Application Note
Concentration dependence of viscosity of alcohol aqueous solution

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

1. Scope

Alcohol is used not only as raw materials, fuels and disinfectants for the chemical industry using solvent but also for foods and cosmetics.
Examples of measuring the concentration dependence of the dynamic viscosity of alcohol aqueous solutions using an EMS viscometer that can be measured by sealing, sterilization and non-contact were shown below.

2. Precautions

None.

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 ： Methanol, ethanol, 2-propanol, deionized water(dilution solvent)

6. Procedure

1) Enter the following conditions in measurement condition of the sequence mode of control software.

✦ Measurement mode   :Repeat mode
✦ Measurement temperature   :20℃
✦ Motor rotation speed   :1,000 rpm
✦ Measurement time   :I (1 second)
✦ Repeat count   :10 times
✦ Measurement interval   :30 seconds

2) Place an aluminum spherical probe of φ 2 mm and a the sample in the solid state to a container, cover with a cap and packing, set the sample container in the EMS Viscometer, and click the measurement button after controlling the temperature for 5 minutes.

3) Take out the sample container at each measurement and stir the sample with shaking by the hand.

4) Add the dilution solvent to the sample after 10 times measurement, and measure under the same condition.

7. Example

The measurement results about the concentration dependence of viscosity of alcohol aqueous solution are shown in Figure 1 and Table 1-3.

And the graph which compares measurement results of methanol and ethanol with the reference data respectively are shown in Figure 2 and 3.

The results of all three samples show the characteristic concentration dependence with the peak around 40%. And, in both methanol and ethanol, it is possible to obtain the measured viscosity value close to the reference data.
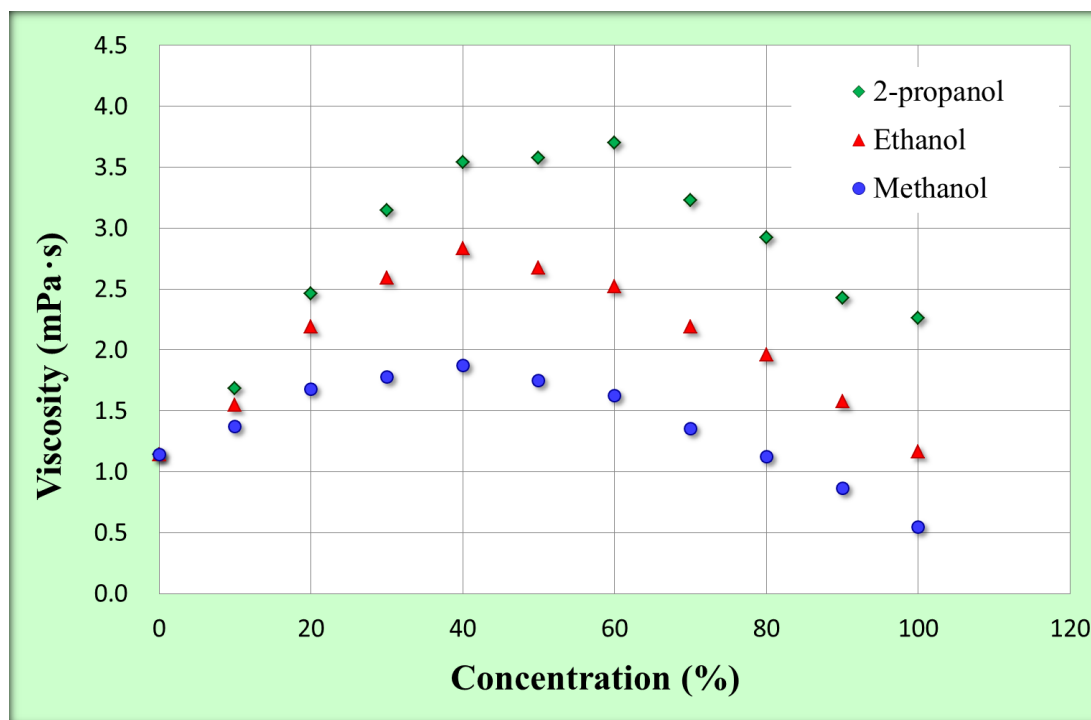

**Figure 1. Measurement result about concentration dependence of viscosity
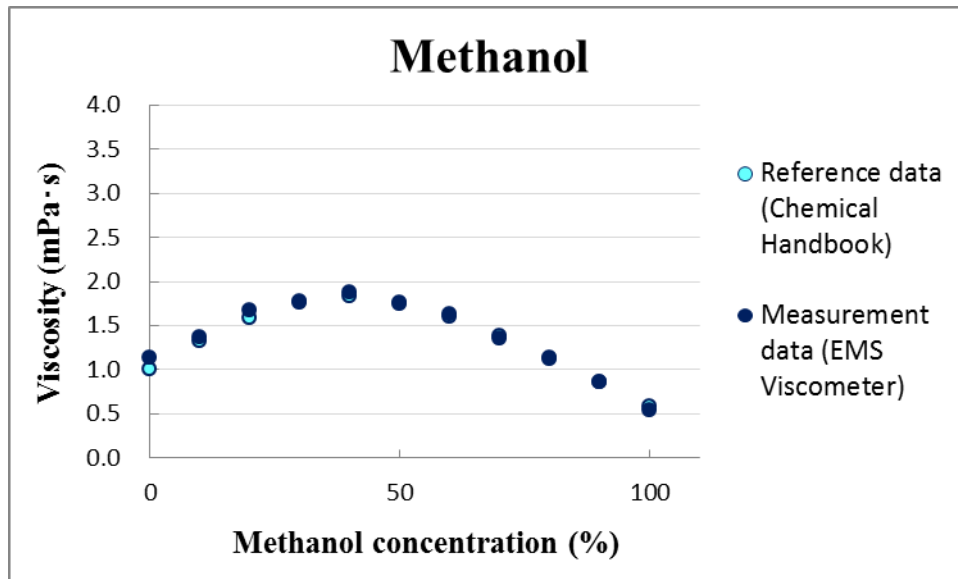of each alcohol aqueous solution**

**Figure 2. Measurement result about concentration dependence
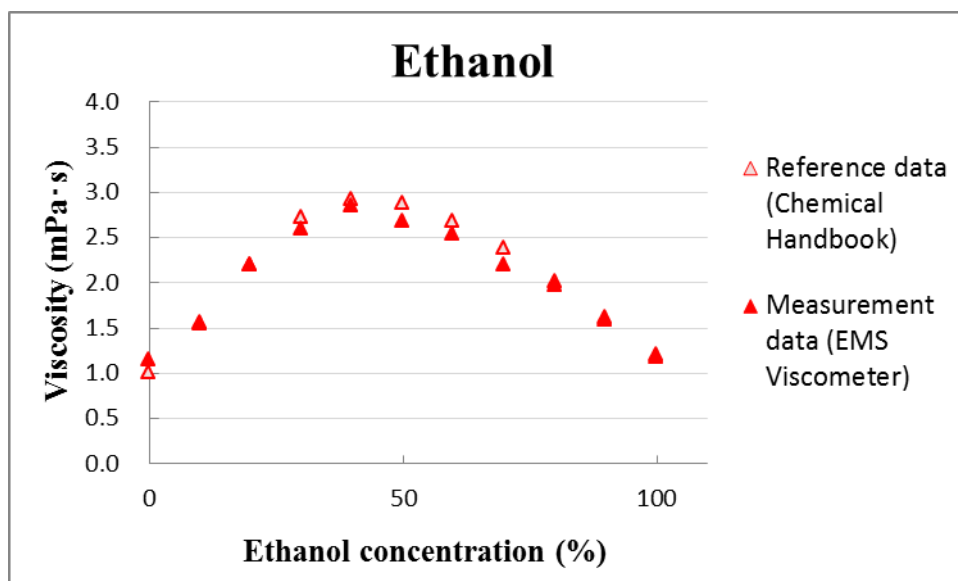of methanol aqueous solution (compared with reference data)**

**Figure 3. Measurement result about concentration dependence
of ethanol aqueous solution (compared with reference data)**

Table 1. Measurement result about concentration dependence of methanol

(mPa・s)

Methanol	Concentration (%)										
	0	10	20	30	40	50	60	70	80	90	100
1	1.10	1.32	1.63	1.74	1.83	1.80	1.58	1.32	1.07	0.82	0.51
2	1.03	1.31	1.75	1.75	1.84	1.71	1.65	1.34	1.09	0.91	0.52
3	1.20	1.42	1.79	1.76	1.82	1.85	1.56	1.36	1.13	0.88	0.52
4	1.07	1.39	1.64	1.82	1.86	1.80	1.70	1.38	1.18	0.87	0.52
5	1.10	1.42	1.66	1.79	1.88	1.73	1.58	1.36	1.12	0.82	0.56
6	1.21	1.33	1.66	1.78	1.94	1.66	1.57	1.37	1.09	0.91	0.57
7	1.14	1.37	1.64	1.76	1.88	1.80	1.58	1.35	1.11	0.88	0.55
8	1.20	1.33	1.66	1.81	1.85	1.70	1.70	1.35	1.13	0.85	0.54
9	1.21	1.33	1.66	1.81	1.87	1.73	1.69	1.37	1.15	0.84	0.58
10	1.15	1.50	1.68	1.74	1.94	1.74	1.63	1.34	1.15	0.87	0.57
Mean	1.14	1.37	1.68	1.78	1.87	1.75	1.62	1.35	1.12	0.87	0.54
Standard deviation	0.06	0.06	0.05	0.03	0.04	0.06	0.06	0.02	0.03	0.03	0.03
RSD (%)	5.64	4.42	3.09	1.70	2.22	3.33	3.52	1.31	2.96	3.75	4.68

Table 2. Measurement result about concentration dependence of ethanol

(mPa・s)

Ethanol	Concentration (%)										
	0	10	20	30	40	50	60	70	80	90	100
1	1.10	1.57	2.18	2.56	2.90	2.69	2.54	2.18	2.03	1.59	1.18
2	1.03	1.55	2.11	2.53	2.81	2.75	2.49	2.23	1.97	1.56	1.16
3	1.20	1.58	2.15	2.67	2.74	2.63	2.54	2.21	2.01	1.54	1.22
4	1.07	1.48	2.06	2.58	2.70	2.71	2.64	2.16	2.09	1.54	1.21
5	1.10	1.54	2.12	2.60	2.96	2.61	2.48	2.24	1.90	1.58	1.13
6	1.21	1.61	2.22	2.58	2.87	2.63	2.49	2.16	1.96	1.57	1.13
7	1.14	1.53	2.26	2.63	2.91	2.60	2.53	2.17	1.89	1.66	1.14
8	1.20	1.50	2.30	2.67	2.79	2.65	2.57	2.18	1.89	1.53	1.17
9	1.21	1.55	2.30	2.49	2.79	2.79	2.48	2.18	1.95	1.55	1.15
10	1.15	1.57	2.20	2.59	2.88	2.71	2.47	2.21	1.95	1.65	1.13
Mean	1.14	1.55	2.19	2.59	2.84	2.68	2.52	2.19	1.96	1.58	1.17
Standard deviation	0.06	0.04	0.08	0.06	0.08	0.06	0.05	0.03	0.03	0.05	0.03
RSD (%)	5.64	2.47	3.73	2.20	2.90	2.36	2.10	1.30	3.30	2.87	2.92

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Table 3. Measurement result about concentration dependence of 2- propanol

(mPa·s)

2- propanol	Concentration (%)										
	0	10	20	30	40	50	60	70	80	90	100
1	1.10	1.63	2.43	3.22	3.44	3.55	3.84	3.18	2.98	2.45	2.25
2	1.03	1.75	2.47	3.03	3.68	3.51	3.78	3.24	2.97	2.53	2.24
3	1.20	1.66	2.43	3.21	3.65	3.53	3.69	3.19	2.92	2.46	2.23
4	1.07	1.68	2.45	3.21	3.59	3.58	3.56	3.22	3.04	2.42	2.29
5	1.10	1.74	2.44	3.21	3.64	3.57	3.89	3.24	2.93	2.39	2.29
6	1.21	1.71	2.48	3.11	3.47	3.57	3.62	3.20	2.82	2.43	2.29
7	1.14	1.74	2.43	3.16	3.53	3.73	3.62	3.27	2.82	2.38	2.29
8	1.20	1.63	2.48	3.04	3.53	3.65	3.52	3.19	2.97	2.45	2.25
9	1.21	1.62	2.49	3.02	3.42	3.51	3.84	3.23	2.86	2.38	2.24
10	1.15	1.68	2.50	3.24	3.47	3.57	3.63	3.33	2.92	2.37	2.23
Mean	1.14	1.68	2.46	3.15	3.54	3.58	3.70	3.23	2.92	2.43	2.26
Standard deviation	0.06	0.05	0.03	0.09	0.09	0.07	0.13	0.05	0.07	0.05	0.03
RSD (%)	5.64	2.93	1.10	2.45	2.64	1.88	3.51	1.40	2.46	2.03	1.18

8. Summary

For EMS viscometer, since it can be measured in sealed state, the viscosity of volatile sample such as alcohol aqueous solution can be stably measured without concentration change of the sample.

9. References

Chemical Handbook (Revision the fifth edition) Basic course II-49
[Table 7.22 Temperature θ dependence of viscosity coefficient η of ethanol aqueous solution]
[Table 7.23 Temperature θ dependence of viscosity coefficient η of methanol aqueous solution]

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