Big Dutchman International GmbH

MagixX-B exhaust air cleaning system

DLG Test Report 5952

DLG SIGNUM TEST
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DLG e.V.
Testzentrum
Technik und Betriebsmittel

Brief description

- single-stage, chemical exhaust air cleaning system consisting of several modules (up to 6) with type AK 150 plastic packed towers for the separation of total dust and ammonia
- continuous cross-flow irrigation of the scrubber with acidified wash water (pH 3.0 to 3.3) with the aid of pipes running over the towers
- for the irrigation of the exhaust air cleaning system, 40 m^3/h or 1.76 m^3/m^2h of wash water are circulated per module
- discontinuous sprinkling of filter walls with the aid of one sprinkling pump per module (capacity 21.7 m^3/h) for cleaning of filter walls as a result of high dust loads (run time: 1 minute every 5 minutes with 0.8 bar nozzle pressure)
- for sprinkling, one pump is installed per module, the nozzle assembly consists of 64 excentric hollow cone nozzles with 130° spray angle and a throughput of 5.66 l/min per nozzle
- daily, automated change of modules to ensure uniform application to filter walls during growing period by the control system, at high ventilation rates all modules are in operation simultaneously at the end of the growing period
- desludging of total wash water of 9.5 m^3 per module takes place after the end of a batch, wash water evaporation losses are replaced almost continuously with the aid of a min/max control

Assessment – summarised

Fig. 2:
Diagram of MagixX-B exhaust air scrubber

Summary 1:
MagixX-B exhaust air cleaning system from Big Dutchman

Test criterion	Result	Rating
Results of emission measurements*		
Total dust (gravimetric, 9 measurement times)		
Average separation from 9 measurements [%]	78.0	○
Ammonia (measured continuously)		
Total separation efficiency from half-hour mean values*	74.9	○
Recovery rate of separated nitrogen (N balance) [%]	> 70	not rated
Consumption measurements		
Fresh water consumption [m³/d]	1.74	not rated
Fresh water consumption with 9 batches per year [l/growing place and year]	13.7	not rated
Desludging volumes** [m³/d]	0.55	not rated
Desludging volumes related to growing place and year** [l/growing place and year]	6.4	not rated
Calculated acid consumption* with 9 batches per year [k**g/growing place and year]	0.11	not rated
Electricity consumption with 9 batches per year [kWh/growing place and year]		
– Exhaust air cleaning system ****	0.19	not rated
– Fans (without emergency ventilation)	0.50	not rated

* The continuous measurement was validated with the aid of additional impingement measuring due to very low ammonia concentrations.

** Desludging takes place after the end of a batch.

*** The value relates to the emission levels of the TA Luft (Technical Instructions on Air Quality Control), in low-emission broiler houses (like reference farm) acid consumption is lower.

**** without subsequently installed pump for pH control

Assessment range: ++ / + / ○ / – / – – (○ = Standard)

Test criterion	Result	Rating
Operating performance		
Technical reliability	no noteworthy disruptions to the system during the test	+
	periods, the acid dosage was improved during the measurements	
	and the improvement was confirmed by subsequent testing.	
Durability	no noteworthy wear during the test periods	+
Maintenance		
Operating instructions	clear operating instructions with good explanation of	+
	servicing tasks to be done and the automatic control system	
Operation	The system is fully automated when operated as intended.	○
	Before every batch, after putting down the litter,	
	additional cleaning of the water reservoir should be carried out	
	to clear the basin of coarse contaminants.	
Servicing	In addition to the recommended service contract between operator and	○
	manufacturer, additional daily function checks and general	
	cleaning work should be carried out after every batch.	
Cleaning of filtering surfaces	In addition to the thorough cleaning of filtering surfaces after every batch,	○
	cleaning of the filtering surfaces should be carried out at a differential pressure	
	of over 95 Pa. This is indicated via the control system	
	by an alarm signal.	
Work time required for daily checks	approx. 10 minutes per day	+
Work after end of batch	approx. 45 minutes per module for cleaning of reservoir and filters,	○
	calibration of pH probe and checking of nozzles	
Packed tower change	if operated as intended and continuously in accordance with	
	manufacturer's directions, not necessary	not rated
Documentation		
Technical documentation	Requirements met	+
Electronic operating logbook	Requirements met	+
Safety		
Industrial safety	confirmed by DPLF (German Testing and Certification Authority for	not rated
	Agricultural and Forestry Equipment)	
Fire safety	Fire protection concept is to be drawn up by the operator for the entire house	not rated
	as part of the building permit procedure.	
Environmental safety		
Noise emissions	no detectable increase in sound intensity level due to exhaust air cleaning system	○
Waste disposal	Disposal of sludge water to separate storage tank,	○
	direct agricultural use possible.	
	Disposal of other system parts by recognised recyclers.	
Guarantee		
Manufacturer's warranty	2 years	

Bewertungsbereich: ++ / + / ○ / – / – – (○ = Standard)

Description and dimensions

Summary 2:
MagixX-B exhaust air cleaning system

Feature	Result / Value
Description	
modular, single-stage exhaust air cleaning system (chemical scrubber) with pre-sprinkling	
Suitability	
Cleaning of exhaust air from short-term poultry growing (up to 35 days) with a litter quantity of 0.5 to 1 kg/m² to reduce dust and ammonia (litter type: cereal straw, wood chippings or other materials with a DM content > 70 % and a particle size < 7 cm)	
MagixX-B dimensioning parameters	
Dimensions of filter wall (scrubber)	
– Packed tower width/height/depth per module [m/m/m]	8.4 / 2.7 / 0.15
– Flow surface per module/tower volumes per module [m²]/[m³]	22.7 / 3.4
– Number of modules on reference farm	3
– Specific tower surface area [m²/m³]	270
– min. residence time at max. summer air flow rate [sec]	0.19
– Maximum tower surface area load [m³/m²h]	< 2,866
– Maximum tower volume load [m³/m²h]	< 19,107
Irrigation (continuous)	
– Irrigation density [m³/m²h]	1.76
– min. wash water [l] per m³ exhaust air	0.62
Desludging	
– Capacity of wash water reservoir of reference system (3 modules) [m³]*	28.5
– Specific capacity [l/growing place]	0.71
– Desludging rate min. to max. during testing [m³/d]	After the end of a grow-out the wash water is replaced in its entirety.
– Desludging rate with 9 batches [l/growing place and year]	6.4
– pH of wash water	< 3.3
Reference farm for measurements carried out (short-term poultry growing, floor management)	
Growing places [number]	40,000
Litter quantity	0.5 to 1.0 kg/m²
Litter type	Cereal straw, wood chippings or other materials with a DM content > 70 % and a particle size < 7 cm
Feed	Adjusted crude protein feed
Installed air flow rate [m³/h]	195,000 m³/h (65,000 m³/h per module) (3 modules with 3 fans with 21,667 m³/h) at 115 Pa pressure loss)** Emergency ventilation: additional 78,000 m³/h at 20 Pa pressure loss, exhaust air routing in bypass
Maximum air change rate in summer according to DIN 18910 [m³/h growing place]	4.74
Maximum air change rate incl. emergency ventilation and safety margin [m³/h growing place]	7.42

* During testing the capacity was 19.2 m³; afterwards, the capacity was increased to bring reliability up to 28.5 m³ (9.5 m³ per module).

** at the maximum pressure loss of 20 Pa via house and 95 Pa via exhaust air cleaning, 65,000 m³/h were still produced per module.

Test results

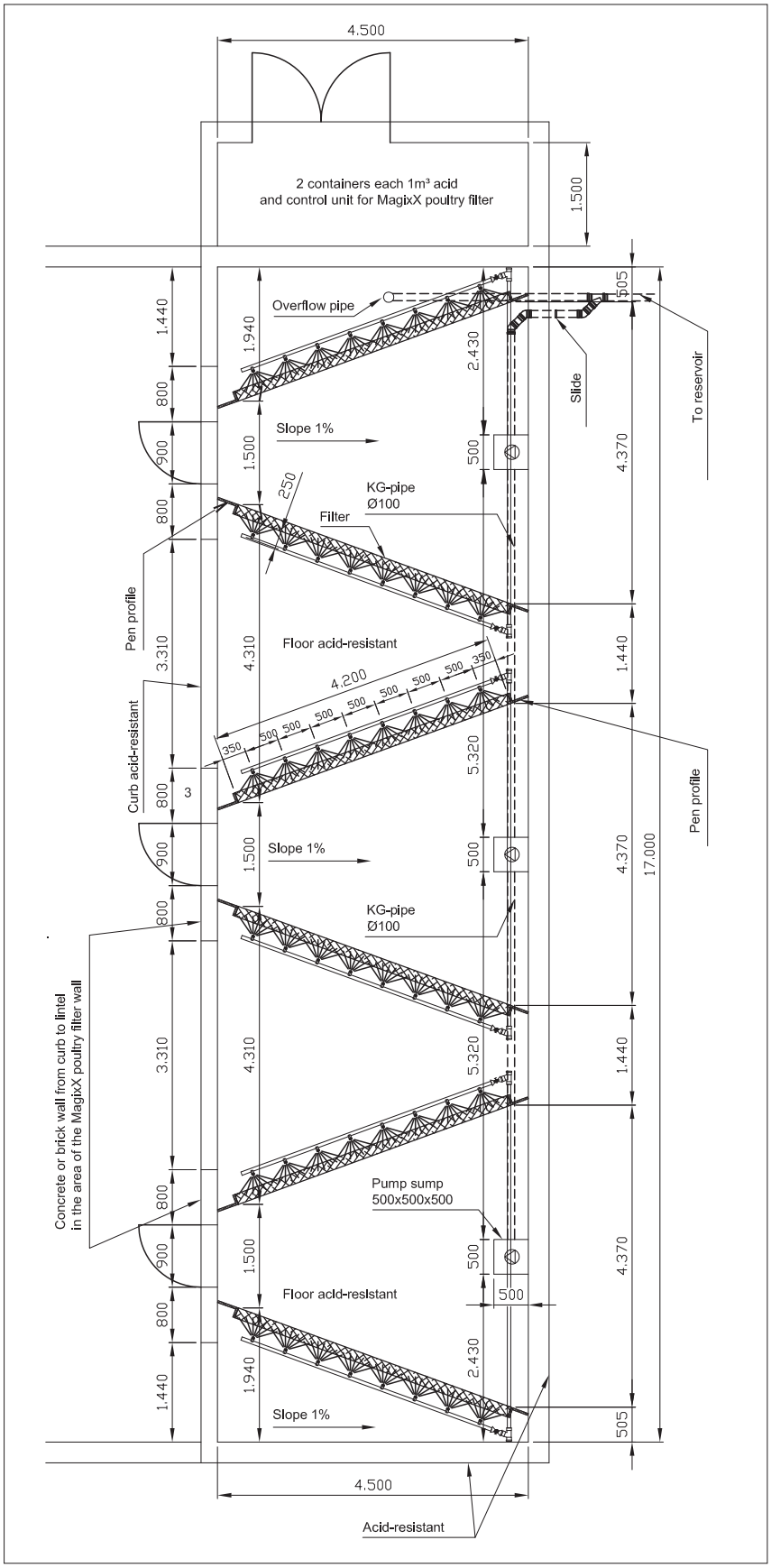

Fig. 3:
Top view of exhaust air cleaning system on the reference farm.
The exhaust air exits the house on the left of the figure and is sprinkled in the direction of flow.

Suitability

The single-stage exhaust air cleaning system is suitable for reducing emissions of dust and ammonia in exhaust air flows from short-term poultry growing units (< 35 days) using litter consisting of cereal straw or wood chippings with a dry matter content > 70 %, litter quantity of 0.5 to 1.0 kg/m² and particle size < 7 cm. Provided the ventilation is designed to DIN 18910 and the process engineering parameters described are adhered to, the exhaust air cleaning system separates ammonia with ≥ 70 % efficiency and dust with ≥ 70 % efficiency.

Description/Function

The "MagixX-B" exhaust air cleaning system is a system for reducing ammonia and dust emissions, operated using negative pressure and designed specifically for the requirements of broiler production.

The exhaust air cleaner is in the form of a chemical scrubber.

The system is of modular construction: according to the manufacturer, each module is capable of guaranteeing the necessary ammonia and dust separation at a maximum air volume flow of up to 65,000 m³/h at 115 Pa in short-term broiler production. A module consists mainly of two packed tower walls with a total area of 22.68 m², an irrigation pump with 40 m³/h delivery capacity, a sprinkler pump with 21.7 m³/h delivery capacity and three fans. A system can be operated with up to 6 modules.

The exhaust air is extracted from the grow-out house and conducted to the exhaust air cleaning system. The air for cleaning enters the tower packing of the MagixX-B from the front. Preliminary dust removal is carried out by appro-

priate, timed-interval sprinkling with wash water (sprinkler pump). The sprinkling also gives the towers a rough clean. The type AK 150 towers are irrigated continuously from above in cross-flow. The ammonia in the exhaust air bonds to the acidified wash water. The pH of the wash water must be 3.0 to 3.3. The specific area of the towers serves to increase the contact area between exhaust air and water to promote the physical and chemical absorption of dust and ammonia. Because ammonia is highly soluble in acidified water, it is washed out into the process water where the ammonia is trapped chemically (ammonium combines with sulphuric acid to give ammonium sulphate) and physically (higher ammonia absorption capacity due to acidified wash water).

The wash water is desludged after the end of the grow-out, up to 35 days. Any evaporation losses are replaced by means of a float valve.

Due to the modular construction, the exhaust air is admitted to a different module each time at the start of the growing period, alternating on a daily basis. This module change takes place automatically and is triggered by the climate computer, which starts up the fans of the relevant module. Towards the end of the grow-out, when a correspondingly high exhaust air volume (approx. 65,000 m³/h per module is required, all of the modules run in parallel. The control of these processes is assumed by both the house climate computer and the controller (electronic operating log) of the exhaust air cleaning system.

Test conditions/ reference house

In the reference house where the measurements were carried out, up to 40,000 broilers were kept in short-term growing (max. 35 days) and floor management using a litter of cereal straw or wood chippings with a DM content of > 70 % and particle size of < 7 cm. The litter quantity in this house was between 0.5 and 1.0 kg/m². The feed used in the reference house was adjusted crude protein (ACP) feed. The exhaust air was extracted from the grow-out house by the air cleaning system using negative pressure, by three fans per module. The system consisted of three modules.

The ventilation equipment was designed to DIN 18910. Accordingly, the maximum air flow rate was supposed to be approx. 189,000 m³/h. At a pressure difference of 115 Pa via the air cleaning system and house, the ventilation still delivers a ventilation rate of 195,000 m³/h. To meet the maximum air flow rate in summer, emergency ventilation is also installed. With a pressure loss of 20 Pa, it delivers an additional 78,000 m³/h in total. The use of emergency ventilation allows air volume peak flows (interpreted according to the Lower Saxony Broiler Order) to be discharged without cleaning. The ventilation of the house produces a pressure loss of 20 Pa. This means that the pressure loss via the air cleaning is limited to 95 Pa.

During the winter measurements, insufficient acid dosage was observed. The pipes became blocked, so adequate distribution of the acid was not guaranteed. As a result the manufacturer installed an additional centrifugal pump. This pump draws water from an additional reservoir with a volume of min. 100 l, which is fed with approx. 3 m³/h from an irrigation pump bypass. Each module now has a separate inlet pipe for pH control. This also ensures that the pH measurement is carried out on the module currently in operation. The additional pump in the closed circuit guarantees uniform, blockage-free return flow. The pump capacity must be 3.3 m³/h per module, so for the 3 modules connected here at least 9.9 m³/h.

Environmental conditions (temperature outside/inside, relative humidity outside/inside) were recorded continuously during the measurements and the following parameters were documented on the dust and odour measurement days:

– Number and weight of birds (estimated)

– NH3 concentration at bird level

– Consumption of fresh water and electricity (meter readings)

– Absolute air volume flow

In addition, the measurement values given by the manufacturer in the electronic operating log were checked for plausibility.

Dust

At the start of the measurements it was agreed that four total dust and two PM 10 and PM 2.5 dust measurements per measurement period would be carried out during both summer and winter. Because the separation efficiency for total dust required according to test standards was not met at the start of the summer measurements, two additional total dust measurements were arranged subsequently for the winter measurements. In addition, the total dust measurements during the winter were carried out only from the third week of the growing period, because noteworthy total dust loads did not occur until after that.

Samples were taken isokinetically in accordance with VDI Guideline 2066 and each sample was assessed one day after being taken, because the samples were first dried to constant weight in the drying chamber.

As Table 1 shows, the separation efficiencies for total dust on three measurement days were > 70 % in both modules and 62 % in module 2 on one measurement day. On that day the dust load was

Table 1:
Measurement results concerning emission reduction by the MagixX-B exhaust air cleaning system (summer measurements)

Date	19.08.2009	25.08.2009		31.08.2009		07.09.2009	
Measurement site*	Module 2	Module 2	Module 1	Module 2	Module 1	Module 2	Module 1
Environmental and boundary conditions							
rel. humidity environment	49 %	62 %		50 %		51 %	
Ambient temperature	26.3 °C	24.1 °C		21.8 °C		19.5 °C	
Untreated gas/clean gas moisture	46/100 %	65/100 %	60/100 %	60/100 %	70/100 %	70/100 %	70/100 %
Untreated gas/clean gas temperature	24 / 22 °C	27 / 24 °C	24 / 19 °C	24 / 19 °C	22 / 19 °C	22 / 19 °C	22 / 19 °C
Number of birds in house	41,385	41,263		40,835		40,044	
∅ Live weight (total)	13,740 kg	25,666 kg		40,835 kg		62,879 kg	
Air volume flow Total	49,760 m³/h	123,000 m³/h		163,000 m³/h		225,000 m³/h	
Dust							
Concentration untreated gas	0.95 mg/m³	1.48 mg/m³		2.59 mg/m³		1.91 mg/m³	
Concentration clean gas	0.36 mg/m³	0.33 mg/m³	0.34 mg/m³	0.30 mg/m³	0.22 mg/m³	0.22 mg/m³	0.40 mg/m³
Separation efficiency	62.1 %	77.7 %	77.0 %	88.4 %	88.4 %	88.5 %	79.1 %
Ammonia							
Concentration untreated gas**				0.75 mg/m³		1.65 mg/m³	
Concentration clean gas**				0.15 mg/m³	0.18 mg/m³	0.17 mg/m³	0.31 mg/m³
Separation efficiency				79.9 %	75.8 %	89.7 %	81.2 %

Table 2:
Measurement results concerning emission reduction by the MagixX-B exhaust air cleaning system (winter measurements)

Date	11.02.2010	15.02.2010	16.02.2010	19.02.2010	19.02.2010	22.02.2010	22.02.2010	23.02.2010	23.02.2010
Measurement site	Module 2	Module 1	Module 2	Module 2	Module 2	Module 2	Module 1	Module 1	Module 2
Environmental and boundary conditions									
rel. humidity environment	82 %	84 %	76 %	82 %	82 %	81 %	81 %	81 %	81 %
Ambient temperature	-2.4 °C	-4.4 °C	0.0 °C	6.5 °C	6.5 °C	6.1 °C	6.1 °C	1.8 °C	1.8 °C
Untreated gas/clean gas moisture	55/100 %	59/100 %	70/100 %	57/100 %	57/100 %	76/91 %	80/100 %	80/100 %	80/100 %
Untreated gas/clean gas temperature	18.3 / 16.2 °C	18.0 / 16.0 °C	19.7 / 17.1 °C	19.0 / 17.0 °C	19.0 / 17.0 °C	18.8 / 16.6 °C	19.3 / 16.0 °C	19.5 / 16.3 °C	19.1 / 15.1 °C
Number of birds in house	39,805	39,738	39,714	39,684	39,684	39,634	39,634	39,624	39,624
∅ Live weight (total)	24,201 kg	34,453 kg	35,743 kg	43,652 kg	43,652 kg	51,247 kg	51,247 kg	51,234 kg	51,234 kg
Air volume flow Total*	26,940 m³/h	33,327 m³/h	37,942 m³/h	57,289 m³/h	57,289 m³/h	71,987 m³/h	71,987 m³/h	62,072 m³/h	62,072 m³/h
Dust									
Concentration untreated gas	3.89 mg/m³	5.14 mg/m³	7.40 mg/m³			7.08 mg/m³	5.41 mg/m³	6.27 mg/m³	7.35 mg/m³
Concentration clean gas	0.96 mg/m³	1.42 mg/m³	2.07 mg/m³			1.20 mg/m³	1.13 mg/m³	1.69 mg/m³	1.37 mg/m³
Separation efficiency	75.3 %	72.4 %	72.0 %			83.0 %	79.1 %	73.0 %	81.4 %
Ammonia									
Concentration untreated gas*			4.91 mg/m³	3.58 mg/m³	3.35 mg/m³	Due to an acid dosage failure the necessary measurement results were not obtained; subsequent measurements were arranged.			
Concentration clean gas*			1.23 mg/m³	1.00 mg/m³	1.02 mg/m³				
Separation efficiency			74.9 %	72.0 %	70.0 %				

* at the outset it was decided that measurements would be carried out only in modules 1 and 2 because module 3 was taken into operation only towards the end of the grow-out. Grey boxes: no measurement carried out due to very low untreated gas concentrations

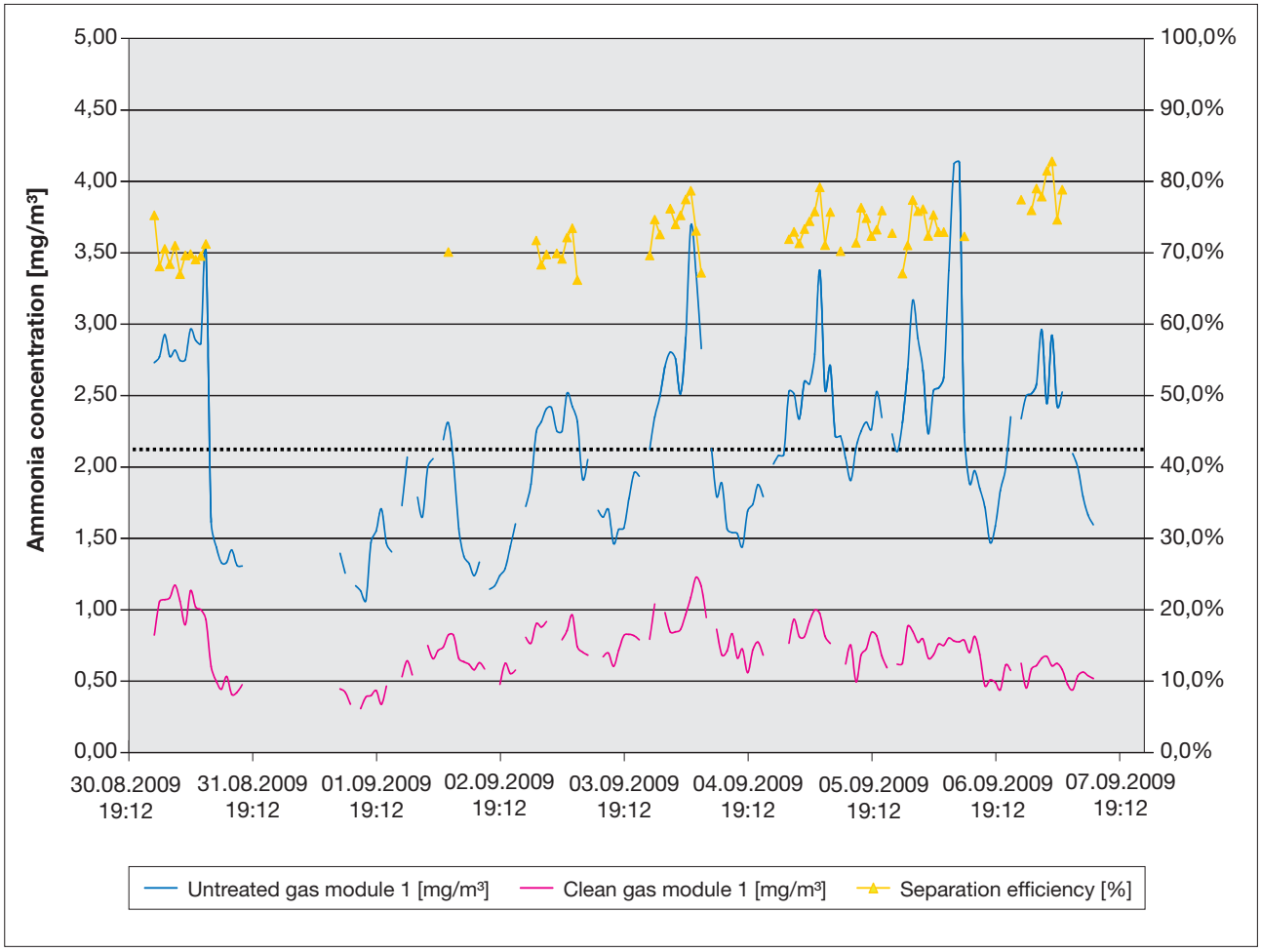

Fig. 4:
*Changes in ammonia concentrations in untreated and clean gas and separation efficiency between 30.8.2009 and 7.9.2009**

extremely low. Additional measurements were then arranged during the winter (see Table 2). For the given boundary conditions, the separation efficiencies established during the 6 total dust measurements in the winter were well above 70 % in some cases, indicating that effective dust separation in short-term broiler production is possible using the Big Dutchman's "MagixX-B" exhaust air cleaning system. Even for PM 10, a separation efficiency of over 70 % was found. For the separation of PM 2.5, the separation efficiencies were > 60 %.

Ammonia

Due to the low NH3 concentration in the untreated gas and because this concentration, at least for the clean gas values, was in some cases below the 1 ppm limit of determination of the continuous ammonia measurement technique (FTIR), it was noted that continuous ammonia measurements are meaningful only during the last two weeks of the summer. Where the untreated gas values here were below 3 ppm, these values were not rated according to DLG test standards "Exhaust air cleaning in livestock keeping (as at 06/2008)", because the clean gas values are below the 1 ppm limit of determination at a separation efficiency of 70 %. Further ammonia measurements were carried out regularly using the impingement process (see Tables 1 and 2), an enrichment process using wet chemical analysis. Based on the relatively low ammonia concentration in the untreated gas, the restriction concerning suitability specified the quantity and type of litter (see Suitability).
Tables 1 and 2 show that the untreated gas values during the summer and winter measurements in September and January varied between 0.75 und 4.91 mg/m³ and the separation efficiency of the exhaust air cleaning system for ammonia was therefore over 70 %. Effective ammonia separation in short-term broiler production is

* According to DLG test standards, 70% separation efficiencies are required only if the ammonia concentration in the untreated gas is over 3 ppm (conversion factor from ppm to mg/m³: 0.708).

therefore guaranteed if the system is operated properly under the described operating conditions (growing period, type and quantity of litter).

During the summer measurements, the untreated and clean gas values shown in Fig. 4 were established for the period from 30.8.2010 to 7.9.2010. Separation efficiencies of between 70.2 % and 86.4 % were found.

Nitrogen balance

The nitrogen separation of the exhaust air cleaning system was verified by means of a nitrogen balance taking account of the ammonia loads (untreated and clean gas), the aerosol discharge (clean gas), the nitrogen oxides in the clean gas and the nitrogen compounds dissolved in the wash water. This means that the nitrogen separated by the exhaust air cleaning system from the ammonia in the untreated gas in the form of ammonium, nitrite and nitrate in the wash water and the residual emissions of ammonia and nitrogen oxides in the clean gas were demonstrated.

During the measurements the nitrogen balance showed that a recovery rate > 70 % was achieved.

Consumption figures

Water consumption

The total wash water has to be desludged after the end of the grow-out and then replaced with fresh water for the next batch, so the water consumption is essentially due to the desludging and evaporation losses and is therefore weather-dependent.

The fresh water consumption was established during the measurement period using a water meter. The assessment of the individual meter readings resulted in average consumption of 1.74 m³ of fresh water per day for the measurement period. This corresponds to a fresh water consumption of 13.7 l per growing place and year.

The desludging volume per growing period is 28.5 m³ at the end of the grow-out. Per module, this corresponds to a desludging rate of 9.5 m³ or 6.4 l per growing place and year.

Electricity consumption

The biggest users of electricity in the exhaust air cleaning system, by some distance, are the pumps (continually operated circulation pump) and the fans, which have to be larger than in clean house ventilation due to the additional pressure loss in the exhaust air cleaning system. On average, the following figures were recorded during the entire measurement period (summer and winter):

Exhaust air cleaning system:
0.19 kWh per growing place and year

Fans:
0.50 kWh per growing place and year

The acid dosing pump that was installed subsequently was not taken into account in establishing the energy consumption. Due to the low pump capacity, however, the effect in terms of expected additional energy consumption is minor.

Other consumption figures

The chemical bonding of ammonia in the wash water requires the use of sulphuric acid. Taking into account the emission factor for broilers of 0.049 kg of NH3 per growing place and year, including the established ammonia separation efficiency of 74.9 %, the calculated requirements in terms of sulphuric acid requirement are 0.11 kg per growing place and year.

Reliability and durability

Improvements were made to the system technology during the test period. For example, the mixing of the acid added to the wash water was inadequate. However, this problem was eliminated and the performance of the adjusted acid dosing was confirmed by subsequent measurements.

No noteworthy damage or wear affected the exhaust air cleaning system as a whole during the trial. The corrosion protection of the individual system parts appears to be sufficiently durable, as far as could be observed during the trial period.

Documentation

The data recorded in the electronic operating logbook are shown in Summary 3. The storage time should be at least 5 years.

Maintenance and work time requirements

To operate the system, it is necessary to receive instruction from the manufacturer and to familiarise oneself with the operating instructions.

After the system has been put into operation, the supply pump in the water reservoir must be checked daily. In addition, the pH control including circulation pump and acid tank filling level should be checked. To ensure adequate sprinkling of the packed towers, daily visual inspection of the nozzles should be carried out. Operating parameters such as pressure loss via the system and air flow rate should also be checked daily in the controller. These tasks require an estimated 45 minutes' work time.

The work time required for the daily checks is estimated at approx. 10 to 15 minutes.

The pH probe should be calibrated after every batch, requiring an estimated 10 minutes of work time. If a service contract is signed, additional calibration is carried out by the manufacturer every six months.

Summary 3:
Meeting of requirements concerning the MagixX-B electronic operating logbook

	met in full	met in part	not met	Comments
Pressure loss over the exhaust air cleaning system	X			Pressure loss is measured over every module.
Air flow rate	X			The air flow rate is determined on the basis of the characteristic ventilation curve in the system for each module.
Pump pressure	X			The irrigation pump pressure is determined for each module.
pH	X			The pH is recorded continuously.
Calibration of pH sensors		X		The pH probe used must be calibrated by the operator after the grow-out, the proof is established manually (entry in operating logbook). If a service contract is signed, additional calibration is carried out by the manufacturer every six months.
Irrigation interval		X		Irrigation is constant. Sprinkling is at timed intervals and is not recorded in the electronic operating logbook.
Total fresh water consumption of scrubber	X			The fresh water supply is included in the electronic operating logbook
Desludged water quantity and residue				Not required, because desludging takes place after the end of a batch.
Spray pattern check	X			Regular manual entry in operating logbook prescribed
Servicing and repair times	X			Regular manual entry in operating logbook prescribed

Servicing requirements

After the end of a batch, the towers should be cleaned using a high-pressure cleaner. According to the manufacturer of the exhaust air cleaning system, the high-pressure cleaner should have a delivery rate of 26 l/min at 180 bar. If the pressure losses of the whole system exceed 100 Pa (displayed in the system's controller), cleaning should be carried out during the growing period.

The process water should be changed after the end of a batch. The concrete basin of the wash water reservoir should then be cleaned using a high-pressure cleaner. After putting down litter in the house, the basin of the wash water reservoir should be free from contaminants (e.g. straw, plastic).

After a batch the nozzles in front of the towers should be checked. If dirty, they should be disassembled.

In addition to the described servicing tasks to be carried out by the operator, the manufacturer recommends that a service contract is taken out. If no contract is taken out, the following additional tasks should be carried out every six months:

- Checking of pumps (pump pressure, operation)
- general function test and visual inspection of whole system
- Flushing of irrigation pipes
- Checking of nozzles and cleaning if necessary

Operating instructions

The operating instructions broadly describe the operation of the plant and tell the operator which tasks to carry out on the system on a daily, weekly or annual basis. The operation of the exhaust air cleaning system is largely automated.

The electronic operating logbook allows the complete recording of all data necessary for the safe operation of the system. The records are kept for 5 years. The authorities or the operator can access these data using a USB

stick. The data can be produced as an Excel file or in pdf format.

The operating manual describes daily, weekly and additional tasks after the end of a batch. These checks should be documented in writing in the service book provided.

Environmental safety

The volume of desludged water depends on the number of modules in operation. In the reference system, three modules were connected and the desludging quantity was 28.5 m³ per batch. Direct mixing of the desludged water with slurry is not permitted, because this leads to the release of hydrogen sulphide. The necessary storage capacity indicated by the manufacturer is 9.5 m³ per batch and module. With 9 batches per year, therefore, additional annual separate storage capacity of approx. 257 m³ is required. The sludge container should be designed to permit 6 months' storage capacity.

According to the manufacturer, the disassembly and disposal of other system parts can be undertaken by recognised recyclers.

The operation of the system requires the use of acid. Its handling is explained in operating instructions provided by the manufacturer.

Safety aspects

Fire safety is ensured by a relevant fire protection concept, to be attached to any necessary building application and drawn up by the operator.

The MagixX-B system from Big Dutchman described here has been approved by the German Testing and Certification Authority for Agricultural and Forestry Equipment (DPLF). There are no objections to the use of the system from an industrial safety perspective.

Guarantee

The manufacturer gives a two-year manufacturer's warranty on the exhaust air cleaning system. The guarantee is conditional upon the proper operation of the system, including the correct keeping of the operating logbook.

Survey results

A survey of owners of similar exhaust air cleaning systems could not be carried out during the test period because the system tested was a prototype.

Testing

Testing was carried out in accordance with DLG test standards "Exhaust air cleaning systems for livestock keeping systems (as at 06/2008)".

The measurements were carried out on a reference system in Bakum at a maximum exhaust air volume flow of 233,000 m³/h. The total testing period was 22 months.

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