AIR QUALITY INSIDE PIG BUILDINGS IN RELATION WITH PHYSIOLOGICAL STAGES AND SEASON

Nadine Guingand, Yvon Salaun
ITP, 35651 Le Rheu, FRANCE

Introduction

In pig facilities, the quality of the atmosphere is an essential aspect of the management of the production. Because animals are very sensible to temperature and air speed, pig farmers have to control these physical parameters of the ventilation (temperature, ventilation rate…) in order to obtain the best performances. Nevertheless, air quality integrates more parameters than physical ones. Ammonia, dust and odour are added to physical parameters noticed before. Buildings involved in this study were considered representative of French pig breeding conditions. Values of air quality given in the following pages could not be applied for others breeding conditions than these described in this paper.

Material and Methods

Animals and husbandry: In this study, three physiological stages were considered: sows in farrowing rooms (FW), piglets in post-weaning rooms (PW) and pigs in growing-finishing rooms (GF). Farrowing rooms were fully slatted floor with metallic slats at the back of the sow for easier removal of slurry and plastic slats for the rest of the pen. Fresh air was entered room via a perforated ceiling and the air extraction was under-floor extraction. Sows entered rooms one week before piglet's birth and stay a total of 5 weeks. Ventilation rate applied per sow during the cold period was 110±21 m^3per hour and 263±43 m^3 per hour during the hot period. Average ventilation rate was 188 m^3per hour per sow and average ambient temperatures were 26±2°C and 23±1.2°C respectively for the hot and the cold period. Concerning piglets in post-weaning rooms, the average weaning weight was 8.7±1.0 kg. Time of presence can vary between five and seven weeks. Average weight at the end of the post-weaning period was 25.3 ±1.9kg. Rooms were fully concrete slatted floor with fresh air entering via a ceiling or via lateral entries. Extraction was under-floor. Surface per piglet was around 0.35 m^2. Ventilation rate applied in post-weaning rooms were 13.5±3.2 m^3 per hour for the cold period and 22.2±4.6 $m^3$for the hot period. Average ventilation rate was 18.6±6 m^3 per piglet per hour. Average ambient temperature was 26±1°C for the cold period and 27±1°C for the hot period. For growing-finishing rooms, average pig weigh was 27.5±11.4kg at the entry and 103.5±5.9kg at the end of the GF period for an average time of 105 days. Rooms were fully slatted concrete floor with storage of the slurry in deep pit. Fresh air entered via a perforated ceiling and air exhaust was under-floor extraction with or without cheminey. Pigs were fed *ad libitum* with a multiphase diet. Average surface per pig was 0.7 m^2. Ventilation rate was 24±7 m^3per hour per pig for the cold period and 35±11m^3per hour per pig for the hot period. The average ventilation rate was 31±11m^3 per hour per pig.

Dust concentration: dust concentration was measured using gravimetric method and expressed in milligrams per cubic meter. Measurements were achieved 1 meter above the floor at the middle of the corridor. Time sampling was between one and three hours.

Ammonia: Concentrations were measured in the room atmosphere and in the extracted duct. In the ambiance, ammonia concentration was measured in the centre of the corridor 1 meter above the floor with passive diffuse tubes. Ammonia concentration was expressed in ppm. In the extracted duct, concentration was measured by bubbling method.

Odours: Sampling of odorous air from extracted duct was achieved in order to determine odour concentrations. Air samples were analysed by CERTECH Laboratory (Seneffe – Belgium) for the determination of the odour threshold which is defined as the dilution factor at which 50 % of an odour panel can just detect an odour (CEN, 1999). Equipments and procedures were conformed to current recommendations (French Standard,NF X43-101, NF X 43-104 – AFNOR, 1986 and 1990 – European project standard prEN 13725 – CEN, 1999). Odour concentration is expressed as odour unit (OU). The rate of emission from an odour source is the product of the concentration and the volumetric flow rate (m^3/h) of the emissions and is expressed in $OU.h^{-1}$. Values were converted in odour emission per day per animal integrated difference between sows, piglets and growing-finishing pigs.

Ambient physical parameters: Outside and ambient temperatures and ventilation rates were recorded during measurements. Measurements were always achieved during the same period of the day (morning). The cold period was from October to April with average outside temperature of 7±3°C and the hot period from May to September with average outside temperature of 18±3°C.

Results and discussion

Dust concentration : Average dust presentated in the following table were calculated with 34 values obtained in 10 FW rooms, 52 in 11 PW rooms and 98 in 27 GF rooms.

Table1: Average dust concentrations (mg/m³)

	FW	PW	GF
Hot period	1.8 ± 1.1	4.1 ± 2.0	2.4 ± 1.3
Cold period	2.5 ± 1.2	6.3 ± 3.3	3.6 ± 1.8
Mean value	2.0 ± 1.1	5.4 ± 3.0	2.9 ± 1.6

In PW rooms, dust levels are twice higher than levels measured in FW and GF rooms. This fact can be explained by the greatest activity of young pigs in PW rooms compared to sows and GF pigs. The link between pig activity and dust concentration in pig housing was clearly illustrated by results of Pedersen (1993)

The effect of the season is clearly identified on dust concentrations. Whatever physiological stages, dust levels measured during the hot period were always smaller than levels measured during the cold period. The effect of the ventilation rate is partially responsible of this difference. In fact, the rise of temperature during the hot period act on the ventilation rate by increasing it. Dust concentrations are reduced by dilution of the atmosphere inside the building. During the hot period, the reduction of dust could also be explained by the reduction of pig activity.

Ammonia concentrations; Average ammonia concentration in the ambiance presented in the following table were calculated with 55 values obtained in 10 FW rooms, 65 in 7 PW rooms and 98 in 16 GF rooms.

Table 2: average ambient ammonia concentrations (in ppm)

	FW	PW	GF
Hot period	5.4 ± 2.9	4.4 ± 2.7	8.3 ± 5.4
Cold period	11.5 ± 5.2	7.8 ± 2.9	12.7 ± 7.2
Mean value	8.9 ± 5.3	6.3 ± 2.9	10.2 ± 6.6

Values presented in table 2 are in accord with previous values published in literature (Wathes, 1998 – Nicks *et al.*, 1989). As for dust, ammonia concentrations were always smaller during the hot period. Also, increasing ventilation rate and the effect of dilution on the atmosphere were responsible of the reduction of ammonia inside rooms (Hoff and Bundy, 1992).

Ammonia emissions: Average ammonia emissions presented in the following table were calculated with 16 values obtained in 5 FW rooms, 35 in 7 PW rooms and 68 in 13 GF rooms.

Table 3: Average ammonia emission (in g day per animal)

	FW	PW	GF
Hot period	28.6 ± 10.6	3.8 ± 3.1	10.1 ± 4.4
Cold period	23.1 ± 7.3	3.1 ± 2.8	8.8 ± 4.2
Mean value	25.6 ± 9.1	3.5 ± 2.9	9.5 ± 4.3

Average quantities of ammonia emitted per animal were calculated including average ammonia emission of table 3 and the average time of presence per animal. The average value slightly lower than 1 kg of ammonia emitted by the building per GF pig is very close to previous values obtained in the same conditions (Guarino *et al*., 2003 – CORPEN, 2001).

Table 4 : Average ammonia quantities emitted per animal

	FW	PW	GF
Average time of presence (days)	365	50	105
Average quantity of ammonia emitted per animal (grammes)	9300	175	998
% of emission by stage in case of a 100 sows closed farm	28.9	6.3	64.8

Effect of the season on ammonia emission was already observed by Gustafsson (1987). The increasing air flow inside room may increase air speeds above emitting surface (slatted floor) and enhance emissions.

Odour emissions: Average odour emissions presented in table 5 were calculated with 14 values obtained in 4 FW rooms, 23 in 5 PW rooms and 63 values in 13 GF rooms. In the same approach that this applied for ammonia emission, odour emission per animal and percentage for both physiological stage were presented in table 6.

Table 5 : Average odour emission (in odour units per day per animal)

	FW	PW	GF
Hot perod	$1.6\ 10^7 \pm 4.8\ 10^6$	$3.0\ 10^6 \pm 2.4\ 10^6$	$4.1\ 10^6 \pm 1.8\ 10^6$
Cold period	$1.3\ 10^7 \pm 5.6\ 10^6$	$1.6\ 10^6 \pm 1.1\ 10^6$	$2.4\ 10^6 \pm 1.9\ 10^6$
Mean value	$1.5\ 10^7 \pm 4.8\ 10^6$	$2.4\ 10^6 \pm 2.0\ 10^6$	$3.3\ 10^6 \pm 2.0\ 10^6$

Table 6 : Odour emitted per animal

	FW	PW	GF
Average time of presence (days)	365	50	105
Average quantity of odour per animal (odour unit x 10^6)	5475	120	346.5
% of emission by stage in case of a 100 sows closed farm	35	15	50

Around 50 % of odours are emitted by GF rooms in our example of 100 sows closed farms. The high level of odour emission of GF rooms and the time of presence explained the weight of this stage.

Conclusions

Data obtained in this study show the diversity of air quality in relation with physiological stages. Except for dust concentrations, GF rooms appear to have the worst air quality in comparison to FW and PW rooms. The effect of the season on dust, ammonia and odours was clearly noticed. For dust and ammonia in the atmosphere, concentrations were lower during the cold period. At the opposite, ammonia and odour emission were higher during the hot period. In both cases, the effect of the ventilation rate in relation with ambient temperature was the main explanation. In France, the increasing number of conflicts with neighborhood about odours and the eventual tax linked to ammonia emission should encourage pig farmers to invest in air treatments especially adapted to GF rooms.

Acknowledgements

References

- CORPEN, 2001, les emissions d'ammoniac d'origine agricole dans l'atmosphère – Etat des connaissances et perspectives de reduction des emissions – 110 p
- Gustafsson G., 1987, Latest Developments in Livestock Housing, September 22th, St Joseph, Michigan (USA)
-Hoff S.J., Bundy D.S., 1992, AgEng, Uppsala (Sweden), 1-4 June
-Pedersen S., 1993, International Livestock Environment Symposium IV, Coventry (England), 6-9 July :718-725
- Nicks B., Deschamps P., Canart B., Buzitu S, Dewaele A., 1989, Annales de Médecine Vétérinaire 133 : 691-701
- Wathes C.M., 1998, 15th IPVS Congress, July 5-9, Birmingham (England) : 259-265