

## Application Note

# Temperature dependence of viscosity of commercial eye drops

Industry	:	Pharmaceutical
Instrument	:	EMS Viscometer
Measurement method	:	Electro Magnetically Spinning Method
Standards	:	-

## 1. Overview

Viscosity is an important property of eyedrops, influencing how they cover the surface of the eye, as well as their effectiveness in locking in moisture.

In this application note, the determination of the temperature dependence of the dynamic viscosity of commercially available eye drops using the EMS Viscometer, a non-contact viscometer that uses autoclavable and airtight sample tubes, is shown.

## 2. Precautions

If the instrument is set to measure at temperatures lower than ambient, make sure to introduce dry air into the instrument before starting measurement to prevent condensation.

## 3. Post-measurement procedure

All sample tubes and samples are discarded according to proper waste disposal procedures.

## 4. Apparatus

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

## 5. Reagents

- Sample: 3 commercially available eye drop products

## 6. Procedure

- 1) Set the following measurement parameters in the EMSVisco software:
  - ✧ Temperature :10-40°C (5°C intervals)
  - ✧ Motor rotation speed :1,000 rpm
  - ✧ Meas. time :1 (1 second)
  - ✧ Repeat times :10 times
  - ✧ Meas. interval :5 seconds
  - ✧ Hold time :10 minutes
- 2) Transfer a 2mm diameter aluminum probe ( $\phi 2\text{mm}$ ) and 300 $\mu\text{L}$  of sample into a sample tube, seal it with its tube cap and packing, set the sample tube into the EMS Viscometer, and then click the measurement button.
- 3) After measuring the first sample, measure the remaining samples using the same parameters.

## 7. Results & Discussion

The viscosity data for the eye drop products (“A”, “B”, and “C”) across a temperature range of 10-40°C is shown in Tables 1-3, and plotted on the graph in Figure 1, illustrating their temperature dependence of viscosity trends. The viscosity of product C was very low, almost equal to that of water, and underwent negligible change across the temperature range investigated. The average viscosities of A and B were 15 and 11 mPa · s respectively at 10°C and approx. 4 at 40°C.

This temperature dependence of viscosity study required 80 minutes per product, equaling about 4 hours in total to perform all measurements.

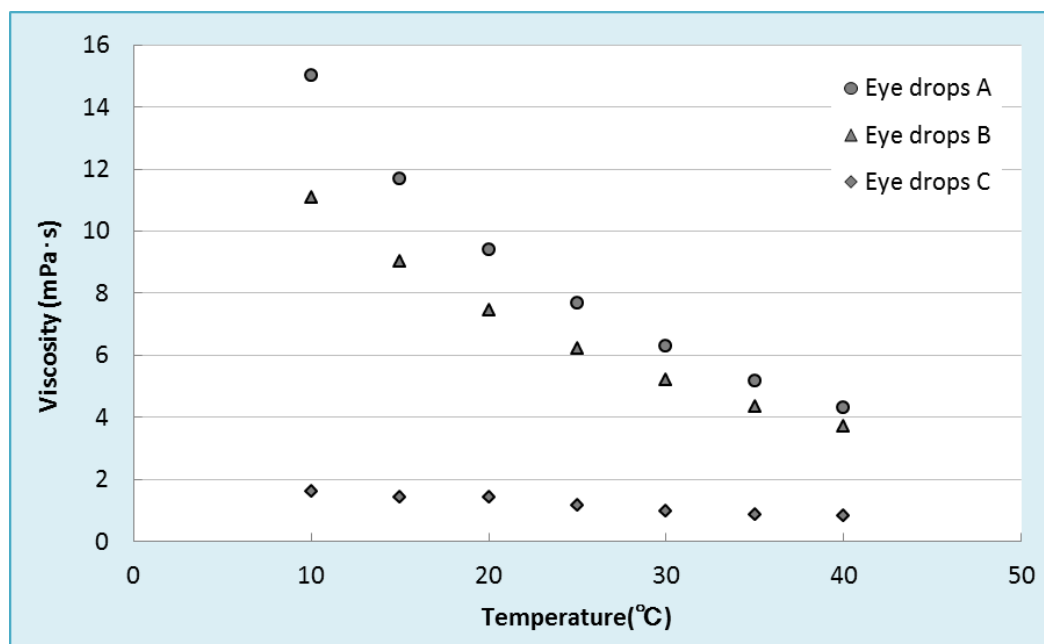


Figure 1. Data showing the temperature dependence of viscosity for eye drops

**Table 1. The viscosity of eye drop product A over a temperature range of 10 - 40°C**  
(mPa·s)

Frequency of measurement	Temperature (°C)						
	10	15	20	25	30	35	40
1st	15.1	11.7	9.45	7.66	6.28	5.19	4.33
2nd	15.0	11.7	9.42	7.66	6.28	5.19	4.33
3rd	15.1	11.7	9.38	7.67	6.28	5.19	4.32
4th	15.0	11.7	9.37	7.67	6.28	5.19	4.34
5th	15.0	11.7	9.36	7.67	6.28	5.17	4.33
6th	15.0	11.7	9.35	7.73	6.28	5.17	4.32
7th	15.0	11.7	9.35	7.70	6.28	5.21	4.33
8th	15.0	11.7	9.37	7.68	6.29	5.18	4.31
9th	14.9	11.7	9.35	7.71	6.29	5.17	4.34
10th	15.0	11.6	9.45	7.68	6.29	5.18	4.32
Mean	15.0	11.7	9.39	7.68	6.28	5.18	4.33
Standard deviation	0.1	0.0	0.04	0.02	0.00	0.01	0.01
RSD (%)	0.4	0.3	0.4	0.3	0.1	0.2	0.2

**Table 2. The viscosity of eye drop product B over a temperature range of 10 - 40°C**  
(mPa·s)

Frequency of measurement	Temperature (°C)						
	10	15	20	25	30	35	40
1st	11.1	9.03	7.46	6.21	5.21	4.40	3.68
2nd	11.1	9.02	7.48	6.17	5.22	4.39	3.69
3rd	11.1	9.03	7.48	6.21	5.21	4.35	3.73
4th	11.1	9.02	7.52	6.25	5.21	4.36	3.70
5th	11.1	9.02	7.52	6.25	5.21	4.36	3.70
6th	11.1	9.01	7.49	6.25	5.21	4.34	3.70
7th	11.1	9.01	7.41	6.25	5.21	4.34	3.68
8th	11.1	9.00	7.45	6.24	5.15	4.34	3.69
9th	11.1	9.08	7.46	6.26	5.19	4.34	3.69
10th	11.1	9.04	7.43	6.25	5.20	4.35	3.69
Mean	11.1	9.03	7.47	6.23	5.20	4.36	3.70
Standard deviation	0.0	0.02	0.04	0.03	0.02	0.02	0.01
RSD (%)	0.0	0.2	0.5	0.5	0.4	0.5	0.4

**Table 3. The viscosity of eye drop product C over a temperature range of 10 - 40°C**  
(mPa·s)

Frequency of measurement	Temperature (°C)						
	10	15	20	25	30	35	40
1st	1.62	1.44	1.40	1.19	0.99	0.87	0.82
2nd	1.62	1.45	1.40	1.19	0.99	0.88	0.80
3rd	1.62	1.44	1.40	1.19	0.98	0.88	0.82
4th	1.63	1.44	1.42	1.19	0.99	0.87	0.82
5th	1.62	1.44	1.41	1.19	0.99	0.87	0.82
6th	1.62	1.43	1.42	1.19	0.99	0.87	0.84
7th	1.62	1.43	1.42	1.18	0.99	0.87	0.83
8th	1.62	1.43	1.44	1.17	0.98	0.87	0.84
9th	1.63	1.43	1.43	1.17	0.98	0.87	0.85
10th	1.63	1.43	1.44	1.17	0.99	0.87	0.84
Mean	1.62	1.44	1.42	1.18	0.99	0.87	0.83
Standard deviation	0.00	0.01	0.02	0.01	0.00	0.00	0.01
RSD (%)	0.3	0.5	1.1	0.8	0.5	0.5	1.8

## 8. Summary

The EMS Viscometer was successfully utilized to measure data required in determining the temperature dependence of viscosity for 3 eye drop products. The difference in temperature dependence of viscosity for slightly viscous eye drop products and an eye drop product with very low viscosity (close to that of water) was determinable.

It was interesting to visualize the comparatively large dependence viscosity had on temperature for products A and B, and this likely helps explain one of the reasons eye drops may “feel” a little different when applied in differing temperatures and seasons, useful information in product development for example.

## 9. References

None.