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# Reducing Ammonia Emissions by Using Urease Inhibitors

*The effectiveness and practice oriented use of urease inhibitors were tested with three measurement systems: the 5l glass bottle measurement-system (BeWaSys), the wind tunnel measurement system (WiWaSys) and the standardised method to record urease activity. With BeWaSys, dose-effect ratios depending on temperature and test duration were ascertained. In the WiWaSyS, under constantly kept similar conditions in the animal house, reproducible $NH_3$-releases were found. Despite wide variations in urease activity on top of house floors, the effect of the urease inhibitor can be recorded with a standard measuring method.*

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## Keywords
Ammonia emission, urease, urease inhibitors

In agriculture cattle husbandry is the main source of ammonia emissions. The major part of these ammonia emissions is released from housing systems. Therefore strategies to reduce ammonia emissions in this area will be especially effective [1, 3].

From there the current research project does focus on the effectiveness of the application of urease inhibitors in cattle facilities and the main research goal is to develop a practice oriented strategy to apply urease inhibitors on top of housing floors. By strongly decreasing the catalytic breakdown of urea on top of emitting surfaces (housing floors) through the application of urease inhibitors a reduction of the formation process of ammonia ($NH_3$) is induced.

### Material and method

To measure the effectiveness and the application characteristics of urease inhibitors to reduce ammonia emissions in laboratory scale and under practical conditions three measurement systems are used:

1. 5 l-Glas-Bottle-Measurement-System (BeWaSys) (dynamic measuring chambers) with max. 28 containers (5 l-glass-bottles) to study the dosage-effectiveness effects and relations of different urease inhibitors under constant and replicable conditions in laboratory scale [7];
2. Wind tunnel-water bath-measurement-system (WiWaSys) for continuous measurements of the formation process of ammonia emissions on emitting surfaces (dynamic measuring chamber) and the effectiveness of urease inhibitors under replicable conditions in laboratory scale simulating housing situations. Concrete and rubber floor elements (0,4 • 0,65 m) (pre-conditioned with dairy faeces and synthetic urea solution) are placed inside the WiWaSys representing emitting (housing floor) floor elements [5, 7];
3. A standardised method [2] to measure the urease activity on floor surfaces (static measuring chamber). These method is a tool to measure the urease activity in relation to the ammonium ($NH_4^+$) formation on top of emitting housing floors in practice as well as on floor elements in the WiWaSys in laboratory scale. This method does indicate the activity of the ureolytic bacteria on emitting surfaces [5, 7].

### Preliminary results

Following preliminaries of the three measurement systems become introduced. The testing of urease inhibitors in the BeWaSys, the validation and verification of the reproducibility of the settings, conditions respectively in the WiWaSys and the usability of the standardised method to examine the urease activity in practical housing systems.

*1. Dosage-effectiveness-relations of urease inhibitors (BeWaSys)*
To study the dosage-effectiveness-effects a commercially available urease inhibitor (type-C) and a new developed urease inhibitor (type-D) were tested. The reduction of ammonia emissions caused by the application of urease inhibitor type-C was in all accomplished trials clearly lower than the ones caused by the urease inhibitor type-D, when the inhibitor was applied at same concentration level. In general the reduction effects of the examined urease inhibitors depended on the concentration (dosage) and temperature of the substrate (liquid manure) (*Fig. 1*); the higher the temperature the lower is the effectiveness of the inhibitors.

*2. Validation of the wind tunnel-water bath-measurement-System (WiWaSys) and verifying of replicabibility of $NH_3$-emission curves*
Extensive and systematic measurements for the validation of the WiWaSys showed that it is possible to detect differences between intake airflow and outlet airflow of ≥ 0,5 ppm ammonia, ≥ 0,3 Kelvin and ≥ 1,5 % rel. humidity. These values indicate, that it is possible to measure replicably the reduction of ammonia caused by the application of urease inhibitors in the WiWaSys.

To simulate housing conditions in the WiWaSys, i.e. the cows urination behaviour on top of the housing floor and the following urea catalytic breakdown as well as the ef-

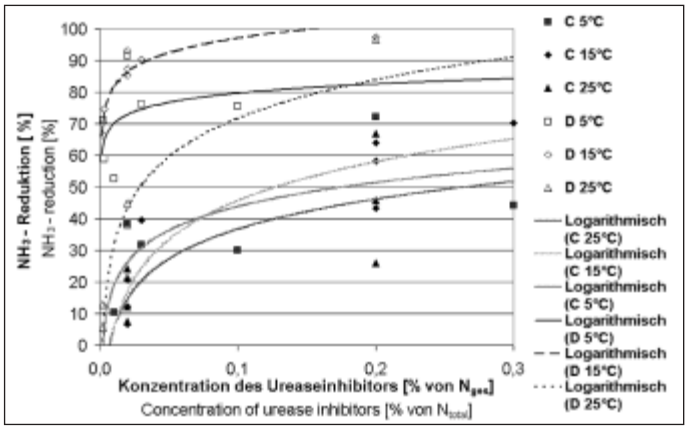


*Fig. 1: Reduction of ammonia subject to slurry temperature and concentration of two different urease inhibitors of type-C and type-D*

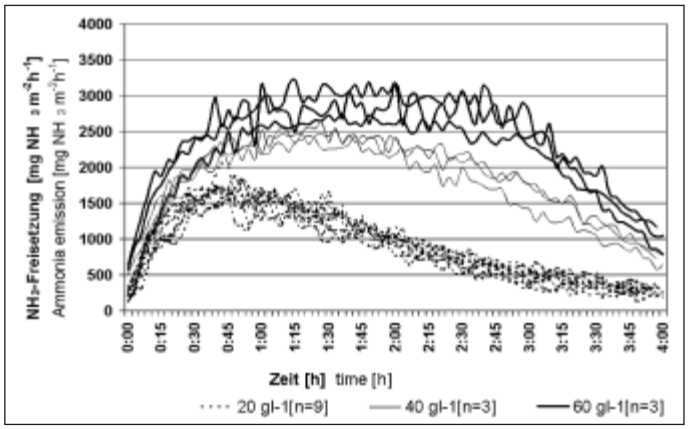


*Fig. 2: Course of $NH_3$-emission curves after different synthetic urea-solution-concentrations under constant conditions in the WiWaSys*

fectiveness of the urease inhibitors, it is necessary to create replicable ammonia formation processes. This means that under constant conditions in the WiWaSys (like a defined airflow above the surface, tunnel temperature and surface temperature) the successive application of synthetic urea solution should lead to almost identical $NH_3$-emission curves. To prove these hypothesis, on six following days three times per day with a time difference of four hours urea solution was applied. Urea solution concentrations were 20, 40 und 60 g $l^{-1}$ at day 1 to 2, 3 to 4, 5 to 6, respectively were applied. The results of these trial settings have shown, that as expected, increasing concentrations of urea solution induce increasing $NH_3$-emissions curves (*Fig. 2*). Furthermore $NH_3$-emissions curves, which were caused by the same settings (concentration of urea solution) show similar courses and levels. So, a basic assumption is met to measure the effectiveness of the urease inhibitors on top of emitting surfaces in the WiWaSys.

The course of the $NH_3$-emissions curves indicate (*Fig. 2*) that the catalytic breakdown of nitrogen from synthetic urea solution to ammonia after four hours in a range from 48 to 86 % is in accordance to literature data. This means that urease enzymes have been almost hydrolysed the urea in this period of time. [4, 6]

*3. Use of the standardised method to measure urease activity on housing floors*

Measurements of urease activity with the standardised method on housing floors in dairy operations have shown a high variability of the urease activity levels under practical conditions (*Fig. 3*) which is in accordance to literature [2, 6].

Nevertheless differences in urease activity levels could be measured between floors without and with inhibitor applicated as well as to a clean surface made of glass. The urease inhibitor type-D reduces the hydrolysis of urea on top of emitting surfaces and hence of $NH_3$-emissions (WiWaSys; laboratory scale) as well as the urease activity (practice dairy housing floors) measured with the standardised method. Like the results accomplished under laboratory conditions [7] a decreasing effectiveness of the inhibitors in accordance to duration of the tests could be observed.

### Conclusions

With the 5 l-glass-bottle-measurement-system (BeWaSys; laboratory scale) dosage-effectiveness relations of urease inhibitors related to temperature and duration of the tests could be determined. The wind tunnel-water bath- measurement-system (WiWaSys; laboratory scale) is capable to replicate $NH_3$-emissions curves on emitting floor surfaces and to measure the effectiveness of urease inhibitors. The standardised method to measure urease activity on emitting floor surfaces is a tool to examine the effectiveness of urease inhibitors on housing floors under laboratory and under practical conditions. On top of emitting surfaces a high variability of urease activity levels could be detected under laboratory and under practical conditions. The application of urease inhibitor type-D induced always a distinct decrease of urea hydrolysis, the $NH_3$-emissions, (BeWaSys und WiWaSys; laboratory scale) and as well the urease activity (dairy housing floors) respectively. In general a decreasing effectiveness of the urease inhibitors after application with longer trial duration is shown.

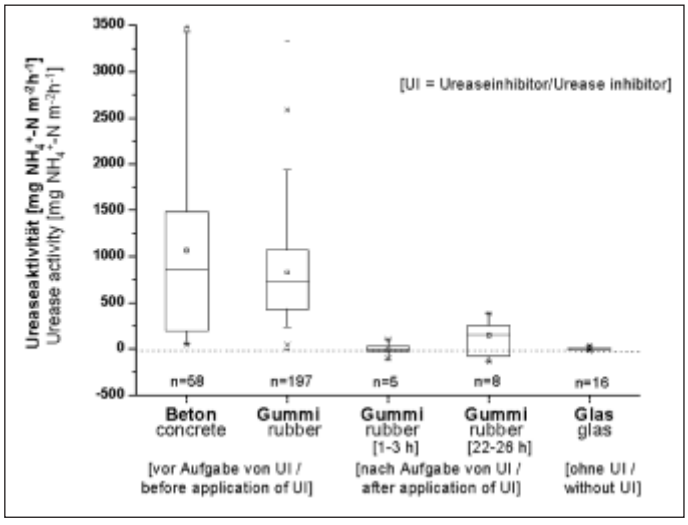


*Fig. 3: Urease activities on top of different floor types in an dairy cow house, before and after application of 30 mg $m^{-2}$ urease-inhibitor-type-D*

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