipoint feeders situated in cross splitting restraint of pens. Air exchange in each section in the summer period was provided by 5 fans situated at backside of stable (2 front, 2 side fans and 1 fan for under-slatted exhaust). External air input was from scope controllable openings situated in front wall. Incoming outlets by their area nearly covered whole internal vertical front wall intersection and their immediate largeness was adaptable by means of folded curtain. In winter time external air is soaked by ceiling shutters from garret space to provide its preheating.

System of tunnel ventilation in pig fattening house was evaluated on the basis of measurement of microclimatic parameters during hot summer weather. Temperature, relative humidity and air velocity were measured in each section in two marginal pens (P1, P6) and in two middle pens (P3, P4) in animal zone 500 mm above floor level by ALMEMO 2290-4 device. Measurement was repeated for case with out-of-operation only 1 front fan (experiment 1) and with operating both front fans (experiment 2). External air parameters were registered during each measurement, too, at the beginning and at the end of measurement of indoor parameters. At evaluation of measured date the average values were expressed for both sections.

Results and discussion

In 1st experiment one of 2 front fans was out of operation. External air temperature was 37.1 and 37.5 °C, relative humidity 24.0 and 28.1 % and air velocity 0.34 and 0.49 m/s. At average external temperature 37.3 °C average temperature in animal zone was 35.5 °C. Average internal temperatures in P1, P3, P4 and P6 pens were lower by 1.1 – 2.6 °C than the lowest measured value of external temperature. The highest average temperature was in P4 pens (36.0 °C) and the lowest in P6 pens (34.5 °C). Average values of relative humidity in stable were essentially lower than low limit of optimum 50 % (28.7 and 35.8 %). It was as consequence of low humidity of soaked external air (26.1 %) and because air humidizing was not used in the stable. The highest air relative humidity in animal zone was noticed in P6 pens and the lowest in P4 pens. Average air velocity in animal zone was 0.95 m/s at the range of 0.27 to 1.99 m/s, the highest in P4 pens and the lowest in P6 pens. The highest average value did not exceed maximum 2.0 m/s according to the required parameters (Botto et al, 1995, Botto et al, 2010).

In 2nd experiment all fans were in operation. External air temperature was 37.8 and 37.4 °C, relative humidity 23.5 and 24.7 % and air velocity 1.64 and 1.10 m/s. At average external temperature 37.6 °C average temperature in animal zone was 36.6 °C. Average internal temperatures in evaluated pens were lower only by 0.3 – 1.5 °C than the lowest measured value of external temperature. The highest average temperature was noticed in P3 pens (37.1 °C) and the lowest in P6 pens (35.9 °C). Average values of relative humidity in stable at average external relative humidity of air 24.1 % were lower than in the 1st experiment. Relative humidity of interior air was lower than the low limit of optimum (50 %) by 25 – 18.5 % for equal reasons as in experiment 1. The highest relative air humidity in animal zone was noticed in P6 pens (31.5 %) and the lowest in P3 pens (25.7 °C). Average air velocity in animal zone increased to 1.22 m/s at the range of 0.20 to 2.14 m/s (in P6 and P4 pens). The highest average value did not exceed maximum 2.0 m/s according to the required parameters (Botto et al, 1995, Botto et al, 2010).

Our previous evaluations of microclimatic parameters in 3 stables for fattening pigs with cross forced ventilation showed that were noticed higher interior air temperatures than external temperature, although temperatures of external air did not exceed 30 °C in summer period (Botto et al, 2000). It was proved true fact that the process of evaporative cooling during our measurement was effective (Myer, Bucklin, 2001), therefore in evaluated stable with tunnel ventilation housed pigs tolerated better higher temperatures at lower relative humidity of interior air. It favourably influenced the reduction of thermal load.

Behaviour of pigs did not indicate deflection in standard manifestations at lying, movement, urination and gluttony. It did not confirm the fact (Aarnink et al, 2001) that fattening pigs preferred to lie on slatted floor at high ambient temperature, shifted their excreting area to the solid floor and daubed themselves with manure and urine to cool them by evaporative cooling.

Conclusion

Evaluation of tunnel ventilation (without humidification) in pig fattening house showed that we noticed lower average internal temperatures by 1.8 and 1.0 °C than external temperature (37.3 and 37.6 °C) during hot summer the day. Enhanced air flow velocity in animal zone (on average 0.95 and 1.22 m/s) ensured evaporative cooling of housed pigs; consequently sensational decreasing ambient temperature occurred. Pigs tolerated better higher temperatures under interoperation with low relative humidity of air (32.9 and 28.6 %).

For enhancing the cooling effect, mainly at external air temperatures above 30 °C, it would be appropriate to improve a pad cooling system in stable, as it was designed in the reconstruction.

Acknowledgement This article was written during realization of the project "CEGEZ č. 26220120042" supported by the Operational Programme Research and Development funded from the European Regional Development Fund.

References

Aarnink, A.J.A., Schrama, J.W., Verheijen, R.J.E., Stefanowska, J.: Pen fouling in pig houses affected by temperature. In: *Livestock Environment VI*, Galt House Hotel Louisville, Kentucky, 2001, 180-186.

Botto, Ľ., Waldnerová, S., Mihina, Š., Brestenský, V., Lendelová, J.: Documentation for modernization and reconstruction of stables for pig rearing. Research report. (In Slovak). RIAP, Nitra, 1995, 61 p.

Botto, Ľ., Šottník, J., Brestenský, V., Szabová, G.: Microclimatic evaluation in pig fattening houses with different construction and technological designs (In Slovak). In: *Proc. of 13th Scientific. Int. Conf. – Bioclimatology and the Environment*. Košice, Slovak Republic, 12-14 September, 2000, SBkS SAV, 2000, 8 pp., CD, ISBN 80-88985-22-6.

Botto, Ľ., Brestenský, V., Demo, P.: Information handbook on pig housing technology and methods with fulfilment of all welfare conditions. (In Slovak). 1st edition - Bratislava: MA SR - Nitra: APRC Nitra, 2010, 98 p.

Brown-Brandl, T.M., Eigenberg, R.A., Nienaber, J.A., Kachman, S.D.: Thermoregulatory profile of a newer genetic line of pigs. *Livestock Production Science* 71, 2001, 253-260.

Harichová, D., Venglovský J., Petrovský M., Pačajová, Z.: The effect of microclimate on the health and productivity of fattening pigs (In Slovak). In: *Proc. of 13th Scientific. Int. Conf. – Bioclimatology and the Environment.* Košice, Slovak Republic, 12-14 September, 2000, SBkS SAV, 2000, 7 pp., CD, ISBN 80-88985-22-6.

Kemp, B., Verstegen, M.W.A.: The influence of climatic environment on sows. In: Verstegen, M.W.A., Henken, A.M. (eds.) *Energy metabolism in farm animals effects of housing, stress and disease.* Martinus Nijhoff, Dortrecht, 1987, 115.

Mount, L.E.: Adaptation to thermal environment: Man and his productive animals. Edward Arnold Limited, London, 1979.

Myer, R., Bucklin, R.: Influence of Hot-Humid Environment on Growth Performance and Reproduction of Swine. *Document AN107*, Extension, Institute of Food and Agricultural

Sciences, University of Florida, 2001, 7 pp., http://edis.ifas.ufl.edu/AN107.

Nienaber, J.A., Hahn, G.L., Eigenberg, R.A.: Quantifying livestock responses for heat stress management: A review. *International Journal of Biometeorology*. 42, 1999 (4), 183-188.

Vansickle, J.: Crossfostering: Less is more. National Hog Farmer, 43, 1998 (3), 37-38.

Verstegen, M.W.A., Brascamp, E.W., v. d. Hel, W.: Growing and fattening of pigs in relation to temperature of housing and feeding level. *Canadian Journal of Animal Science,* 58, 1978 (1), 1-13.

Xin, H., McFadden, V.J.: Tunnel Ventilation to Alleviate Animal Heat Stress. In: *Livestock Industry Facilities & Environment, Pm-1606,* Iowa State University, Ames, Iowa, 1995. http://www.extension.iastate.edu/Publications/PM1606.pdf (2007-08-08)

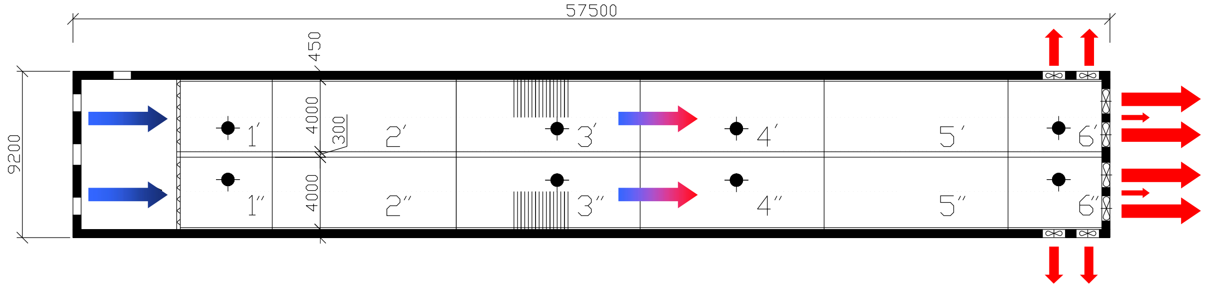

Fig. 1 Ground layout, measurement places in pens (1, 3, 4, 6) and air movement in stable

Table 1. Average values of the microclimatic parameters – 1st experiment (one front fan out of operation)

Measurement place	**Outdoor**			**Pens in stable**				
Parameter	V1	V2	Average	P1	P3	P4	P6	Average
Air temperature, °C	37,1	37,5	37,3	35,7	35,8	36,0	34,5	35,5
Relative humidity of air, %	28,1	24,0	26,1	35,1	31,9	28,7	35,8	32,9
Air velocity, m/s	0,34	0,49	0,42	0,45	1,09	1,99	0,27	0,95

Table 2. Average values of the microclimatic parameters – 2nd experiment (all fans in operation)

Measurement place	**Outdoor**			**Pens in stable**				
Parameter	V1	V2	Average	P1	P3	P4	P6	Average
Air temperature, °C	37,8	37,4	37,6	36,7	37,1	36,7	35,9	36,6
Relative humidity of air, %	23,5	24,7	24,1	27,8	25,7	29,5	31,5	28,6
Air velocity, m/s	1,64	1,1	1,37	0,64	2,14	1,88	0,20	1,22

Comment: P1 (1´+1´´), P3 (3´+3´´), P4 (4´+4´´), P6 (6´+6´´) in animal zone 500 mm above floor level