EFFECTIVE VENTILATION

Harry Huffman, P.Eng.
Huffman Engineering
86 Southfield Cres., London, Ontario N6K2B7
E-mail: harryhuffman@rogers.com

ABSTRACT

Good air quality in swine rooms can only be achieved if sufficient air is exchanged to remove both the respired moisture from the pigs as well as the ammonia gas produced by the decomposition of the manure. Regardless of the size of the pigs in all rooms with slatted flooring and no bedding, this generally requires the use of some supplemental heat to both maintain the desired room temperature and still exchange sufficient air. Ideally, the ammonia gas level should be kept below 20 PPM and the relative humidity level under 70%. Some common mistakes regarding under-ventilating and heater management are discussed.

AIR QUALITY IN SWINE ROOMS

The majority of swine enterprises utilize liquid manure handling systems. One of the main manure gases produced as part of the decomposition process is ammonia. Ammonia gas is water soluble and will readily attach itself to every moisture molecule found in the room air. Given that pigs regardless of size expel significant moisture into the room air from respiration, there is an abundance of water vapour available to absorb the ammonia gas. This gas combination is quite odorous and reduces air quality.

Table 1 shows the typical quantity of moisture that various classes of pigs contribute to the room air. This moisture must be exhausted from the room on a continuous basis to prevent the room from becoming very humid and hence very odorous. This table shows that pigs produce more moisture as they grow and hence the minimum ventilation rate must also be increased to keep up with the moisture production rate. Unfortunately, this does not happen automatically in most rooms during cold weather and thus air quality often deteriorates as the pigs grow.

Ammonia gas is easy to measure and should be kept under 20 PPM (parts per million) and preferably under 15 PPM, but that can be hard to achieve during cold weather. Passive type gas diffusion tubes are available that can be broke open and hung in the room for a measured length of time. When the gas tube is retrieved and the colour change reaction value read and divided by the exposure time, the average concentration of ammonia gas is determined. Should the result be higher than 20 PPM, then the room is likely being under-ventilated.

All air exhausted from an animal room also expels significant heat energy along with the moisture and various manure gases. If sufficient air is exhausted to maintain a room relative humidity under 70%, the heat loss is sufficient to cause all swine rooms to be heat deficient during cold winter weather. Since all ventilation systems use temperature as the main control

basis for operating the exhaust fans, the minimum fans are going to slow down or shut off rather than allow the room temperature to drop very much. Of course this control strategy will simply increase problems with poor air quality.

Table 1. Typical moisture production from pigs.

Swine Category	Animal Mass kg	Moisture Production L / Day
Breeding & Gestation	150	2.8
	200	3.4
Farrowing Sow	160	4.9
	200	5.4
Weaned Pig	5	0.8
	10	1.1
	20	1.2
Grow – Finish Pig	25	1.3
	50	1.9
	75	2.1
	100	2.2
	120	2.4

Source: OMAFRA Fanvent Analysis Program

The proper solution is to add supplemental heat so that the exhaust fans can operate continuously and even increase their minimum speed as the pigs grow to both remove the moisture and still maintain the desired room temperature. Table 2 shows the typical quantity of supplementary heat required for each type of swine environment. Yes, even breeding and gestation rooms should be equipped with a heater for outside temperatures lower than about -10°C. All-in, all-out grow-finish rooms require some supplementary heat until the pigs reach about 45 kilograms.

Table 2. Supplementary heat requirements for swine rooms.

Pig Type & Size	Minimum Ventilation Rate	Outside Temperature -20°C	Outside Temperature -10°C	Outside Temperature 0°C
Breeding/Gestation	10 CFM / pig	500 BTU/h	250 BTU/h	0 BTU/h
Farrowing	17 CFM / crate	1000 BTU/h	600 BTU/h	200 BTU/h
5 Kg Pigs [a]	1.3 CFM / pig	225 BTU/h	180 BTU/h	130 BTU/h
20 Kg Pigs [a]	2.5 CFM / pig	50 BTU/h	25 BTU/h	0 BTU/h
25 Kg Pigs [b]	3.0 CFM / pig	200 BTU/h	100 BTU/h	0 BTU/h
40 Kg Pigs [b]	4.0 CFM / pig	110 BTU/h	0 BTU/h	0 BTU/h

Source: OMAFRA Fanvent Analysis Program

[a] Weaned pigs housed in a typical all-in, all-out nursery room

[b] Pigs moved from nursery room to an all-in, all-out grow-finish room

COMMON MISTAKES TO AVOID

1. Not Exhausting Sufficient Moisture

Under-ventilating a swine room during cold weather is the most common cause of poor air quality. This can occur due to several reasons.

- The minimum ventilation fan(s) may be allowed to shut off based on the room temperature dropping below the set point temperature and not re-start until the pigs have warmed the room back above the set point temperature. Ideally, the minimum exhaust fan should be sized such that it should never need to shut off. If it does shut off, then it should not be allowed to be off for any longer than 3 minutes or the humidity level climbs too high and the room becomes quite smelly.

- The minimum ventilation fan(s) may be operating on the timer function of the ventilation controller whenever the room temperature drops below the set point temperature. The timer settings may not be allowing the fan to run a sufficient portion of the total cycle time such that the off time is longer than 3 minutes. The only time that a longer off cycle is acceptable is when the room is empty between animal groups. During these time frames, it is only the manure gases that continue to deteriorate the room air quality and shorten the life of all metal components within the room. Running the minimum exhaust fan at its slowest speed for a couple of minutes out of every 10 minute time cycle is usually sufficient to maintain reasonable conditions in an empty room.

- The minimum speed setting on the first stage ventilation fan(s) may not be set high enough to exhaust all of the moisture being produced. This can be checked by measuring the relative humidity in the room with a temperature/humidity pen. If the humidity level is above 70%, the ventilation rate must be increased. One can also measure the ammonia gas concentration to ensure it is less than 20 PPM. If not, increase ventilation rate.

- Very often the minimum ventilation is not increased as the pigs grow. While quite a few of today's ventilation controllers provide a minimum fan speed curve feature that allows the operator to program an automatic minimum speed increase based on growth days in the room, many producers do not use this feature. If a room is heat deficient, then the pigs will never cause a temperature increase during cold weather to have the ventilation fan speed up on its own. The operator must ensure that the minimum speed is raised each week as the pigs grow to keep up with their moisture production rate.

2. Stingy with the Heat

All swine rooms should be equipped with some supplementary heat to ensure sufficient minimum ventilation can occur and the desired room temperature is also maintained. Yes, heat costs money, but so do poor air quality and animal discomfort (not to mention herdsmen working conditions). Even when heaters are installed in the various rooms, there can be air quality problems and also heat waste.

- Ensure all swine rooms are equipped with an appropriately sized heater and it is operated with the ventilation system controller to guarantee an interlock and minimize any unnecessary conflict between the two systems.

- If the relative start temperature for the heater is too far under the main set point temperature for the room, then often the heater will rarely turn on and coupled with too low of exhaust rate, air quality can remain poor. Normally, a relative heater set point of 1.0 or 1.5°C below the main set point temperature for the room is good.

- The heater differential temperature (degrees of temperature rise) needs to be properly set for good economical heater operation. If the heater differential is too small, the heater does not run long enough to help dry out the air volume of the entire room and thus the room will remain quite odorous. On the other hand, the heater off temperature is frequently set to match the main set point temperature for the room. This control strategy will almost always waste energy. With the heater sized for the coldest expected weather, it is over-sized for a good percentage of the year. Secondly, the typical temperature sensors that are used to control ventilation systems are relatively slow to react to a temperature change. Thus when a sensor signals a heater to shut off, the room temperature is actually still climbing, since the sensor has not fully responded to all of the heat energy available in the room. Any room temperature climb above the main set point temperature will automatically increase the speed of the first stage fan(s) and dump this extra heat. Therefore, the heater should always be shut off at least 0.3°C below the main set point temperature for the room.

- For many small rooms, a standard heater can be oversized such that it can alter the room temperature quite quickly. This can be stressful on the pigs and cause some heat waste. Many of today's box heaters have an adjustable gas orifice that can be partially closed to reduce the flow of gas to the burner and thus it's heat output. Be sure to check whether or not your heater has this feature. It is very useful for all rooms housing younger pigs during the two swing seasons when less supplemental heat is required.

ALTERNATIVE HEAT SOURCES

Since heat is required, one is always interested in getting the most energy for the least cost. As fuel costs continue to rise, this aspect of production costs will demand more attention. Some producers have explored the use of corn as a fuel. However, it would currently appear that this commodity is better utilized as a food source than a source of fuel. It may be that corn stover and/or other crop refuse will become a more viable fuel source in the future. Methane gas or waste heat from on-farm digesters both look like they may have potential as a fuel source down the road.

Currently, the two technologies that are proven and commercially available for livestock farmers are heat exchangers and passive solar energy collectors. Heat exchangers can re-capture some of the heat energy leaving the barn through the minimum exhaust fan(s). Passive solar collectors can be installed on the air intake side of the building and warm the incoming air whenever the sun shines.

Both of these technologies will work well with existing ventilation and heating systems and can have a reasonable pay back period, particularly when some of the available energy grants are considered. Tom Sangster with Exacon Incorporated will discuss their experiences with these alternate heat sources on some swine farms.