DLG Test Report 7449

Grillo-Werke AG

ImproBed®

Ammonia emission reduction

www.DLG-Test.de

Overview

A test mark 'DLG-APPROVED for individual criteria' is awarded for agricultural products which have successfully fulfilled a scope-reduced usability testing conducted by DLG according to independent and recognised evaluation criteria. The test is intended to highlight particular innovations and key criteria of the test object. The test may contain criteria from the DLG test scope for overall tests, or focus on other value-determining characteristics and properties of the test subject. The minimum requirements, test conditions and procedures as well as the evaluation bases of the test results will be specified in consultation with an expert group of DLG. They correspond to the recognised rules of technology, as well as scientific and agricultural knowledge and requirements. The successful testing is concluded with the publication of a test report, as well as the awarding of the test mark which is valid for five years from the date of awarding.

The DLG test for 'Indoor processes for emission reduction' tests the effectiveness of process-integrated measures that prevent or reduce the occurrence or the release of harmful substances within the stable area itself. Such emission-reducing measures can include, for instance, special feeding strategies or the use of special feed additives, litter materials, feeding, drinker and climate control technologies.

Besides their emission-reducing effects, the process-integrated measures can also have positive effects on animal health and animal welfare, energy and water consumption and on the livestock farmer's working conditions.

The DLG Testing Framework 'Indoor processes for emission reduction' includes methods for testing and evaluating systems for reducing:

– ammonia emissions,

– dust emissions and

– noise emissions.

The DLG test mark is awarded on the basis that the ventilation system is designed in accordance with DIN 18910, operation is carried out subject to compliance with the German Animal Protection and Keeping of Production Animals Ordinance (TierSchNutztV) and the provision of proof that the process used is sufficiently effective compared to an untreated control facility.

The relative reduction capacity of the tested process compared to the untreated reference is used as the evaluation standard. The reference variables used for this are the calculated mass flows or emission factors.

In this test, the ImproBed® litter treatment was analysed with regard to its effectiveness in reducing ammonia emissions in broiler fattening facilities. Its effects on dust and odour emissions were not part of the test.

No criteria other than the product's effectiveness in reducing ammonia emissions in broiler fattening facilities were tested.

The level of emission reduction in this DLG test report describes the percentage difference in ammonia emissions between the case and control facility. Emission factors derived from this are indicated without evaluation.

Assessment in brief

The ImproBed® litter treatment from Grillo-Werke AG demonstrated its effectiveness in reducing ammonia emissions in broiler fattening facilities in the DLG test. The test was conducted in accordance with the DLG Testing Framework 'Indoor processes for emission reduction'. The tests took place at two independent test locations on farms (TF = test farm). In order to assess the ammonia reduction potential, parallel measurements were carried out with and without treatment (case and control facility) under otherwise comparable conditions (case-control approach). The measurement scope undertaken in each location encompassed three complete fattening cycles under winter, transitional and summer conditions. At the test locations, the case and control facilities were exchanged after each cycle so that each poultry house was used as a case facility at least once. The relative reduction capacity of the tested process compared to the untreated reference is used as the evaluation standard. N- and P-reduced feeding and drinker cups are used on both farms. At 0.0209 kg per Animal Place (AP) and year and 0.0164 kg/(AP · a) respectively, the emission factors of the two control facilities were already at a very low level. During the test, ImproBed® additionally achieved an ammonia reduction level of 58.2 % on average over both farms and all measurement series compared to the untreated control facilities.

Emission factors of 0.0090 and 0.0068 kg/(AP · a) were achieved in both case facilities.

N- and P-reduced feeding results in a reference emission factor of 0.0437 kg/(AP · a) as defined in the currently valid German Technical Instructions on Air Quality Control (TA Luft). This reference value for broilers fattened for 42 days was significantly undershot on both farms (Figure 2).

The tested process did not reveal any significant influences on feed conversion or the mortality rates. The achieved reduction levels refer only to littered poultry house with broilers fattened for 42 days. The effects on dust and odour emissions were not tested. Corrosive effects on stable components during the test were not the subject of this test.

The result of the test is summarised in Table 1.

Table 1:
Overview of results

DLG QUALITY PROFILE	Evaluation*
Ammonia emission reduction	■ ■ ■ ■ ■

* The DLG test framework specifies the following evaluation range: ■ ■ ■ or better = meets, exceeds or clearly exceeds the specified DLG standard, ■ ■ = meets the statutory requirements for marketing the product, ■ = failed

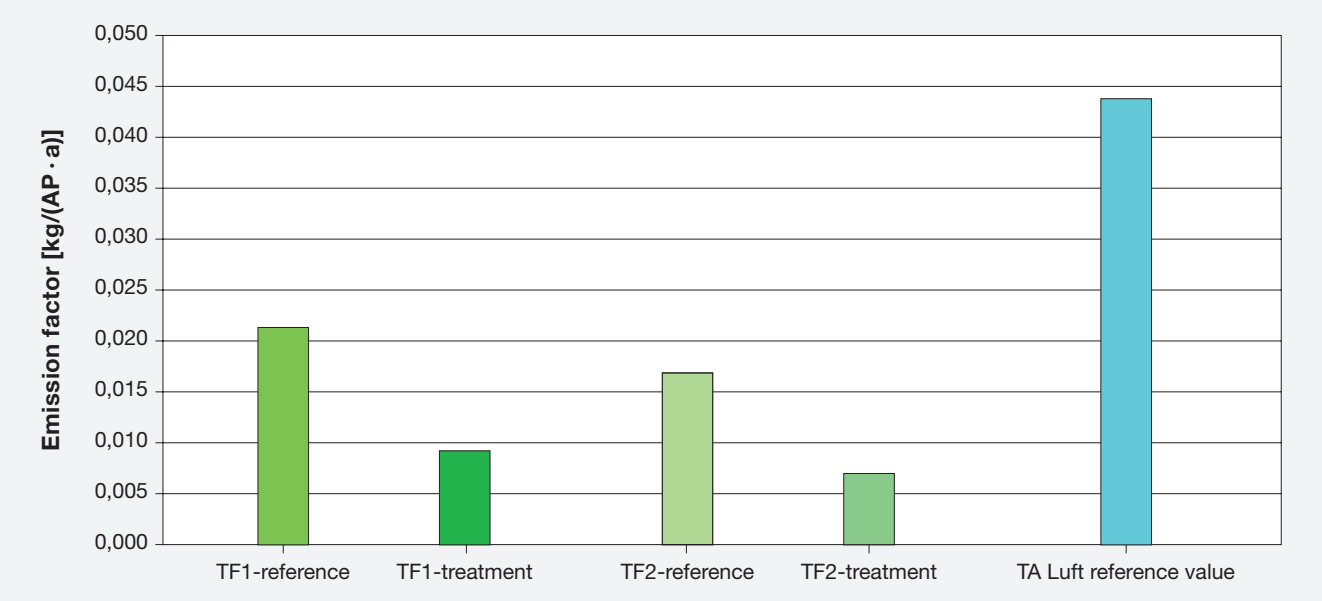

Figure 2:
Determined emission factors

The product

Manufacturer and applicant

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ImproBed®

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Description

The ImproBed® from Grillo-Werke AG is a straw pellet enriched with an additive that reduces the pH value. Based on the low pH value of the litter (down to approx. pH 2), microbial growth is inhibited and ammonia in the manure layer is bound as ammonium sulphate.

The additive is approved as a preservative in the food and feed industry.

The ImproBed® is applied using conventional spreading technology. The manufacturer essentially recommends distributing a quantity of 1.5 kg per m² of poultry house area. Subsequent littering was carried out differently on both test farms (Table 3).

The maximum ImproBed® shelf life of 12 months is pointed out.

The use of ImproBed® can be verified by means of gap-free documentation (delivery documents, etc.) and random-sample laboratory tests. Sampling should take place soon after littering, as the additive in the pellets can be easily detected at the start of fattening.

Depending on the poultry house temperature and the ventilation, dust formation can occur when applied the litter in the poultry house. The dust has a low pH value (down to approx. pH 2). The measures recommended by the manufacturer during littering (shock ventilation, FFP2 mask) must be adhered to. Tests conducted by the manufacturer after the distribution of ImproBed® in the poultry house confirm its harmlessness (for humans and animals).

Tests commissioned by the manufacturer in an independent laboratory also demonstrated that the additive does not become enriched in the animals and that there are therefore no misgivings concerning the proper use of ImproBed® in broiler fattening.

The manure can additionally be put to further use in a biogas plant without limiting biogas production in any way. This was verified by tests at an external laboratory commissioned by the manufacturer.

Table 2 shows the most important product characteristics.

Table 2:
Product specifications (manufacturer's specifications)

	Tested by DLG	optional (not tested)
ImproBed® substrate	Straw pellets	Pellets made of spelt husks
Substrate content	80 % straw	80 % spelt
Additive content	20 %	
Additive in ImproBed®	Compound of sodium and sulphur	
Quantity of litter	1.5 kg/m²	

The method

The DLG test for 'Indoor processes for emission reduction' tests the effectiveness of process-integrated measures that prevent or reduce the occurrence or the release of harmful substances within the poultry house area itself. Such emission-reducing measures can include, for instance, special feeding strategies or the use of special feed additives, litter materials, feeding, drinker and climate control technologies.

Besides their emission-reducing effects, the process-integrated measures can also have positive effects on animal health and animal welfare, energy and water consumption and on the farmer's working conditions.

The DLG Testing Framework 'Indoor processes for emission reduction' includes methods for testing and evaluating systems for reducing:

– ammonia emissions,

– dust emissions and

– noise emissions.

In order to assess the emission reduction potential in the case of proper use, measurements are conducted on at least two farms.

The measurements are carried out according to the case-control approach, i.e. in parallel on each test farm with and without treatment (case and control facilities) under otherwise comparable conditions.

At least six measurement series must be carried out in each case, with the temporal sequence being selected such that summer, transitional and winter periods are included in the course of the measurements. Alternatively, measurement technology can be used to accompany three complete fattening cycles at each location so that precisely one cycle always takes place under summer, autumn or spring and winter conditions.

The ammonia, dust or odour emissions are measured using primary measurement parameters.

What are called secondary measurement parameters are also recorded. These can influence the level of the emissions of primary measurement parameters (e.g. air rates, CO_2 concentrations, stable and outdoor climate data) or are used to describe the production processes and production intensities (e.g. number of animals, live weights, feed quantities and feed composition, quantities and composition of litter and slurry or dung, animal performances).

The collected production data is used to determine an N balance. Before and after each measurement series, litter and feed samples are taken from each poultry house and then analysed with respect to their contents of nitrogen (Kjeldahl analysis in accordance with DIN EN 16169:2012-11), organic matter and water. The farm logbooks are used to determine the introduced quantities of feed and the weight gains in the poultry house, taking losses and early removals into consideration. The nitrogen that is bound via flesh development is calculated using the 30 g N/kg approach in Table 5 of the German Material Flow Balance Regulation, as is the value of 4 g P/kg for phosphorus. To determine the N and P content in the straw of the litter, samples are taken at the beginning and end of each fattening cycle and analysed in the laboratory.

The relative reduction capacity of the tested process compared to the untreated reference is used as the evaluation standard. The reference variables used for this are the calculated mass flows or emission factors.

All emission measurements are conducted by an independent measurement laboratory with practical experience that is accredited in accordance with DIN EN ISO 17025.

Detailed account of the test results

The measurements were conducted from January to August 2023 on two farms in Lower Saxony.

Female and male birds were placed as hatched on both farms. In order to maintain conformity with current German regulations, however, reference is made to broilers throughout the DLG test report.

Test farms

Both of the test farms involved broiler fattening facilities with floor management on litter in self-contained poultry houses with forced ventilation. The day-old chicks were placed with a weight of approx. 40 g. The average fattening duration was 42 to 43 days.

Both farms applied the splitting procedure, in which approx. 25 % of the housed animals were removed from the flock on around the 30th day of fattening and approx. a further 20 % on around the 35th day of fattening via early removal.

The final fattening weights in the tests were between 2,800 g/animal and 3,000 g/animal on average and the animal weights at the time of the first and second early removal lay between 1,500 g and 1,600 g and between 2,100 g and 2,300 g respectively. Both farms used N- and P-reduced feeding and are equipped with drinker cups.

Table 3:
Technical parameters of the test facilities

	Test farm 1	Test farm 2
Fattening places per poultry house	41,800	36,500
Floor space per poultry house	1,800 m²	1,686 m²
Number of drinker lines per poultry house	8	8
Number of feed lines per poultry house	4	4
Feed scale in the poultry house	Skov DOL 99-2 (measuring range 0-30 kg, measurement accuracy 0.5 %)	Skov DOL 99 (measuring range 0-30 kg, measurement accuracy 0.5 %)
Animal scale in the poultry house	Hand-held scale Kern FCB12K1 (measuring range 0-12 kg, measurement accuracy ±3 g)	BigDutchman Swing20 (measuring range 0-20 kg, measurement accuracy 0.03 %)
Ventilation	Tunnel ventilation with active negative pressure regulation	Tunnel ventilation with active negative pressure regulation
Water treatment/drinker	Drinker cups	Drinker cups
Floor heating	no	no
Floor insulation	no	no
Number of early removals	two	two
Basic litter straw pellets	1.1 kg/m²	1.1 kg/m²
Basic litter ImproBed pellets	1.5 kg/m²	1.5 kg/m²
Subsequent littering, winter, straw/ImproBed® (per poultry house)	800/1,000 kg	800/1,000 kg
Subsequent littering, transition, straw/ImproBed® (per poultry house)	no subsequent littering	800/1,000 kg
Subsequent littering, summer, straw/ImproBed® (per poultry house)	no subsequent littering	800/1,000 kg

The operating times and the emission durations on both farms were approx. 8,760 h/year and 24 h/day.

Test farm 1 had two poultry houses, each with 41,800 approved fattening places.

Test farm 2 also had two poultry houses, but each with 36,500 approved fattening places.

On both test farms, the case and control facilities were alternated with each measurement series. On test farm 2, no further alternation was carried out after the second fattening cycle (measurement under autumn/spring conditions).

Ventilation on both test farms was carried out using tunnel ventilation. Active negative pressure regulation was implemented in both cases. The fans were connected in groups. One to two fans per poultry house are always switched on continuously, whereas all other fans are activated as required by means of on/off regulation. Regulation is carried out via the temperature and the CO_2 concentration in the poultry house.

The case facilitiy on the first test farm was littered with 2,700 kg of ImproBed® and the control facility with 2,000 kg of straw pellets. On this farm, subsequent littering was only carried out for the winter measurement. This involved approx. 1,000 kg of ImproBed®, which was distributed several times during the first two thirds of fattening. During the same time period, 800 kg of straw pellets were added in the control facility.

Besides a basic litter of 2,400 kg per poultry house, an additional quantity of 1,000 kg was also subsequently distributed directly after initial splitting in the case facility on the second farm. In parallel, the control facility was littered with 1,800 kg of straw pellets and subsequently littered with 800 kg.

Subsequent littering in the tested poultry houses was mainly carried out because the manure quality had to be guaranteed above all in the winter measurements, primarily in the drinker/feed area. Subsequent littering was used in the transitional and summer measurement phase in order to ensure the quality of the litter in the sense of animal welfare following initial splitting. In order to achieve the tested emission reduction, it is necessary to subsequently distribute at least 0.56 kg ImproBed®/m² floor space, at least following initial splitting.

The farms were run properly during the measurements. The case and control facilites were identically equipped, and management during the measurement phases was comparable in the case and control facilities.

Measurement gas concentrations, mass flow and emission reduction rate

Three complete fattening cycles were recorded at each of the locations. During the measurement series, both the case and control facilities were sampled within a test farm. The measurement series were commenced at the beginning of housing and ended after the manure removal phase. No sampling was carried out during the service times. The fattening cycles were distributed throughout the seasons, resulting in the availability of measurement data under winter, transitional and summer conditions. Changes in the number of animals were taken into consideration in the evaluation.

The emissions of ammonia (NH_3) in the poultry house air were measured. Sampling was carried out from the exhaust air flue in the vicinity of the fan, whereby attention was paid to the availability of sufficient measurement gas even when little ventilation was required. The measurement points were equipped with end filters in order to minimise the entrainment of dust particles. The air in the poultry house was suctioned off from the measurement points into the technology room via heated PTFE lines. The pumps continuously pumped the measurement gas via a multi-channel measurement switch into an FTIR analyser (type: Gasmet DX 4000), in whose measuring cell the measurement gas was analysed by means of infrared spectroscopy. The measuring range of the measuring device was 0 to 20 ppm ammonia; the measurement uncertainty of the device can be specified as ± 5.0 %. The measurement uncertainty is significantly higher in the lower measuring range (less than 0.5 ppm), with the result that these measurement values have to be processed accordingly prior to evaluation. In order to rule out background influences outside of the poultry house, the unpolluted ambient air (pre-pollution) was additionally suctioned off on each farm and was tested with regard to its concentration of ammonia, nitrous oxide and carbon dioxide.

The air volumetric flows in the poultry house were determined in order to calculate the emission mass flows. To do this, the stable computer was read out and shown as the average half-hour value. These values were

verified on the basis of CO_2 balancing using the relevant animal- and stable-specific measurement data. Grid volumetric flow determination at the exhaust air flue was additionally used to better verify this measurement data. The measurement uncertainty of the volumetric flow determination can be specified as ± 10 %. The climate data required for the calculation was collected via an outdoor weather station.

The current number of animals in the poultry house, animal weights, losses and early removals, stable temperatures as well as feed quantities and water consumption were taken from the stable logbooks. The data on animal weights and feed quantities originates from the farms' own weighing equipment or was additionally taken from the slaughter logs. The weighing equipment used is shown in Table 3.

Table 4:
Levels of reduction of ImproBed® from Grillo-Werke AG

	Level of reduction in %	Evaluation*
Test farm 1	63.0	–
Test farm 2	53.4	–
Average	**58.2**	🟩🟩🟩🟩🟩

Table 5:
Comparison of the determined emission factors

	Emission factor kg/AP·a, control facility	Emission factor kg/AP·a, case facility
Test farm 1	0.0209	0.0090
Test farm 2	0.0164	0.0068
Average	**0.0186**	**0.0079**

* The DLG test framework specifies the following evaluation range:
🟩🟩🟩 or better = meets, exceeds or clearly exceeds the specified DLG standard,
🟨🟨 = meets the statutory requirements for marketing the product, 🟥 = failed

The measured concentrations of ammonia in the stable air were converted into mass flows via the air volumetric flows. Both poultry houses have to be operated as identically as possible to compare the mass flows of the case and control facilities. This was the case in this DLG test.

The reduction levels determined for both test farms are shown in Table 4. The emission factors determined from both farms are listed in Table 5.

An average reduction level of 58.2 % was achieved. The calculated emission factors refer to the approved animal places at an average animal weight of 1,130 g (arithmetic mean value over all fattening days) and with 7.45 (TF1) and 7.93 (TF2) fattening cycles per year respectively.

The reference value of 0.0437 kg ammonia/(AP·a) defined in TA Luft for broiler fattening was significantly undershot on both farms during the test.

Due to the comparable ventilation in the case and control facilities, the carbon dioxide concentrations in both poultry houses remained virtually identical. This was also confirmed by the gas measurements. There were no anomalies in the nitrous oxide concentrations throughout the entire test period. The N_2O concentrations in the case facility were only slightly higher at the beginning of fattening, but the increase was only in the 0.1 to 0.2 ppm range and only persisted for a few days. No explanation was found for this.

The specifications of the German Animal Protection and Keeping of Production Animals Ordinance were adhered to. The ammonia concentrations constantly remained below 20 ppm; apart from a few exceptions, the carbon dioxide limit of 3,000 ppm was not exceeded.

Nitrogen and phosphorus balance, plausibility of the measurement results

In order to check the plausibility of the results that were obtained, a nitrogen balance was established for each tested fattening cycle using the nitrogen input via the litter and the feed. The nitrogen outputs via the weight gains during the fattening cycles, the increase in nitrogen contents in the manure and the measured emissions were also taken into consideration in this. The same procedure was applied to establish a phosphorus balance.

The litter that was distributed corresponded to the quantities of straw commonly used on the farms per animal place. On both test farms, the quantities of manure were weighed and documented following removal from the poultry houses by the contractor.

The resulting nitrogen and phosphorus balance was calculated in kg by comparing the totals of nitrogen and phosphorus inputs and nitrogen and phosphorus outputs and was placed into relation to the input nitrogen.

The calculated nitrogen balances contain measurement uncertainties that are primarily attributable to the difficulty of removing a representative sample of poultry house manure during fattening operations without causing excessive disruptions in the poultry house and thereby jeopardising animal welfare. In addition, sampling only ever represents a snapshot of the current situation during the highly dynamic courses of growth in the poultry house. Precise registration of the manure quantities following removal from the poultry house and the taking of a representative sample from them for the laboratory analysis are also susceptible to errors. Based on these measurement uncertainties, recovery rates of over 100 % are also possible.

The established balances can therefore only be used as supporting information to obtain indications of whether the measurement results can be classified as plausible subject to consideration of the attendant conditions.

An average of 107.9 % and 105.0 % of the input nitrogen were recovered on test farm 1 and test farm 2 respectively over all of the measurement series. An average of 93.7 % (test farm 1) and 95.7 % (test farm 2) phosphorus were recovered.

The recovery rates are thus comparatively high and the measurement results can therefore be classified as plausible.

Feed conversion and mortality rates

In order to ascertain any possible influence of the treatment on the livestock and animal health, live weight developments, the feed conversion rates and the mortality rates were determined using the data in the stable logbooks.

With an average feed conversion rate of 1 : 1.47 (kg weight gain : kg feed) in both the case and control facilities during the measurement phases, test farm 1 has achieved a good level for the broilers fattened for 42 days. An average feed conversion rate of 1 : 1.50 was ascertained in both poultry houses for test farm 2. The tested emission reduction method did not reveal any significant effect on feed conversion on either of the two test farms. The individual results are shown in Table 6.

Table 6:
Feed conversion (kg feed per kg weight gain)

	Farm 1		Farm 2	
Feed conversion	**control facility**	**case facility**	**control facility**	**case facility**
Fattening cycle 1 (winter)	1.47	1.44	1.46	1.51
Fattening cycle 2 (transition)	1.52	1.48	1.50	1.53
Fattening cycle 3 (summer)	1.44	1.49	1.52	1.48

The mortality rates determined during the test period via the number of losses stated in the stable logbook were between 1.44 % and 2.87 % on test farm 1 (around 2 % on average) and between 1.95 % and 2.25 % on test farm 2 (around 2 % on average). The mortality rates fluctuated by approx. 0.2 % (TF2) to 0.7 % (TF1) over the three tested fattening cycles. No significant influence of the emission reduction measure on the mortality rate was ascertained.

Documentation and verification of proper application

The user is obliged to retain corresponding documentation in order to furnish proof of the proper operation or use of the emission reduction measure. The documents and files used as proof must be stored for at least five years and must be submitted to the supervisory authority on request.

ImproBed® is introduced into the poultry house with the litter and begins to take effect as of this point in time. Subsequent littering is carried out depending on farm management and the season. The minimum quantities of subsequent littering material must be noted in this case. In order to furnish proof of use, the delivery documents or purchase invoices must be collected and stored by the farmer.

The litter and the feed must additionally be analysed in a laboratory at least once a year for each poultry house. The laboratory reports concerning the commissioned analyses must also be stored for five years and shown to the supervisory authority on request.

The additive in the litter can be detected via the pH value and the sodium and sulphur content. As the effect of the substance declines over time, however, verification by means of a laboratory analysis is only sensible at the beginning of fattening or possibly directly after subsequent littering. This should be taken into consideration in corresponding sampling.

Summary

The tested ImproBed® emission reduction method was analysed as regards its reduction potential in a DLG-APPROVED individual criteria test and successfully passed the test.

In the test, ImproBed® succeeded in demonstrating its effectiveness in reducing ammonia emissions in broiler fattening facilities with floor management on litter in self-contained poultry farms with forced ventilation. An average emission reduction level of 58.2 % was achieved over both farms and all measurement series compared to the untreated control facility.

The tested process did not reveal any significant influences on feed conversion or the mortality rates.

The application of ImproBed® in practice can be continuously documented and its use verified.

ImproBed® was able to demonstrate its effectiveness without the presence of an additional reduction method. The DLG award therefore refers to the application of ImproBed® as an individual measure.

No criteria other than the product's effectiveness in reducing ammonia emissions in broiler fattening facilities were tested.

Further information

Testing agency

DLG TestService GmbH,
Gross-Umstadt location, Germany

The tests are conducted on behalf of DLG e.V.

Laboratory and emissions measurements

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DLG test framework

"Indoor processes for emission reduction"
(current as of 07/2023)

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DLG – the open network and professional voice

Founded in 1885 by the German engineer Max Eyth, DLG (Deutsche Landwirtschafts-Gesellschaft – German Agricultural Society) is an expert organisation in the fields of agriculture, agribusiness and the food sector. Its mission is to promote progress through the transfer of knowledge, quality standards and technology. As such, DLG is an open network and acts as the professional voice of the agricultural, agribusiness and food sectors.

As one of the leading organisations in the agricultural and food market, DLG organises international trade fairs and events in the specialist areas of crop production, animal husbandry, machinery and equipment for farming and forestry work as well as energy supply and food technology. DLG's quality tests for food, agricultural equipment and farm inputs are highly acclaimed around the world.

For more than 130 years, our mission has also been to promote dialogue between academia, farmers and the general public across disciplines and national borders. As an open and independent organisation, our network of experts collaborate with farmers, academics, consultants, policymakers and specialists in administration in the development of future-proof solutions for the challenges facing the agriculture and the food industry.

Leaders in the testing of agricultural equipment and input products

The DLG Test Center Technology and Farm Inputs and its test methods, test profiles and quality seals hold a leading position in testing and certifying equipment and inputs for the agricultural industry. Our test methods and test profiles are developed by an independent and impartial commission to simulate in-field applications of the products. All tests are carried out using state-of-the-art measuring and test methods applying also international standards.

Internal test code DLG: 2212-0019

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