Application Note

Refractive index and urea content of AdBlue®

Industry	:	Chemicals
Instrument	:	Refractometer
Measurement method	:	Detection of critical angle of optical refraction
Standards	:	ISO 22241, JIS K2247

1. Scope

Refractive index and urea content of AdBlue® were determined based on “ISO 22241 Diesel engines - NOx reduction agent AUS 32 -.

First, refractive indexes of urea standard solution at a concentration of 30-35% were measured, and calibration curve of refractive index and urea concentration was prepared. Then, refractive index of a sample was measured, and urea content was calculated by using the calibration curve. The calculated urea content was corrected by deducing biuret content of the sample determined by spectrophotometry.

2. Precautions

1) Perform a calibration with air and pure water before measurement.

3. Post-measurement procedure

1) Wash the prism surface of refractometer with pure water and wipe it.

4. Apparatus

Main unit : Refractometer

5. Reagents

・Urea standard solution (concentration : 30.0, 31.5, 32.5, 33.5, 35.0 mass%)
These solutions were prepared by dissolving urea dried at 105°C for 2 hours in pure water.

6. Procedure

-Measurement-
1) Set the measuring temperature of the main unit to 20°C, and wait until it is stabilized.
2) Perform a calibration with air and pure water.
3) Drip the standard solution or the sample on the prism surface, and close the cover.
4) Start a measurement.
5) Wash the prism surface with pure water and dry it.

7. Calculation

-Evaluation factor-

$$F = \frac{\sum_{i=1}^{5} w_{\mathrm{U},i}}{\sum_{i=1}^{5}\left(n_{\mathrm{U},i} - n_{\mathrm{W}}\right)}$$

F	:	Evaluation factor
$w_{\mathrm{U,i}}$	:	Urea content of standard solution (mass%)
$n_{\mathrm{U,i}}$	:	Refractive index of standard solution
n_{W}	:	Refractive index of water = 1.33299

-Urea content-

$$W_{\mathrm{U}} = (n_{\mathrm{P}} - n_{\mathrm{W}}) \times F - w_{\mathrm{Bi}}$$

w_{U}	:	Urea content of sample (mass%)
n_{P}	:	Refractive index of sample
n_{W}	:	Refractive index of water = 1.33299
F	:	Evaluation factor
w_{Bi}	:	Biuret content of sample*[1] = 0.11(mass%)

*1 Biuret content of sample was separately determined by spectrophotometry. Biuret forms in alkaline solution in the presence of sodium-potassium-tartrate with bivalent copper a complex with an absorption maximum at 550 nm. This complex was read spectrophotometrically at 550 nm and the biuret concentration was determined by reference to a calibration curve prepared from standard biuret solutions.

*2 The limit value of biuret content is below 0.3 mass%.

8. Example

-Parameter-

<Measurement Parameter>

Set temperature : 20.0 (°C)
Stability sense : Stability 0
Wait time : 0 (sec)
Limit time : 600 (sec)

<Contents>

Contents : nD
Decimal place : 5

<Temprature Compensation>

Temp. Comp. : Off

（This parameter is an example of our refractometer. For other models, parameter items may be different or other items may be added.）

-Measurement results-

Preparation of calibration curve

Measurement results of refractive index of urea standard solution and calibration curve are shown in Table 1 and Fig. 1 respectively. The evaluation factor was calculated to be 655.29.

Table 1 Measurement results of urea standard solution

Urea content	Refractive index		
(mass%)	1	2	Mean
29.97	1.37850	1.37850	1.37850
31.45	1.38087	1.38087	1.38087
32.47	1.38254	1.38254	1.38254
33.48	1.38417	1.38417	1.38417
34.99	1.38664	1.38664	1.38664

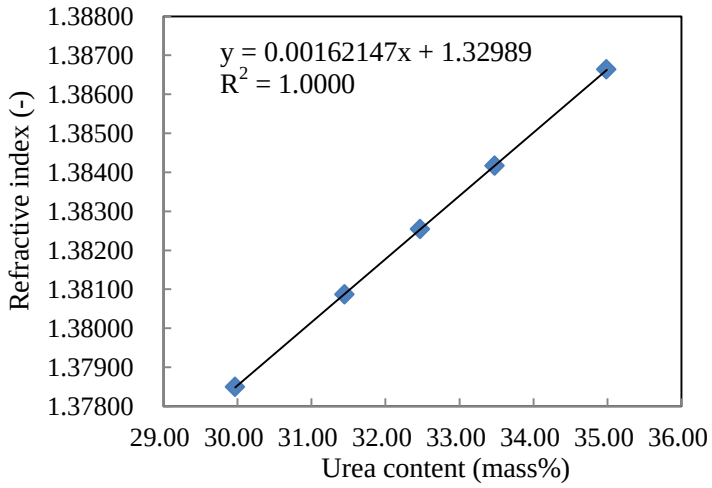

Fig. 1 Calibration curve

Measurement of sample

Measurement results of refractive index and urea content of sample are shown in Table 2.

Table 2 Measurement results of sample

	Refractive index	Urea content
	(-)	(mass%)
1	1.38321	32.80
2	1.38322	32.81
Mean	1.38322	32.81
Repeatability*	0.00001	0.01

*Repeatability means the difference of the two results.

9. Summary

As the measurement results of refractive index and urea content of AdBlue®, both repeatabilities were within the limit (Refractive index : 0.0001, Urea content : 0.1) specified by the ISO and JIS standards, and both results satisfied the quality requirements (Refractive index : 1.3814 - 1.3843, Urea content : 31.8 - 33.2).

When actually measuring, please refer to the latest standards.

10. References

1) ISO 22241 : 2006 (E) Diesel engines－NOx reduction agent AUS 32－

2) JIS K2247 : 2009 Diesel engines－NOx reduction agent AUS 32－