

Verification of Combi scrubber 'MagixX'

Use of existing and additional data

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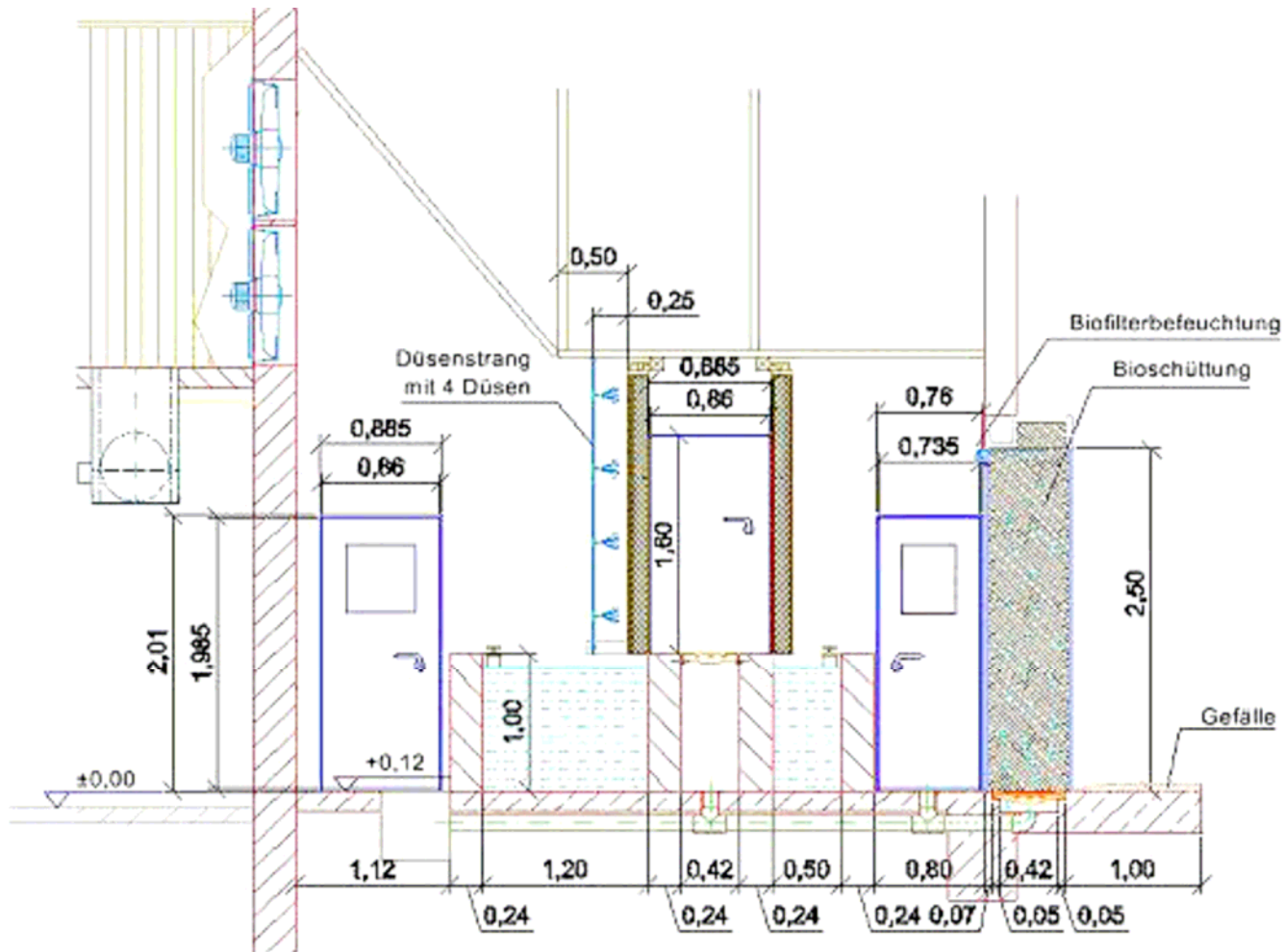
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Layout of 3-stage combi scrubber "MagixX"



Working principle

- First stage: physical scrubber
 - Water spraying and wetted packed bed
 - Fluid recirculation
 - Dust removal and humidification
 - Effluent discharge: once every 3-4 months
 - Mixed with manure → fertilizer
- Second stage: chemical scrubber (sulphuric acid)
 - Wetted packed bed
 - Fluid recirculation - pH regulated
 - Ammonia removal
 - Effluent discharge: once every 3-4 months
 - Chemical waste
- Third stage: biofilter
 - Root wood (crushed)
 - Degradation of ammonia and odour

Combi scrubber technology 'MagixX' for Pig Houses

Supplier: Big Dutchman GmbH (Germany)

Claims:

Emission reduction efficiency

- > 80% for ammonia
- > 90% for total dust
- > 80% for fine dust (PM10)
- > 80% for odour or outlet concentration < 300 ouE

Verification of claims based on average yearly performance

- Characteristics of application for animal housings
 - Ammonia emission varies over the year (factor 5)
 - Grow cycle (fattening pigs: 25 – 120 kg)
 - Manure temperature in stable
 - Stable management (feeding, manure handling)
 - Air flow varies over the year (factor 5)
 - Summer/winter, day/night
- Required operational conditions during verification test

Parameter	Requirement
Percentage of animal places occupied	> 80%
Test moment in animal grow cycle	> 40%
Outside air temperature	5 – 20 °C
- Percentage waste gas flow rate	20 – 60 %

Specific verification protocol for Combi scrubber

- Basis for protocol development
 - Report Wageningen University
 - Harmonisation of measuring protocol for emissions of ammonia, odour and fine dust from animal houses
 - Landkreis Cloppenburg
 - Leitfaden Abluftreinigungsanlagen Tierhaltung
- General description of technology (suppliers info)
 - Application (in this case pig houses)
- Claims of the supplier
 - Emission reduction claims
- Parameters to be measured for verification of the claims
 - Concentrations at in- and outlet
 - Temperatures at in- and outlet

Specific verification protocol (continued)

- Combi scrubber operation requirements
 - Refreshment of scrubber fluids (> 6 weeks before test)
 - Registration of acid grade of chemical scrubber fluid
 - Fluctuation of air flow over biofilter surface < 20%
- Other parameters to be determined
 - Pressure difference over combi scrubber (energy use)
 - Cross media effects (suppliers info: not verified)
 - Use of resources (e.g. energy, water, acid)
 - Waste production and handling (manure)
 - Operation and maintenance (manhours/year)
- Measuring methods: International standards (if available)
- Summary of parameters to be tested (table)
 - Parameter
 - Claimed or required value
 - Measuring method
 - Level of verification (verified / estimation / expert guess)

Existing reports

- Delivered by supplier
 - University Bonn
 - Measurements at stable (600 sows) in Steinfeld
 - In- and outlet concentrations
 - ammonia, total dust and odour
 - Resource use
 - Cross media effects
 - University of Wageningen (Animal Science Group)
 - Engineering data of combi scrubber system
 - Measurements at stable (520 fattening pigs) in Petersfeld
 - In- and outlet concentrations of fine dust (PM10)

Verification of claims based on existing data

- Use of available data for verification
 - Uni Bonn
 - Ammonia claim (not verified)
 - Measured reduction efficiency 79% (claim > 80%)
 - Uncertainty ($\pm 3\%$)
 - Odour claim (verified successfully)
 - Measured outlet concentration 110 ouE (claim < 300)
 - Total dust claim (verified successfully)
 - Measured reduction efficiency 95% (claim > 90%)
 - ASG Wageningen
 - PM10 claim (not verified: operating conditions not fulfilled)
 - outside temperature / waste gas flow too low
 - Measurement in winter

Test plan for measurement of missing data

- Missing data
 - Ammonia and PM10 reduction efficiency
 - Waste gas fluctuation over biofilter outlet area
 - Operational parameters of combi scrubber
- Test location for additional measurements
 - Supplier proposed stable (fattening pigs) in Nordhorn
 - TNO proposed SGS Environmental BV for measurements
 - Inventory of measurement possibilities (visit to stable)
 - Agreements with operator stable / combi scrubber system
 - Refreshment of scrubber fluids
 - No manure handling during measurements
- Global test plan made by verification manager
- Offer for additional measurements by SGS (detailed test plan)
 - Comments on test plan from experts in the AIRTV project

Additional measurements on location

Order for additional measurements given to SGS

Additional measurements

- Location: pig stable in Nordhorn (Germany)
- Continuous measurements during 3 times 24 hours
 - Ammonia inlet and outlet concentration
- Sampling and analysis
 - PM10 inlet and outlet concentration
 - Scrubber fluids
 - Operational conditions of combi scrubber
- Measurement of fluctuation of outlet air over biofilter surface

Measurement report made by SGS

- Draft commented by verification manager
- New draft commented by AIRTV experts and supplier

Verification report

- Draft verification report made by verification manager
 - Existing report of Uni Bonn
 - Measurement report of SGS
 - Additional information from supplier
 - Pressure difference over combi during additional test
 - Operation and maintenance manhours
- Draft verification report commented by external project expert
 - Final draft report send to AIRTV project coordinator and supplier

Verification results

Parameters	Claim	Measured
Ammonia reduction efficiency	> 80%	82 ± 3%
Total dust reduction efficiency	> 90%	95 ± 6%
PM10 reduction efficiency	> 80%	83 ± 5%
Odor outlet concentration	< 300 ouE	110 ± 50 ouE

Claims are verified successfully

Cost related and cross media effects (not verified)

Based on existing reports and supplier info

- Consumables
 - Use of sulphuric acid: 1.8 kg/kg ammonia reduced
- Resources
 - Electricity: 0.1 kWh/day per pig
 - pumps and pressure difference waste gases
 - Water use: 3.7 kg/day per pig
- Emissions
 - Waste water (chemical): 0.1 liter/day per pig
- Manpower: 100 hours/year
- Space requirement: 2 – 3 m³ per 1000 m³/h

Problems and hurdles

- Combination of 4 unit operations
 - Stable (fluctuating emissions, stable management)
 - Combi-scrubber system (3 stages)
- Use of available data
 - Not in line with prescribed operating conditions
 - Missing information on quality and accuracy of test results
 - Very time consuming effort
- Engineering details of verified system
 - Trust suppliers info of verified system
 - Dimensioning aspects of Combi scrubber system
 - Operating conditions during testing
 - Pressure difference, pH, L/G ratio etc.
 - Registered by scrubber management computer
- Cross media effects (suppliers info)
 - Specific parameters (choice use per hour, pig or kg reduction)
 - Electricity use for fan (only combi scrubber part)
 - Formula developed based on pressure difference

Conclusion

- Developed verification procedure works
- Good cooperation with supplier and stable operator
 - Thanks to Big Dutchman and stable operator
- Evaluation of existing data is time consuming
 - Non compliance with prescribed operating conditions
- Communication with participants is time consuming
 - Supplier, operator, testing lab, experts
- Supplier claims are verified for combi scrubber system
 - existing and additional data
- Questions?