BIOSECURITY
In the sphere of bio-aerosols

Dusts, or aerosols, form a significant vector for micro-organisms in livestock farming. They must be considered in a comprehensive approach to biosecurity in animal production. Thus, disinfection by air is a very effective technique to reduce infection pressure during the production period and completes the disinfection phase during the sanitary break.

by Franck Foulon,
Global Product Manager Hygiene,
Huvepharma.
www.huvepharma.com

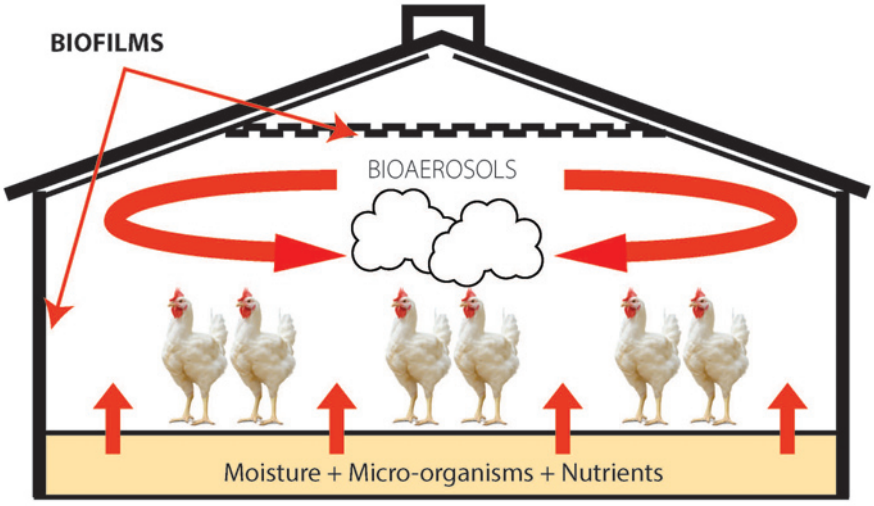

Fig. 1. Bio-aerosols and biofilms formation.

Aerosols are particles small enough to remain suspended in the airspace of a room, given that 'suspended', by definition, means that which settles to the ground at a rate of less than 25cm per second.

Why do these particles remain in the air?

● Because of their weight and the nature of the carrier fluid, in particular its humidity factor, and also because of the nature of gases in the ambient air (CO_2, NH_3). brought to bear on its 'viscosity'.
● By reason of other characteristics:
• The electric charges of these particles,
• The temperature gradients of the particles,
• The repellent nature of heat sources for aerosols, in particular by animal bodies.
• The light sensitivity of the particles (ie the amount of light which they absorb).

Contaminating bio-aerosols in livestock farming are aerosols that contain micro-organisms: bacteria, viruses, fungi, yeast, or fragments thereof (fragmented bacterial bodies, bacterial toxins or mycotoxins).

They are generated in close relation to the level of activity of animals and come basically from two sources:
• Animals which cough, urinate or defecate.
• Biofilm (attached bacterial pool) fractions separated from the surfaces, especially during periods of sizable hygrometric or temperature variations (Fig. 1).

Table 1. Size of micro-organisms and their probability of entry into the respiratory tract.

		0.001	0.01	0.1	1	10	100	1,000
Size in microns (µm) of the aerosol constituents determined by electron microscopy (American Thoracic Society, 1998)	Fungi 20-100					↔		
	'Spores' of fungi 5-15				↔			
	Bacteria 5-20				↔			
	Spores of bacteria 0.5-3			↔				
	Viruses 0.01-0.05		↔					
Penetration in the respiratory tract: classification of aerosols depending on the function of their aerodynamic diameter	Inhalation (<100µm)	←					→	
	Thoracic (<10µm)	←				→		
	Alveolar (<4µm)	←			→			

Bio-aerosols maintain infection pressure

Partially controlled by ventilation, bio-aerosols play an important role in the spread of pathogens amongst animals and in the transmission of infectious agents between the buildings in livestock farms.

In the presence of animals, micro-organisms carried by bio-aerosols can become pollutants under three conditions:
● They should penetrate the airways of animals. In order to be inhaled, their carriers should have specific dimensions (aerodynamic diameter) (Table 1).
● They should be alive, or their possible toxins should be active.
● Animals should be sensitive to their impacts.

Bio-aerosols constitute an active part of what we commonly call infectious pressure. Given that the dynamic bacterial pool is maintained by the high concentration of organic matter and the heat and humidity in the barn, levels of infectious agents in aerosols are directly proportional to the number and concentration of animals in the farm or the facility (herd size, density) or in the region (population density).

Measurements in livestock farms refer to the number of bacteria per a total of 10^4CFU/m^3 air, and of moulds per 10^3CFU/m^3

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versus the average values per 10^8-10^9 bacteria/cm^2 for surfaces.

Persistence of bio-aerosols

● **Hygrometry (RH):**
Enveloped viruses (for example avian influenza virus) are hydrophobic and show better survivability in dry air (RH ‹50-70%). Non-enveloped viruses (for example foot-and-mouth virus) are more stable in humid air. The foot-and-mouth disease virus is known to be transmitted by air, particularly in temperate zones (over distances of up to 60km overland and 300km offshore).

● **Temperature:**
The temperature-related effect depends on the structure of micro-organisms. Bacterial concentrations carried by air are higher in winter than in summer.

● **Ventilation:**
The effect of dilution through ventilation on aerosol concentrations seems obvious, but it also causes an accelerated extraction of aerosol particles from litters and manures. The effect of ventilation is highly dependent on the characteristics of the ventilation system and on the design of the building.

Air disinfection: Improvements under certain conditions

Airborne disinfection (nebulisation and thermal fogging) involves a device which propagates the product over some distance. Air is the vector of the product, whilst in contact disinfection, the product is applied directly to the surface by spraying.

In Europe, the efficiency of the method is evaluated for specific products and equipment according to EN 17272 standard.

A specific volume can be subjected to disinfection by thermal fogging in an optimal manner using dry mist consisting of particles with a diameter of less than 30 microns. Nebulisation (cold fogging) gives rise to particles with a diameter of less than 100 microns (Table 2).

Glutaraldehyde and quaternary ammonium-based formulations are intended for use by spraying (first disinfection), nebulisation or thermal fogging in empty buildings (during the sanitary break period).

Vulkan Air, a new formulation developed by Huvepharma, is designed particularly for poultry farms. The concentration ratio between glutaraldehyde and quaternary ammoniums compounds is in favour of glutaraldehyde. As such, Vulkan Air has a perfect diffusion in the air, does not leave greasy deposits on the treated surfaces and demonstrates high effectiveness by thermal fogging and cold nebulisation: bactericide, virucide, yeasticide at 0.75ml/m^3, fungicide (Aspergillus niger) at 1ml/m^3, according to EN 17272.

Recently, Huvepharma also developed a disinfectant composed of peroxide and lactic acid synergised with essential oil: Aeroclean.

Aeroclean is a new generation disinfectant that can be used by aerial diffusion in livestock buildings, in hatcheries, in the food industry and in general disinfection. Its original formulation allows application in the presence of animals. The product represents one of the best innovations in airborne disinfection, formulated with a view to reducing risks to the environment, its users, and the animals and exhibiting a broad-spectrum efficacy against viruses, bacteria and fungi which create airborne contagion in livestock farms. ■

Table 2. Relationship between the size of droplets and the device used.

Average particle diameter (microns, µm)	Common name	Rate of settling in absence of air flow (mm/sec)	Method used	Diameter of particles generated by this method (µm)
0.01-0.1	Light smoke	Remains suspended	Vaporisation Gassing	Molecules
			Fumigation	0.1-0.5
0.1-1	Thick smoke	Remains suspended	Fine powder scattering	1-2
2-10	Dry mist	0.12-3.0	Thermal fogging	‹30
10-50	Wet mist	3.0-7.5	Aerosol	‹50
50-100	Drizzle	7.5-27.2	Cold fogging	‹100
			Low-volume atomisation	50-100
100-150	Light rain	2.72-1.875	Spraying	›200
500-1000	Normal to heavy rain	1.875-3.53	Not applicable	

Optimal air disinfection zone Optimal surface disinfection zone