Nitrogen determination in urea

KjelDigester K-449, KjelMaster System K-375 / K-376 with Scrubber K-415 TripleScrub: Nitrogen determination in urea according to the Kjeldahl method

Urea is a common source of nitrogen in all solid nitrogenous fertilizers and it is widely used as a nitrogen release fertilizer. The standard crop-nutrient rating (NPK rating) of urea is 46-0-0. Hence, it contains 46 % elemental nitrogen (N) 0 % elemental phosphorous (P), and 0 % elemental potassium (K). Therefore, it has very low transportation costs per unit nitrogen. [1]
Urea decomposes when applied to the soil due to the activity of the enzyme urease. In presence of soil moisture and enzyme, urea normally hydrolyzes and converts to NH_4^+ and CO_2 (reaction 1). [2]
The reaction takes place after the urea is dissolved in water. To complete the reaction it takes about 48 hours under the alkaline conditions.

$CO(NH_2)_2 + H_2O + [urease] \rightarrow 2NH_3 + CO_2$ (reaction 1)

Ammonia gas will volatilize if not protected. After the application of urea placed on the soil surface or plant it may loose from 50 % to 90 % of its nitrogen as ammonia if not protected Therefore, the urea is put into the soil and not on the soil to conserve fertilizer nitrogen. [3]
Here, the determination of nitrogen in a urea sample used as a fertilizer is performed using the KjelDigester K-449 and KjelMaster System K-375 / K-376.

1. Introduction

To determine the nitrogen content, the samples require digestion with sulfuric acid to convert nitrogen into ammonium sulfate. After conversion to ammonia through the alkalization with sodium hydroxide, the sample is distilled into a boric acid receiver by steam distillation, followed by a titration with sulfuric acid solution.

2. Experimental

***Equipment*:** KjelDigester K-449, KjelMaster System K-375/K-376, Scrubber K-415 TripleScrub.

***Sample*:** Urea received from customer.

Determination: The samples were added directly into a sample tube. Two Titanium Tablets to each sample were added. Then 20 mL of sulfuric acid (conc. 98 %) were added. The digestion was performed using the K-449, by applying the parameters specified in Table 1. After digestion the ammonia of the sample was distilled into a boric acid solution by steam distillation and titrated with sulfuric acid (Table 2) performed by the KjelMaster K-375.

Table 1: Temperature profile for digestion with the K-449.

Step	Temperature [°C]	Time [min]
Preheating	350	0
1	420	120
Cooling	-	30

Table 2: Parameters for distillation and titration with the KjelMaster K-375.

H_2O volume	50 mL	Receiving solution vol. (boric acid)	60 mL
NaOH volume	90 mL	Titration solution	H_2SO_4 0.25 mol/L
Reaction time	5 s	Titration mode	Standard
Distillation mode	Fixed time	Titration start time	0 s
Distillation time	240 s	End point pH	4.65
Stirrer speed distillation	5	Stirrer speed titration	7
Steam output	100 %	Titration algorithm	Optimal

3. Results

The results of the nitrogen determination are presented in Table 3.

Table 3: Results of the nitrogen content in urea. Expected value is 46.63 % (N).

	mSample [g]	VSample [mL]	%N
Urea_1	0.2028	13.490	46.30
Urea_2	0.2125	14.322	46.93
Urea_3	0.2079	13.851	46.38
Urea_4	0.2075	13.806	46.32
Average [%]	–	–	46.49
SD	–	–	0.30
Rsd [%]			0.6
Recovery			99.70

The mean blank volume (VBlank) was 0.081 mL (n = 4).

4. Conclusion

The determination of nitrogen in urea using the KjelDigester K-449 and the KjelMaster System K-375 / K-376 provides reliable and reproducible results with low relative standard deviations (rsd).

These results correspond well to the labelled values of the nitrogen in urea.

5. References

[1] https://en.wikipedia.org/wiki/Urea.

[2] http://www.extension.umn.edu/agriculture/nutrient-management/nitrogen/fertilizer-urea.

[3] http://extension.usu.edu/files/publications/publication/AG_283.pdf.