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MINIMIZING THE SPREAD OF PRRS VIRUS

Ventilation and filtration in pig farms

AIR PURIFICATION

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VENTILATION AND FILTRATION IN PIG FARMS

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WHAT IS PRRS VIRUS

Porcine Reproductive and Respiratory Syndrome (PRRS) is a viral disease that primarily affects the respiratory and reproductive system of pigs. It is highly contagious and represents one of the greatest challenges for the swine industry, causing serious economic losses (USD 1.2 billion annually in the US swine industry between 2016 and 2020 / Derald Holtkamp - Iowa State University).

HOW PRRS IS TRANSMITTED

The PRRS virus **is transmitted in several ways**: by direct contact between infected animals, through the air and, critically, through semen, which poses a great risk to farms dedicated to breeding.

This virus has the ability to mutate rapidly, making it difficult to control once it enters a farm. In addition, it can cross the placenta, affecting pregnant sows and causing the death of their piglets before birth. The consequences for the rest of the individuals on the farm is one of the most severe impacts: the destruction of 40% of pulmonary macrophages, which drastically decreases the pigs' defences against other diseases.

THE ROLE OF VENTILATION IN THE PREVENTION OF PRRS VIRUS

Ventilation plays a key role in preventing the spread of the PRRS virus within pig farms.

The main airborne transmission route for PRRS is due to the accumulation of viral particles in the air, which spread easily in closed environments (in agricultural areas up to 2.4 km from an infected population).

An adequate ventilation system guarantees the constant flow of clean air and minimizes the concentration of pathogens in the air.

Our farm fans are designed to maintain optimal air circulation, which reduces the areas where viral particles can accumulate. By keeping humidity levels under control and regulating temperature, the overall well-being of the animals is also improved, decreasing the incidence of stress, which is a key factor in the spread of the virus.

USING HEPA FILTERS: ADDITIONAL PROTECTION AGAINST PRRS

To maximize the effectiveness of the ventilation system, our fans can be equipped with HEPA filters. These filters are capable of capturing ultra-fine particles, including those carrying viruses such as PRRS. By installing HEPA filters we are adding an extra barrier of protection, especially in higher risk areas such as the breeding sectors, where semen transmission is a major concern.

A typical HEPA filter has a **capture efficiency of up to 99.997% (H14)** of 0.3 micron particles, however, due to the fibrous structure of HEPA filters, they are able to capture and retain smaller particles down to 0.1 microns through the effect of diffusion, interception and sieving.

PRRS virus particles are approximately 50 to 65 nanometers in size (i.e. 0.05 to 0.065 microns) but travel in the air associated with droplets from 0.5 microns to more than 10 microns (for example, saliva or mucus) and these particles are easier for the HEPA filter to capture, as well as the transported viral particles.

The combination of efficient ventilation and the use of HEPA filters protects against the spread of the PRRS virus and can help prevent the occurrence of outbreaks in its most acute form, as well as control the chronic form of the virus, which can cause persistent problems on farms.

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EXAMPLE OF CALCULATION OF RENOVATIONS ON FARMS

To create a complete example on air renewal in a farm with a HEPA filter and its impact on ventilation, we first need some typical parameters that will allow us to make representative calculations. Here is a detailed outline of how to approach this calculation, taking into account:

- **Farm size** (area in square meters and height).
- **Number** of pigs.
- **Air changes per hour** (ACH) requirement, recommended for pig farms.
- **Pressure drop** associated with a HEPA filter and its efficiency for small particles, such as the PRRS virus.

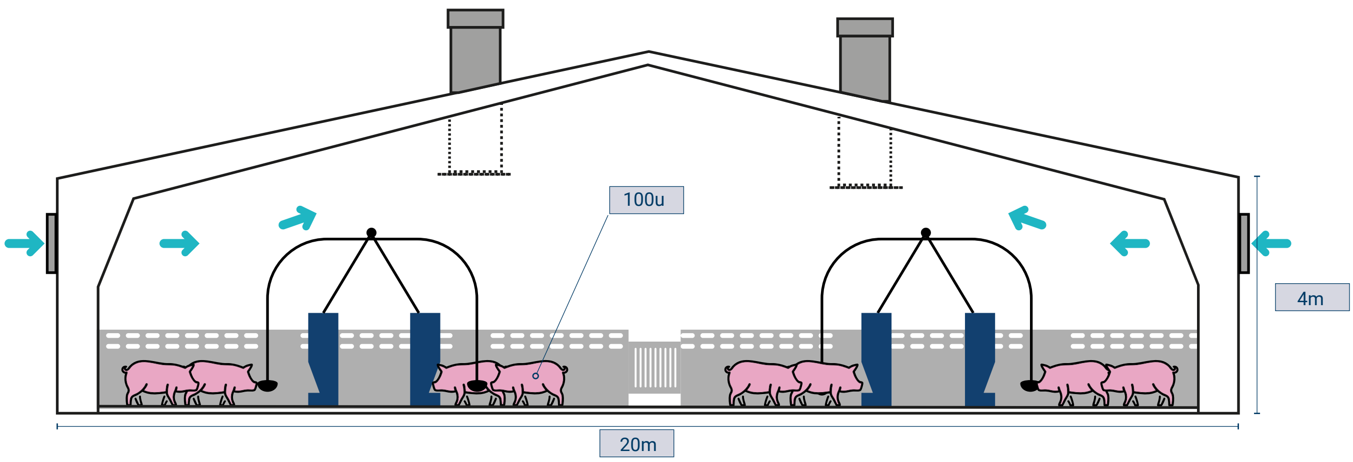
1. EXAMPLE DATA

Let's assume we have a farm with the following parameters:

- Farm size: 300 m² (15 m long x 20 m wide) and a height of 4 m.
- Number of pigs: 100u.
- Standard ventilation requirement: 6 air changes per hour (ACH), a typical value in farm environments to maintain air quality.

The total volume of the farm would be:

$$\text{Volume} = \text{Area} \times \text{Height} = 300m^2 \times 4m = 1200m^3$$



2. NECESSARY AIR FLOW

To meet the **6 air changes per hour**, the necessary air flow is:

$$\text{Air flow} = \text{Volume} \times \text{ACH} = 1200m^3 \times 6 = 7200m^3/h$$

3. PRESSURE DROP THROUGH THE HEPA FILTER

The pressure loss that a HEPA filter must overcome is related to its **pressure drop** (Pa: **Pascal**), which is generally in a range of **250 Pa initially with a clean filter up to 500 Pa with a dirty filter**, depending on the type and construction design of the filter.

For this example, let's take a pressure loss of **550 Pa** as the average value for the installation (duct system + prefilters (initial P: 60Pa) + filters (initial P: 100Pa) + HEPA (initial P: 250Pa))

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4. FAN REQUIREMENT AND ADJUSTMENT FOR PRESSURE LOSS

To compensate for the pressure loss through the HEPA filter, the ventilation system must be able to generate enough additional pressure to maintain adequate airflow. Industrial fans must be selected not only to generate the desired airflow (7200 m^3/h), but also to overcome the resistance of the filter.

Fan selection calculations are based on the relationship between **static pressure and airflow**. If we assume that the fan has to overcome a total pressure of **550 Pa**, we must size the fan to provide the 7200 m^3/h at that pressure.

Calculation summary:

1. For a 300m^2 farm with 100 pigs and 6 air changes per hour, the ventilation system needs to move **7200 m^3/h**.
2. When installing a HEPA filter, the fan must overcome a **pressure drop of 550 Pa**.
3. HEPA filters are highly effective against viral particles suspended in droplets, including PRRS.

COMMERCIAL SOLUTIONS OF CASALS VENTILACIÓN

The solution involves 3 fans with filter box: 3 x 2500m3/h@550Pa

System	Model	Quantity	Power	Link
System 1	**BOX RL 500 T4**	3	1.5 kW	see in Fanware
System 2	**KASTORM 454 T4**	3	1.1 kW	see in Fanware
System 3	**HMR EVO 450 T4**	3	1.1 kW	see in Fanware

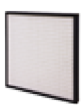
For each system mentioned above, 3 sets of filter batteries will be installed, consisting of a pre-filter (G4) + filter (M7) filtration box, and a HEPA filtration box (H13). In all cases, the **bag-in / bag-out** system is used to avoid cross-contamination during maintenance and filter replacement tasks.

Filtration box with pre-filter and filter:

- 1x CPCR S 1 (614x614x650) see in Fanware
  - 1x FILT ISO Coarse≥60% (592x592x48) SHEET METAL FRAME PREFILTER see in Fanware
  - 1x FILT ePM1≥50% (592x592x292) HIGH EFFICIENCY IN V MINIPLEATED see in Fanware

Filter box with HEPA:

- 1x HCPCR 1 see in Fanware
  - 1x FILT H13 (610x610x292) ABSOLUTE TURBULENT FLOW see in Fanware

FANS	 BOX RL	 KASTORM	 HMR EVO
FILTERS BATTERY	 CPCR S 1		 HCPCR
	 FILT ISO Coarse≥60%	 FILT ePM1≥50%	 FILT H13

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Upgrade option: photocatalysis lamp UVC TOWER

PHOTOCATALYSIS-UVC TOWER carries out a photocatalytic oxidation process that combines UV-C radiation with a substance (catalyst) titanium dioxide (TiO_2) that produces a reaction that transforms harmful contaminants (bacteria, viruses and volatile organic compounds or VOCs) into H_2O, CO_2 and detritus.

CALCULATION STANDARD USED

A typical general ventilation standard has been used to perform the calculation, which is 6 air changes per hour (ACH), common in many types of agricultural facilities. However, for pig farms, it is essential to take into account some specific factors that influence ventilation requirements, such as:

- **Temperature**: maintaining an adequate temperature range is crucial for pig welfare. Excessive heat or cold can increase stress, which directly influences the spread of diseases such as PRRS.
- **Humidity control**: ventilation must manage humidity levels to prevent the build-up of gases such as ammonia, which affects both animals and workers.
- **Noxious gas control**: in pig farms, ammonia and carbon dioxide levels can be significant, and ventilation must ensure that they are adequately diluted.
- **Stocking density**: ventilation requirements increase with the number of pigs per square metre.

Specific ventilation requirements on pig farms

- **Fattening pigs**: **60-80 m³ of air per hour per pig** is recommended under normal conditions, based on recommendations from experts in pig facility management.
- **Piglets**: Requirements can be lower, between **20-40 m³/h per piglet**, as they generate less heat and humidity than adult pigs.

For our example of 100 adult pigs on a 300 m² farm:

$$\text{Air flow} = 100 \text{ pigs} \times 70 m^3/h = 7000 m^3/h$$

This air flow is in line with the initial calculation of 7200 m³/h based on 6 ACH, but in this case adjusted to the specific ventilation needs of a fattening pig farm.

VORTICE GROUP COMPANIES / SOCIEDADES DEL GRUPO VORTICE

VORTICE S.P.A
Strada Cerca, 2
Frazione di Zoate
20067 Tribiano
(Milan) Italy
Tel. (+39) 02 906991
Fax (+39) 02 90699625
vortice.com

VORTICE LIMITED
Beeches House-Eastern
Avenue Burton upon Trent
DE13 0BB United Kingdom
Tel. (+44) 1283 492949
Fax (+44) 1283 544121
vortice.ltd.uk

VORTICE INDUSTRIAL S.R.L.
Via B. Brugnoli 3,
37063 Isola della Scala
(Verona) Italy
Tel. (+39) 045 6631042
Fax (+39) 045 6631039
vorticeindustrial.com

CASALS VENTILACIÓN AIR INDUSTRIAL S.L.
Ctra. Camprodon, s/n 17860
Sant Joan de les
Abadesses
(Girona) Spain
Tel. (+34) 972720150
casals.com

VORTICE LATAM S.A.
Bodega #6
Zona Franca Este Alajuela,
Alajuela 20101
Costa Rica
Tel. (+506) 2201 6934
vortice-latam.com

VORTICE VENTILATION SYSTEM
(Changzhou) Co.LTD
No. 388 West Huanghe Road
Building 19, Changzhou
Post Code: 213000 China
Tel. (+86) 0519 88990150
Fax (+86) 0519 88990151
vortice-china.com