The importance of air quality in livestock buildings

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In recent years, concerns regarding air quality in and around livestock buildings have increased. Not only are odorous volatile organic compounds (VOC), such as ammonia and hydrogen sulfide, a nuisance, but they can be detrimental to animal and human health alike (Curtis et al., 1975). Dust in buildings is a diverse airborne mixture of microorganisms, dried dung and urine, dander, grain mites, spores, pollen, and feed particles. Dust may facilitate the spread of these VOCs (Razote et al., 2004) and infectious agents (Pedersen et al., 2000; Vansickle, 2013). Dust is categorized, depending on particle size (PM), as inhalable (PM₁₀₀), thoracic (PM₁₀), or respirable (PM₅; Watt et al., 2010). Respirable dust is most hazardous because it reaches the level of gas exchange within the lungs (Watt et al., 2010). The first study to report deleterious health affects associated with dust concentrations on pigs occurred in 1967. The study found that 87% of pigs found to have pneumonia at the time of slaughter originated from buildings with high dust levels (Pedersen et al., 2000). Another study found dust above 5.1 mg/m³ may reduce pig performance (Wathes et al., 2002). One study used 960 wean pigs and determined that exposure to poor air quality decreased live weight ($P = 0.04$) and tended to decrease feed intake ($P = 0.12$). The effects of ammonia levels on pigs were directly related to the level of airborne dust (Wathes et al., 2002).

The physiological nature of birds’ respiratory system suggests poultry may be more sensitive to the poor air quality than humans or pigs. Both poultry health (Nimmermark et al., 2009; Ullman et al., 2004) and performance may be affected by poor air quality (Kentucky Agriculture Development Board, 2014).

Although not directly applicable to animal health, the Occupational Health and Safety Administration (OSHA) recommends workers wear respiratory protection to avoid health hazards of poor air quality. For the U.S., OSHA regulates time-weighted maximum exposure levels for VOCs, dust, and other gasses which pose human health risk at high levels (Table 1). However, recent research has recommended that ammonia levels should be no more than 10 ppm (Colina et al., 2004).

Table 1. Recommended maximum exposure standards for important gasses¹ and dust² in the U.S.

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Maximum Exposure</th>
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<tbody>
<tr>
<td>Ammonia, ppm</td>
<td>50</td>
</tr>
<tr>
<td>Hydrogen sulphide, ppm</td>
<td>50</td>
</tr>
<tr>
<td>Carbon monoxide, ppm</td>
<td>50</td>
</tr>
<tr>
<td>Carbon dioxide, ppm</td>
<td>5,000</td>
</tr>
<tr>
<td>Inhalable/total dust, mg/m³</td>
<td>15</td>
</tr>
<tr>
<td>Respirable dust, mg/m³</td>
<td>5</td>
</tr>
</tbody>
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¹OSHA, 1994a-c.
²OSHA, 2006.
In the past, improving air quality often meant increasing airflow through the buildings. However, this method is not always feasible especially in the winter months. Other methods include reducing nitrogen output (and thus ammonia formation) by altering the pigs’ diet, sprinkling vegetable oil over dust to reduce its ability to become airborne, and controlling humidity and temperature within the building (Watt et al., 2010). In a study of several types of dust mitigation techniques, it was determined that sprinkling dust with oil was most effective of the techniques studied (Figure 1; Pedersen et al., 2000).

![Figure 1. Efficacy of dust mitigation techniques tested in 1994 (Pedersen et al., 2000)](image)

One study using an electrostatic precipitator system installed in pig nursery and farrowing environments saw reduction in overall and respirable dust levels. In the nursery, overall dust was reduced 58% and respirable dust was reduced 36%. In the farrowing room, overall dust was reduced by 45% and respirable dust was reduced by 50% (Rosentrater, 2003). Another study of the effects of ionization on 21 day old chickens, used negative air ionizers installed in upstream, downstream, and central locations of the housing. This study revealed an approximate 75% reduction in dust levels in the barn. Additionally salmonella enteritidis levels were reduced approximately 50% (Gast et al., 1998).

The latest innovation in electrostatic particle ionization devices (EPI II Air®) has made the improvement of air quality inside livestock buildings more feasible. This system requires no air movement through or by the device. The current version (EPI II Air® System) of this device is comprised of 3 components: a transformer for power regulation, a corona pipe to support the wire, which transports ions, and a winch system to lower and raise the corona pipe. The corona pipe is equipped with a wire off which many sharp points project. The ions flow out of the system and into the air from the sharp points. When no workers are in the barn, EPI Air® operates just above pig level. When workers need to enter the barn, the system can be shut off and the corona pipe raised while the workers are present.
When EPI Air® is implemented, air quality is improved in three ways. First, particles in the air are charged and become attracted to each other and to surfaces in the barn thus forcing them out of the air (Vansickle, 2013; Rosentrater, 2004). This action reduces dust levels thereby reducing the levels of gasses and infectious agents clinging to the dust. Second, infectious agents are disabled or destroyed in two ways: 1.) Infectious agents are pulled out of the air reducing danger of infection for the animals, 2.) Overwhelming charge causes protein membranes of infectious agents to rupture, thereby disabling them. Finally, gases react with the ions and are broken down into harmless compounds. The amount of dust that can be seen stuck to surfaces within the barn illustrates improvement in air quality (Figure 2).

One recent study used 44,000 nursery pigs over 5 turns (2009-2010) and determined that dust was reduced 40 to 50% in a barn equipped with EPI versus a barn without EPI. The PRRS virus, as measured in the air, was reduced 24% in the barn equipped with EPI Air® compared to the barn that did not have EPI Air® installed. Hydrogen sulfide gas was also reduced 58.6% in barns where EPI Air® was installed compared to the barn that did not have EPI Air® installed. Pigs in the EPI barn had 12.2% greater ADG and 1.2% fewer mortalities over the barn where EPI Air® was not installed (Vasickle, 2013). The animals' immune systems may be more effective at fighting off infectious agents because the EPI Air® system reduces the challenge of poor air quality (Lowe, 2014).

In addition to improving the environment in the building for both workers and animals, the system has the potential to improve air quality around the building. Because particles are forced out of the air, fewer will exit the building through the ventilation system. This could result in reduced spread of dust, VOCs, and infectious agents. The Australian government recommended EPI Air® for reducing pollution around poultry buildings as “one of the least costly technologies [of those reviewed]” and that “it is unobtrusive, low maintenance and does not interfere with the ventilation system (Dunlop, 2009).”
Literature Cited


