Application Note

Temperature dependence of viscosity of ethylene glycol

Industry	:	Petroleum, Energy
Instrument	:	Viscometer
Measurement method	:	Electro Magnetically Spinning Method
Standards	:	

1. Scope

Ethylene glycol is a kind of dihydric alcohol widely used as a solvent, antifreeze solution, synthetic raw material, etc.
The viscosity rises as the concentration of ethylene glycol increase in the minus temperature range. In addition, the rise in viscosity causes degradation of circulation flow rate and cooling capacity.
An example of measuring the temperature dependence of the dynamic viscosity of ethylene glycol using an EMS viscometer that can be measured by sealing, sterilization and non-contact was shown below.

2. Precautions

When performing measurement below the ambient temperature, make sure to introduce dry air to the instrument before starting measurement in order to prevent dew condensation.

3. Post-measurement procedure

The sample container and the sample are discarded appropriately.

4. Apparatus

- EMS Viscometer
- Control Laptop PC
- Dry Air Unit
- Compressor

5. Reagents

- Sample : Ethylene glycol

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6. Procedure

1) Enter the following conditions in measurement condition of the sequence mode of control software.
   - ✧ Measurement mode :Sequence mode
   - ✧ Measurement temperature :0-200℃ (10℃ interval)
   - ✧ Motor rotation speed :1,000 rpm
   - ✧ Measurement time :I (1 second)
   - ✧ Repeat count :10 times
   - ✧ Measurement interval :5 seconds
   - ✧ Waiting time for temperature stability :10 minutes
2) Place an aluminum spherical probe of φ 2 mm and a sample of 300 μL in a container, cover with a cap and packing, set the sample container in the EMS Viscometer, and click the measurement button.

7. Example

The viscosity measurement results about the temperature dependence of ethylene glycol are shown in Figure 1 and Table 1,2.
The result is confirmed to be corresponding to the value described in the reference below well.

The difference of measurement results is seen to be large in the high temperature, however, it can be measured stably within R.S.D.3% even in the vicinity of boiling point (197.3℃).

For your information, it takes about 4 and half hours to measure the temperature dependence of the viscosity with sequence measurement.

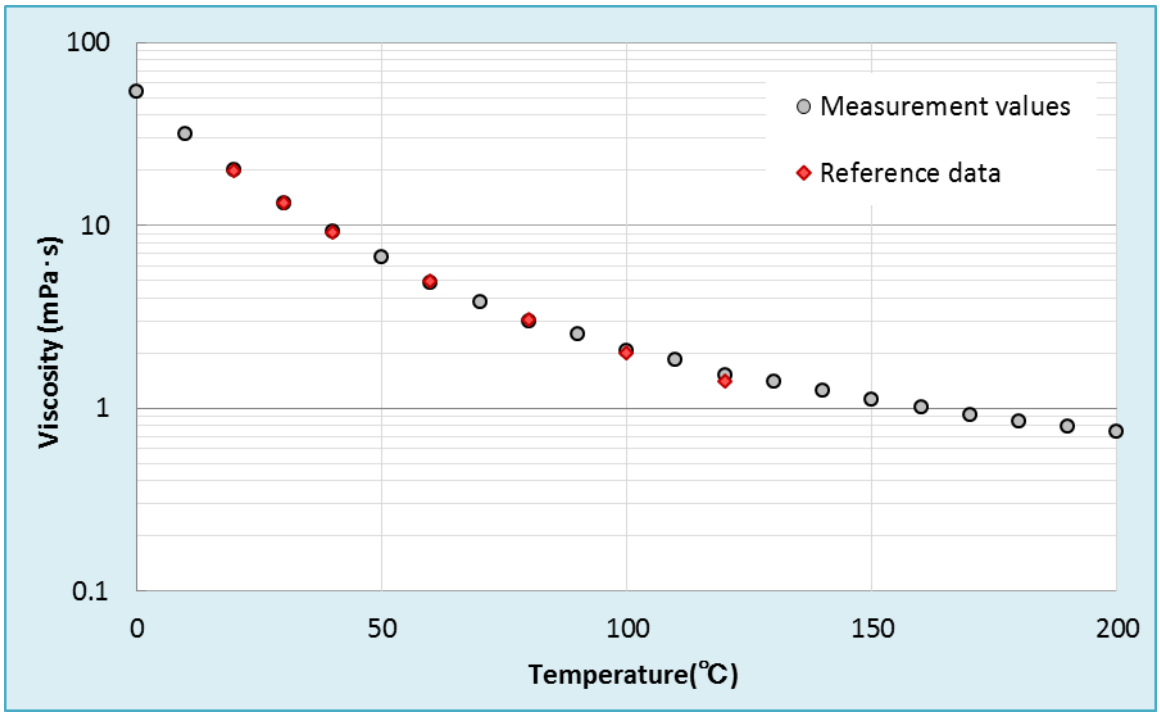


Figure 1. Measurement result about the temperature dependence of the viscosity of ethylene glycol

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Table 1. Measurement result about the temperature dependence of the viscosity (0 - 100℃)

(mPa･s)

Frequency of measurement	Temperature (℃)										
	0	10	20	30	40	50	60	70	80	90	100
1st	53.8	31.4	20.0	13.2	9.29	6.65	4.88	3.82	2.98	2.53	2.05
2nd	53.8	31.4	20.0	13.2	9.26	6.69	4.88	3.82	2.98	2.53	2.05
3rd	53.8	31.5	20.0	13.2	9.28	6.67	4.88	3.82	2.99	2.53	2.06
4th	53.8	31.4	20.0	13.2	9.29	6.68	4.89	3.83	2.99	2.53	2.05
5th	53.8	31.5	20.0	13.2	9.28	6.67	4.89	3.83	2.99	2.53	2.06
6th	53.8	31.5	20.0	13.2	9.29	6.66	4.88	3.82	2.98	2.53	2.05
7th	53.7	31.5	20.0	13.2	9.28	6.67	4.88	3.82	2.98	2.53	2.05
8th	53.7	31.5	20.0	13.2	9.28	6.67	4.89	3.83	2.98	2.53	2.05
9th	53.7	31.4	20.0	13.2	9.28	6.67	4.88	3.82	2.98	2.53	2.05
10th	53.7	31.5	20.0	13.2	9.29	6.67	4.88	3.82	2.98	2.53	2.05
Mean	53.8	31.5	20.0	13.2	9.28	6.67	4.88	3.82	2.98	2.53	2.05
Standard deviation	0.1	0.1	0.0	0.0	0.01	0.01	0.00	0.00	0.00	0.00	0.00
RSD (%)	0.1	0.2	0.0	0.0	0.1	0.2	0.1	0.1	0.2	0.0	0.2
Reference data			19.9	13.2	9.13		4.95		3.02		1.99

Table 2. Measurement result about the temperature dependence of the viscosity (110 - 200℃)

(mPa･s)

Frequency of measurement	Temperature (℃)									
	110	120	130	140	150	160	170	180	190	200
1st	1.84	1.51	1.39	1.24	1.12	1.01	0.92	0.85	0.79	0.70
2nd	1.83	1.52	1.39	1.24	1.12	1.01	0.92	0.85	0.78	0.77
3rd	1.83	1.51	1.39	1.25	1.12	1.00	0.92	0.85	0.77	0.76
4th	1.83	1.51	1.39	1.25	1.11	1.01	0.93	0.85	0.81	0.74
5th	1.82	1.51	1.40	1.24	1.12	1.01	0.92	0.85	0.81	0.74
6th	1.83	1.51	1.39	1.24	1.12	1.01	0.92	0.84	0.80	0.72
7th	1.83	1.51	1.39	1.24	1.12	1.00	0.92	0.86	0.79	0.74
8th	1.83	1.51	1.39	1.24	1.12	1.01	0.92	0.83	0.80	0.74
9th	1.83	1.51	1.39	1.26	1.13	1.01	0.92	0.85	0.80	0.74
10th	1.83	1.51	1.39	1.25	1.12	1.01	0.92	0.85	0.80	0.74
Mean	1.83	1.51	1.39	1.25	1.12	1.01	0.92	0.85	0.80	0.74
Standard deviation	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.02
RSD (%)	0.3	0.2	0.3	0.6	0.4	0.4	0.5	1.0	1.7	2.6
Reference data		1.40		1.04						

8. Summary

Temperature dependence of viscosity of ethylene glycol can be measured in a wide temperature range of 0-200℃. Even the high hygroscopic sample like ethylene glycol can be confirmed the measurement stability under sealing without absorbing moisture.

9. References

Chemical Handbook (Revision the fifth edition) Basic course II -40
[Table 7.15 Temperature θ dependence of viscosity coefficient η of organic compound]

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