FarmAir
luchtwassers

POULTRY AIR SCRUBBER

Chemical air scrubber with pre-washing and drop eliminator
for broiler houses

Poultry Air Scrubber for broiler houses

Manufacturer:
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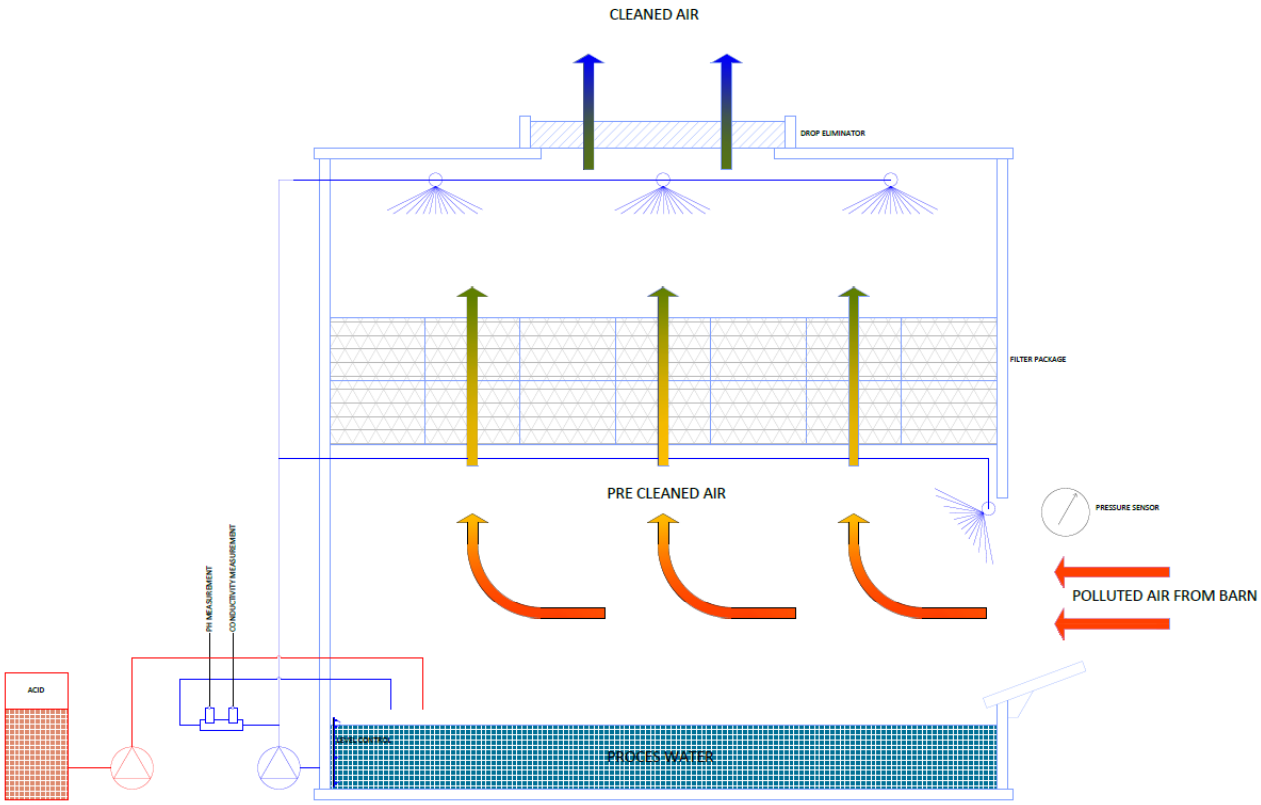
Description and technical information

The exhaust air cleaning system is a 1-stage chemical system for the cleaning of the exhaust air for broilers. Equipped with a pre-washing for dedusting and drop eliminator. With this the dust- and ammonia emissions of the chickens (occupation density till 39kg/m²) will be cleaned.
Figure 1 shows schematically the principal of the air washer.

Figure 1:



The principal of the wet scrubber is based on the operation of the trickle-fill filter with a set pH-value in the process water with a pH $\leq$ 3.3.

The exhaust air from the stable will be sucked in over the entire width of the scrubber and stripped from the coarse dust (feathers, food, and dust particles) with a pre-spraying system that will be mounted to the entire air intake side beneath the filter package. The used nozzles are prepared that the exhaust air of the stable through the form spray floated the same direction.

Afterwards the air will be guided through the filter package and sprayed continuously from above in the counter flow with the process water from the water storage reservoir. The large specific surface from the filling body serves to increase the contact surface between the exhaust air from the stable and the process water, for the separation of the ammonia and dust. Above the packaging (filter package) is a drop eliminator.

The drop eliminator occurs largely that the nitrogenous aerosol comes in to the environment.

The fans can be mounted before or after the air scrubber. From the used fans one or two will be frequency controlled to distract basic air speeds after the animals are housed. Dependent of the required ventilation, the other fans will be switched as unregulated.

If fans are mounted before the air scrubber a distance of at least 3 meters is required between fans and air scrubber. If fans are mounted after (on top of) air scrubber a distance of at least 1 meter is required between air scrubber and fans.

The process tank will be fully emptied after each fatting period for hygienic reasons. The acid dosing technique with conductivity detection doses acid in the process water. The process water circulates till the moment when the animals leave the stable.

During the certification the conductibility will be till 140mS/cm recorded. To prevent salinization in the filter package and to guarantee an average of 90% ammonia cleaning, a maximum conductivity of 140mS/cm can be certificated. If these values during the fattening period will be reached, a quantity water must automatically be deleted through the process pump from the water reservoir. This needs to be deleted so that the conductivity in the process water will be lowered. Usually at least 50% of the total water reservoir will be deleted and again filled with fresh water. The dilution effect lowers the maximum permissible conductivity of 140mS/cm. Because the operation of the washer leads to an increased water evaporation, both values (wastewater and freshwater consumption) will be saved in the digital logbook.

The water level will be regulated by four level sensors, which also protects the process pump against running dry.

To guaranteeing the separation performances which are described in Table 1, it is necessary that the air scrubber is continually running, i.e. from the 7th day of age the installation must be used as meant. There must be taken care of the fact that 70% of the maximum ventilation capacity that must be installed will be transported through the air scrubber. For airspeeds >70% from the design airspeed (definitive bred conditions in the summer), a partial flow can be drained through the emergency fans.

Testing and certification:

The product described in this brochure is applied to the Dutch and German market. For both countries, the product has been tested (according to national protocols and regulations) and certified.

Country: The Netherlands	
Certificate: BWL 2007.05.V6 (latest version from 11-2017)	
Ammonia removal efficiency:	90%
Odor removal efficiency:	40%
Dust removal efficiency (PM_{10}):	35%

Country: Germany	
Certificate: DLG 6260	
Ammonia removal efficiency:	± 91%
Dust removal efficiency (total):	87%
Dust (PM_{10}) removal efficiency:	77%
Dust ($PM_{2.5}$) removal efficiency:	93.7%

DLG-Signum certificate:

To substantiate the reduction values, you will find the measurement results from the DLG-Signum test report #6260 below:

Overview

The Signum-test is the extended use value-test of DLG according independent and recognized evaluation criteria for agricultural products. The DLG Signum-test judges neutrally the essential characteristics of the product, performances, animal welfare till the durability and safety at work. This will be tested and evaluated on the test benches and under different conditions of use, as well as the testing of the test object in a practical test in the operation.

The exact test conditions and -procedures, as well as the rating of the test results will be established by the respective independent audit committees in an appropriate audit and constantly adjusted to the state of the technic and scientific knowledge and the agricultural requirements. The tests will be executed in the following procedures that allow an objective assessment based on reproducible values. The successful test will be closed with a publication of a test report and the award of the test certificate.

In this DLG Signum-test is the 1-stage chemical washer with drop eliminator tested on fitness for reducing the emissions of the dust and ammonia from the exhaust airflow of the broilers stables. The basis for the test is an interpretation of the ventilation system according to the Animal Welfare Regulation, that yields an airflow release of 4.5m^3/(kg live weight · h).

The emission reductions of at least 70% of the total dust, is air dust (PM_{10}, $PM_{2.5}$) and ammonia like described in the test frame of the DLG Signum-test and a maximum odor concentration of 300 FU/m^3 exhaust air in the exhaust gas, whereof the smell a typical characteristic is of poultry which will not be tolerated. The requirements of ammonia, total dust, and the particle reduction will be in a reliable way met and surpasses with this air purification system for exhaust gases. The odor deposition is not certificated.

Rating - in a nutshell

The air purification system is a 1-stage chemical washer for the separation of dust and ammonia for broiler stables. The air purification system for the exhaust gases will be according the counter-flow principle used. After a pre-wetting of the supplied stable air for the separation of the coarse dust, comes the exhausted air in the filter package for ammonia and dust separation. The filter package will be horizontal installed in the air washer. Above the filter package a drop eliminator will be mounted to prevent aerosol discharge. The process water for spraying the filter package will be acidified till a pH-value of ≤ 3.3 with sulfuric acid. On the average the air purifier achieved during the test an ammonia separation of 91%. The total dust separation was 87% whereof the particle deposition PM_{10} at 77%, and $PM_{2.5}$ at 93.7%. The certificate included the most important parameters ammonia and dust.

Further results and determined consumption data are summarized in Table 1.

Table 1:
Overview of the results from the 1-stage air scrubber.

Criterion	Result		Value*
Emission measurements			
Total Dust (gravimetry, ten measurements moments)			
Summer (4 measurements): average separation efficiency	[%]	89.3	+
Winter (6 measurements): average separation efficiency	[%]	85.5	+
Fine Dust (gravimetry, five measurements moments)[1)]			
Summer (2 measurements)			
Average separation efficiency PM_{10}	[%]	72.5	○
Average separation efficiency $PM_{2.5}$	[%]	90.3	++
Winter (3 measurements)			
Average separation efficiency PM_{10}	[%]	81.5	+
Average separation efficiency $PM_{2.5}$	[%]	97.0	++
Ammonia (continuously measured, half-hour averages)[2)]			
Summer (2 measured periods) average separation efficiency	[%]	89.9	+
Winter (3 measured periods) average separation efficiency	[%]	91.6	++
N-accounting, N-taxes [3)]			
Sumer (2 passages)			
N-balance sheet recovery-rate	[%]	91	++
N-taxes	[%]	88	+
Winter (2 passages)			
N-balance sheet recovery-rate	[%]	103	++
N-taxes	[%]	91	++
Aerosol discharge (Sulfate)			
Summer (4 measurements) inorganic aerosol, average	[mg/m^3]	0.04	+
Winter (4 measurements) inorganic aerosol, average	[mg/m^3]	0.05	+

Consumption measurements (Average values per day or per animal place and year)					
Fresh water consumption					
Summer (2 passages)	[m³/d]	4.05	[m³/AP·y)]	0.04[4)]	N.R.
			[m³/AP·y)]	0.04[5)]	N.R.
Winter (2 passages)	[m³/d]	2.16	[m³/AP·y)]	0.02[4)]	N.R.
			[m³/AP·y)]	0.02[5)]	N.R.
Rinse amounts					
Summer (2 passages)	[m³/Psg]	5.0	[l/AP·y)]	0.95	N.R.
Winter (2 passages)	[m³/Psg]	5.0	[l/AP·y)]	0.95	N.R.
Acid consumption (based on 96% Sulphur acid)					
Summer	[kg/d]	15.7	[l/d]	8.4	N.R.
	[kg/(AP·y)]	0.17	[l/AP·y)]	0.09[4)]	N.R.
	[kg/(AP·y)]	0.10	[l/AP·y)]	0.06[5)]	N.R.
Winter	[kg/d]	12.6	[l/d]	6.7	N.R.
	[kg/(AP·y)]	0.14	[l/AP·y)]	0.07[4)]	N.R.
	[kg/(AP·y)]	0.08	[l/AP·y)]	0.04[5)]	N.R.
Use defoamer					
Summer	[kg/Psg]	1.8			N.R.
Winter	[kg/Psg]	1.8			N.R.

Electricity consumption					
Circulation pumps for exhaust air cleaning					
Summer	[kWh/d]	114.4	[kWh/(AP·y)]	1.22[4)]	N.R.
			[kWh/(AP·y)]	0.76[5)]	N.R.
Winter	[kWh/d]	111.2	[kWh/(AP·y)]	1.19[4)]	N.R.
			[kWh/(AP·y)]	0.77[5)]	N.R.
Ventilators stable					
Summer	[kWh/d]	69.3	[kWh/(AP·y)]	0.73[4)]	N.R.
			[kWh/(AP·y)]	0.55[5)]	N.R.
Winter	[kWh/d]	36.9	[kWh/(AP·y)]	0.39[4)]	N.R.
			[kWh/(AP·y)]	0.29[5)]	N.R.

* Valuation area: ++ / + / ○ / - / -- (○ = standard, N.R. = no rating)

[1)] According to experience the washing process can lead to the formation of droplets in the size range of 2.5 till 10 µm, which can cause an increased finding for the particle fraction PM_{10} in the cascade impactor. The particle fraction of $PM_{2.5}$ is less affected by this effect, that is why this particle fraction has calculated a higher separation efficiency than the fraction PM_{10}.

[2)] Attention for all the separation values from the 7th day of fattening (beginning of the scrubber), at which the concentration to unprocessed gas were higher than 3 p.m. (average degree of separation of all the half-hour averages).

[3)] The recovery factor of the N-balance sheet has a tolerance range of ±15% on a base of measurement uncertainties in the water analysis and the gas formation calculated N-taxes. With a recovery rate of >115% or <85% is further troubleshooting necessary.

[4)] Average values per day or per animal place and year are normalized to 365 days including animal losses.

[5)] Average values per animal place and year are standardized to 7.5 passages (DG) a year with a duration of the exhaust air treatment installation of 35 days (39,900 broilers).

Table 2:

Process engineering parameters of the air scrubber.

Characteristics	Result	
Description		
1-stage chemical washer with drop eliminator		
Fitness		
Cleaning of the stable exhaust air from the broilers with scattered string pellets to reduce dust and ammonia.		
Dimensioning parameters, packaging size, reference system		
Packaging		
Length/width/depth	[m]/[m]/[m]	14.4 / 6.6 / 0.6
Surface/volume	[m²]/[m³]	95.04 / 57.02
Maximum filter surface load	[m³/(m²·h)]	2,741
Maximum filter volume load	[m³/(m²·h)]	4,569
Flow at max. summer air speed	[m/sec]	0.76
Residence time at maximum summer air speed	[sec]	0.79
Drop eliminator		
Length/width/depth	[m]/[m]/[m]	14.4 / 4.2 / 0.125
Surface/volume	[m²]/[m³]	60.48 / 7.56
Maximum filter surface load	[m³/(m²·h)]	4,307
Maximum filter volume load	[m³/(m²·h)]	34,458
Flow at max. summer air speed	[m/sec]	1.20
Residence time at maximum summer air speed	[sec]	0.10
Pre-watering (continuous)		
Irrigation amount	[m³/h]	13.50
Sprinkling intensity	[m³/(h·m¹)]	0.94
Number of nozzles	[Pcs/ m¹]	0.8
Watering filter package		
Irrigation amount	[m³/h]	82.50
Irrigation density	[m³/(m²·h)]	0.87
Number of nozzles	[Pcs/m²]	0.25
Rinse		
Capacity wash water reservoir	[m³]	5.00
Drainage percentage per fattening period	[m³/Psg]	5.00
Average rinse distance	[m³/d]	0.119
Average rinse distance	[m³/(AP·y)]	0.001
pH-value process water	[1]	≤ 3.30
Maximum conductivity of the process water	[mS/cm]	≤ 140
Reference mode for executed measurements (farm with 39,900 broilers with roughage)		
Barn floor surface	[m²]	1,800
Maximum occupation density in the stable	[kg/m²]	39.00
Maximum summer airspeed according to "TierSchNutztV"	[m³/h]	315,900
Maximum installed exhaust airspeed through the air purification system for exhaust gases [1)]	[m³/h]	315,900
Max. installed air capacity house by 40 Pa pressure loss	[m³/h]	347,490
Number of fans	[Pcs]	8
Animal places	[Pcs]	39,900
Maximum live weight	[kg/animal]	1.90/2.71
Maximum pressure filterpackage (summer)	[Pa]	31
Maximum pressure drop eliminator (summer)	[Pa]	10
Total pressure loss by stable and exhausted air cleaning (summer) [2)]	[Pa]	60

[1)] Because of costs- and sizing reasons 70% of the maximum summer airspeeds that must be installed (design according to "TierSchNutztV") will be drained via the air scrubber (221,120 m³/h).

[2)] The extra pressure loss via the exhaust chimneys will not be taken into account and must be calculated with the 40 Pa, with the promotion of the maximum summer airspeed.

Maintenance and service:

In order to guarantee operation and reductions, an air scrubber requires attention from the farmer and the supplier.

Maintenance obligation farmer:

Checking the air scrubber on regular basis is a task for the farmer.
Alarm notifications must be checked and corrected, or if not possible, the farmer must contact the supplier. Also doing small maintenance jobs such as cleaning nozzles and filters is for the responsibility of the farmer.

The complete draining and cleaning of the air cleaning system between each fattening period is also a task for the farmer.

Maintenance obligation Supplier:

Upon delivery of the air scrubber, the supplier concludes a maintenance contract with the farmer.

<u>Periodic maintenance:</u>
The maintenance contract describes the periodic maintenance the supplier will carry out.
This includes: At least once every 6 months the conductivity- and pH meters are calibrated.

At least once every 12 months extensive maintenance is carried out on the basis of a checklist, with which all essential parts of the air scrubber are checked.

<u>Service:</u>
In the event of an alarm or malfunction, the farmer must contact the supplier.
The supplier will then ensure to resolve the alarm or malfunction as soon as possible.

<u>Preventive maintenance:</u>
Where preventive maintenance is desired or necessary, this will be carried out in consultation.

Thorough maintenance on a regular basis is essential for proper functioning and guaranteeing the reduction values of the air scrubber.

Product characteristics and equipment:

Housing:

The air scrubber is supplied in a full plastic casing, completely built from robust sandwich panel.

Thickness:	50 mm (2")
Wall thickness:	4,5 mm (0.18")
Material:	PP COPO - UV stabilized
Internal structure:	50 x 50 mm (2"x2") 100 x 50 mm (4"x2")
Weight:	± 13 kg/m² (2.66 lb/ft²)
Insulation value :	R [m²K/W] = 0.56
Colour:	UV beige (RAL 7032)

Filter package:

The air scrubber is equipped with a horizontal filter package. The filter package consists of 2 layers of plastic fills, with a total height of 60cm.

Dimensions of modul:	910 x 300 x 450mm (LxWxH)
Channel opening:	2x20 mm
Specific surface:	150 m²/m³
Channel structure:	crossflow
Material:	PP (UV-stabilized)

Nozzles:

Type:	Full cone nozzle
Material:	PVC
Angle:	150°

Mounted in a PP plastic pipe clamp with swivel ball joint and stainless steel spring.

Pumps:

The air scrubber is equipped with horizontal, sealless PP centrifugal pump(s) with permanent magnet drive system. These pumps do not have a mechanical seal, so there is no risk of leakage.

The separation of liquid chamber / atmosphere by means of an isolation shell is the best solution to pump aggressive chemical, high purity liquids and liquids difficult to seal.

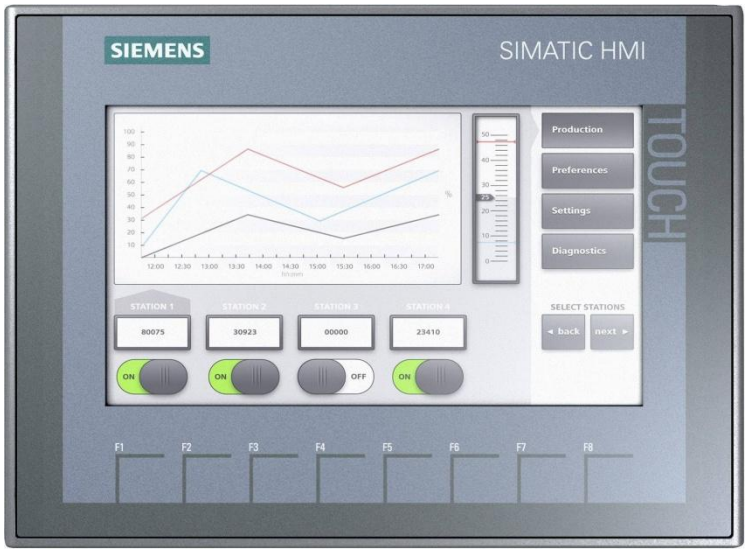
1.1kW and 2.2kW versions are applied, depending on the required capacity.

Danfoss drive(s) are used for fine tuning and energy saving of the pump(s)

Control system:

The air scrubber is equipped with a fully automatic control. The control system is built from Siemens components. Continuous measurement and registration of pH and conductivity ensure reliable operation.

The air scrubber can be operated using a user-friendly touch screen. The current status of the air scrubber can be read on the screen. Any alarm messages are also displayed.



The control system is equipped with automatic flush functionality based on the maximum conductivity.

Built-in router for remote support.
Data cable and internet access are required!

Datalogging:

A data logging system is integrated in the controls.
Hourly registration of:
- Acidity (pH) of the wash water
- Conductivity (mS) of the washing water
- waste water production (cumulative values)
- Pressure drop across the filter package
- Electricity consumption of the pump (cumulative values)

Data is stored on a SD-card in the PLC.

pH-inverter and sensors

Conductivity meter

Applied valves for fresh water intake and
draining of waste water are electrically controlled.
No compressed air connection is required.

Benefits of a FarmAir air scrubber at a glance:

- Bespoke design for every house / project
- Robust and spacious housing made of acid-resistant PP-UV plastic sandwich panel
- The prefab modules are guaranteed to be waterproof
- Separate splash-plate at the air inlet, to prevent splash water in to the pressure chamber.
- An open and thin filter package (60cm) to reduce resistance and easier maintenance/cleaning
- Reliable operation by adding sulfuric acid and a fully automatic control system
- Extra large outflow opening, for as little resistance as possible
- Good accessibility of the spaces under and above the filter package for regular cleaning
- Through the outflow opening the space above the filter package is accessible and can be walked on, this keeps the nozzles en filter easily accessible for cleaning
- Hose connections above the filter package for easy cleaning
- Bottom plate on a slope, so that sludge/contamination remains in a gutter in the front of the module and is more easy to scoop out
- If the air scrubber is placed on a construction, the gutter can also be fitted with a drain in the bottom plate
- Spacious control box for pumps and control equipment
- Continuous development of the system has resulted in an optimal price/quality ratio
- Multiple modules can be connected on site to 1 system
- Complete Siemens PLC control with built-in datalogging
- Built-in router for remote support
- Magnet drive (sealless)pumps with Danfoss drive
- No compressed air required, all valves are electrically controlled
- Water, power (3phase - 5 core cable) and data cable must be routed to the controlbox.
- Dosing pump for sulfuric acid and emergency shower are included
- Expert installation on site by our local supplier
- Full support from Farm Air and our local supplier