



Report

Determination of some physical-chemical properties of Urea

Assignment number	204611.08.0640.03
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Location and date	Basle, 12.02.2009
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1 Aim

The aim of this mandate is to determine some physical-chemical properties of Urea according to the European Regulation 440/2008.

2 SOP and documents

The measurements were performed according to the following SOP:

- SOP. 033 : Abbrandgeschwindigkeit fester Stoffe
- SOP. 046 : Prüfung auf brandfördernde Eigenschaften
- SOP. 061 : Relative Selbstentzündungstemperatur für Feststoffe
- SOP. 421 : Messungen im Differentialkalorimeter Mettler Toledo®-System und TAI 2910/2920

and according to the following documents:

- (internal) Prüfauftrag 204611.08.0640
- (internal) Prüfanweisung PA 05.09.2008 16.47

3 Sample

Number	Designation	Description	Date
204611.08.0640.03 LIMS 11848	Urea	White powder	05.09.2008

4 Methodology

The following tests were performed according to the following methodology:

<i>Test</i>	<i>Methodology</i>
Determination of the melting/freezing point	A.1
Determination of the relative density	A.3
Determination of the water solubility	A.6
Determination of the partition coefficient	A.8
Determination of the flammability	A.10
Determination of the self-ignition temperature	A.16
Determination of the oxidising properties	A.17
Determination of the dissociation constant	OECD 112

5 Results

5.1 Determination of the melting/freezing point

The melting point of the sample was determined according to the A.1 methodology by DSC (Differential Scanning Calorimetry). 5 mg of the sample were heated in a closed, pressure-resistant crucible from 30 °C to 400 °C with a heating rate of 4 °C/min.

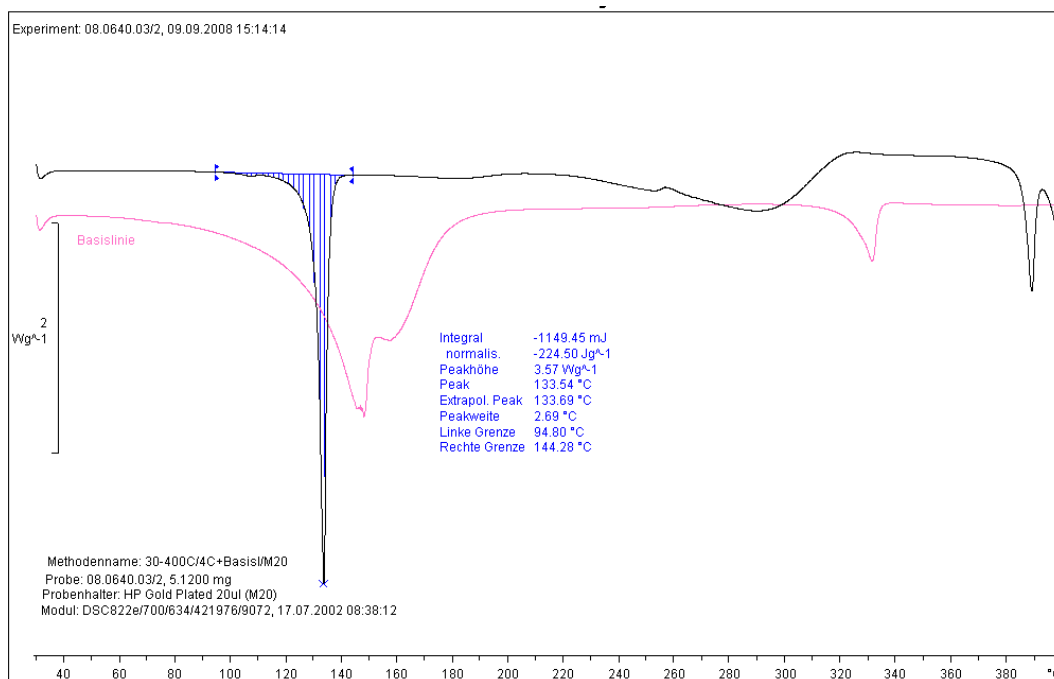


Figure 1. Dynamic DSC-measurement

The melting point of Urea was determined to be 134 °C.

5.2 Determination of the relative density

The relative density was determined by Solvias. The experimental report is in annex.

The relative density of Urea was determined to be 1.33 at 20 °C.

5.3 Determination of the water solubility

The water solubility was determined by ASG (preparation of samples) and sponsor (analytics). The experimental report is in annex.

The water solubility of Urea was determined to be 624 g/l at 20 °C.

5.4 Determination of the partition coefficient

The partition coefficient was determined by BMG Engineering (preparation of samples and reporting) and sponsor (analytics). The experimental report is in annex.

The partition coefficient of Urea was determined to be < -1.73 (sd: 0.16) at $22 \pm 2^\circ\text{C}$.

5.5 Determination of the flammability

The determination of the flammability was done according to the A.10 methodology.

It was not possible to ignite the sample during the preliminary test. The sample in contact with the flame was melting; there was no propagation of the combustion.

Urea is therefore not highly flammable.

5.6 Determination of the self-ignition

The determination of the self-ignition temperature was done according to the A.16 methodology.

A 8 mL wired basket was filled with the sample and heated from 30°C to 400°C in an oven with circulating air. The following figure shows the temperature of the sample and the temperature of the oven.

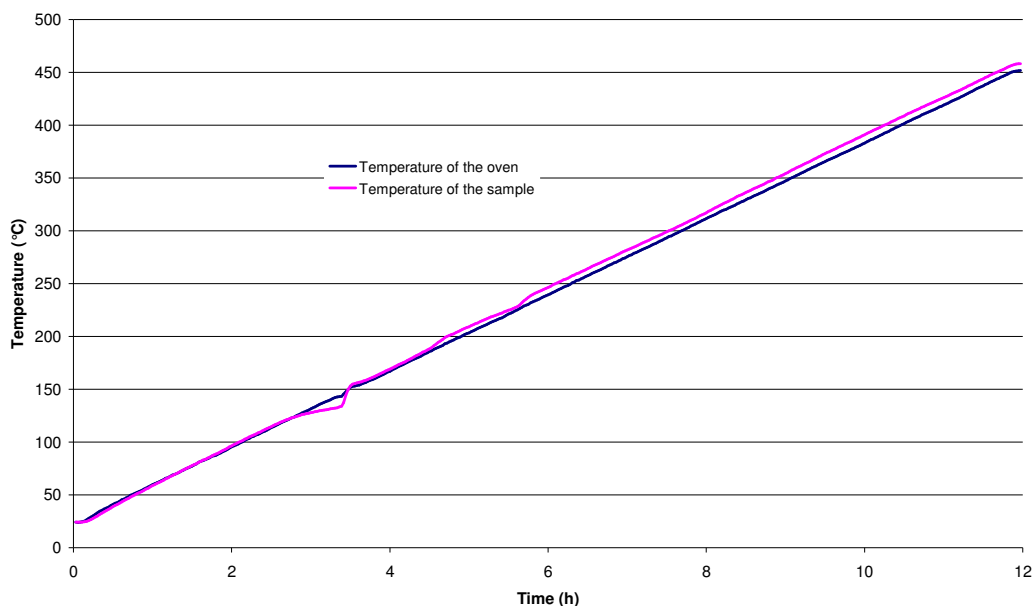


Figure 2. Temperature profile

The sample melts at 134°C ; it is confirmed by this measurement. Below this temperature there is no self-ignition of the sample.

5.7 Determination of the oxidising properties

Based on the chemical structure of Urea, the experience, the data that can be found in the scientific literature and the screening criteria given by the United Nation for the Transport of Dangerous Goods (Urea contains oxygen but it is only bounded to carbon), it is possible to exclude beyond reasonable doubts that Urea has oxidising properties.

5.8 Determination of the dissociation constant

The dissociation constant of Urea was determined by titration. 2.5 g of Urea were dissolved in 200 g of distillate water. HCl 1M was added continuously under stirring and the pH-value was measured. After reaching the pH-value of 0.6; NaOH 1M was added. The following curve shows the pH-curve as a function of the amount of HCl added.

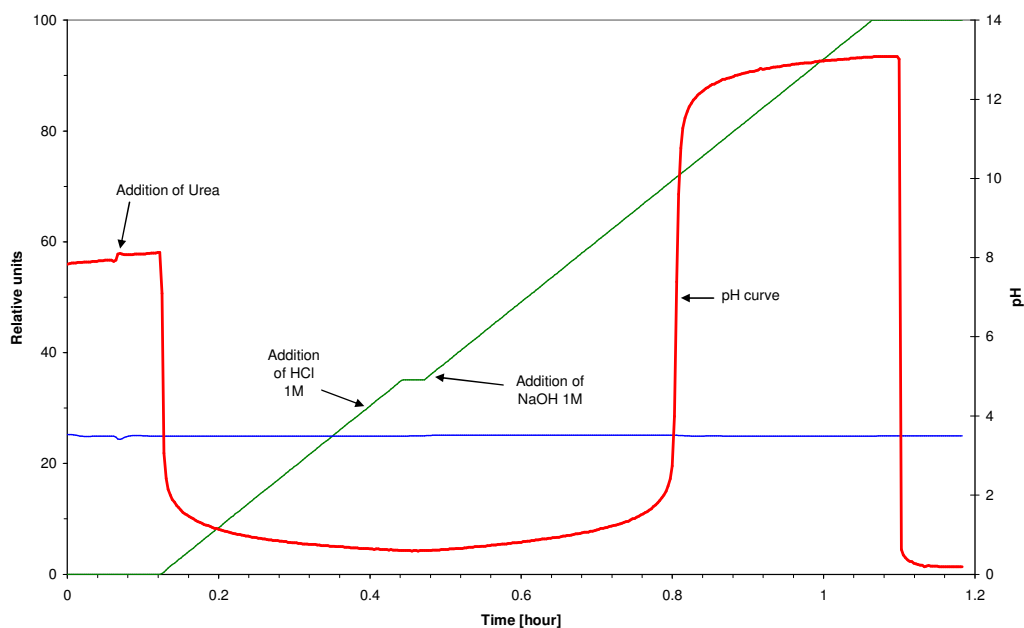


Figure 3. pH-curve

It is not possible to distinguish a contribution of Urea to the pH-curve. Therefore it has to be concluded that the dissociation constant of Urea is lower than 0.6 ($pK_b < 0.6$).

6 Summary

The following table summarises the results obtained during this study.

<i>Test</i>	<i>Value</i>
Melting point	134 °C
Relative density	1.33 at 20 °C
Water solubility	624 g/l at 20 °C
Partition coefficient	< -1.73 (sd: 0.16) at 22 ± 2 °C
Flammability	Not highly flammable
Self-ignition	No self-ignition below the melting point
Oxidising properties	No oxidising properties (expert statement)
Dissociation constant	$pK_b < 0.6$