

Application Note

Measuring the viscosity of xanthan gum solution and creating a flow curve

Industry	:	Food & beverage, Cosmetics & soap, Pharmaceutical
Instrument	:	EMS Viscometer
Measurement method	:	Electro Magnetically Spinning Method
Standards	:	-

1. Overview

Xanthan gum is a polysaccharide product made by the fermentation of starch (derived from plants such as corn) with the bacterial species *Xanthomonas campestris*. Xanthan gum becomes viscous when mixed in water, making it ideal as a thickener and stabilizing agent in dressings, sauces, retort pouch foods, frozen meals, etc.

In this application note, the measurement of the dynamic viscosity of xanthan gum at various concentrations using the EMS Viscometer, a non-contact viscometer that uses autoclavable and airtight sample tubes, is shown.

2. Precautions

Although xanthan gum is soluble in water, it will require agitation using a Vortex or similar after it has been afforded sufficient time to swell.

In this measurement example, samples of varying concentrations were prepared by adding the appropriate amount of xanthan gum to ion-exchanged water and allowed to stand at room temperature for about 14 hours or more to swell.

3. Post-measurement procedure

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

4. Apparatus

- EMS Viscometer
- Control Laptop PC

5. Reagents

- Samples: 0.1%, 0.2%, 0.3% xanthan gum solution (food additive grade)
- Deionized water

6. Procedure

- 1) Select sequence mode in the control software and set the following measurement parameters:

✧ Measurement mode	: Repeat mode, Sequence mode
✧ Temperature	: 25°C
✧ Motor rotation speed	: I (1,000rpm: repeat mode) II (100~1,000rpm: sequence mode) : Rise and descent in increments of 100 rpm)
✧ Meas. time	: I (1 second)~III(10 seconds)
✧ Repeat times	: I (5 times: repeat mode) II (5 times sequence mode)
✧ Meas. interval	: 5 seconds
✧ Hold time	: 5 minutes/300 sec
- 2) Transfer a 2mm diameter aluminum probe ($\phi 2\text{mm}$) and 300 μL 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

Viscosity measurement results for each concentration of xanthan gum solution using repeat measurement mode under a constant 1000rpm are shown in Figure 1 and Table 1. Figure 2 shows the flow curve of 0.1% xanthan gum solution after measuring in sequence mode. The viscosity results for the same sequence mode measurement of 0.1% xanthan gum solution are shown in Table 2, while the Casson plot is shown in Figure 3.

Although the coefficient of variation (CV) for viscosity results of 0.1%, 0.2%, 0.3% xanthan gum solution increased as the concentration increased, it stayed under 0.5% so the results are considered reliable.

For repeat mode measurement, each sample took approximately 6 minutes to measure, involving 5 minutes of temperature stabilization time and 1 minute to take 5 measurements.

For sequence mode measurement, it was possible to generate all desired data and have a flow curve plotted in approximately 40 minutes.

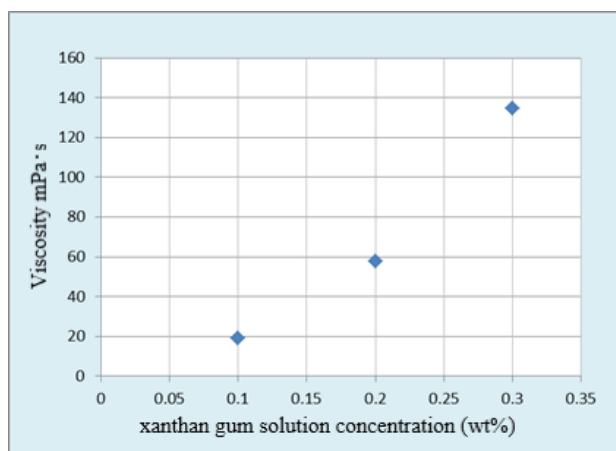


Figure 1. The viscosity of 3 concentrations of xanthan gum solution (Repeat Mode Measurement)

Table 1. The viscosity of 3 concentrations of xanthan gum solution (Repeat Mode Measurement)

Motor rotation speed rpm	n	Concentration of xanthan gum solution(%)					
		0.1		0.2		0.3	
		Viscosity (mPa·s)	Shear rate s ⁻¹	Viscosity (mPa·s)	Shear rate s ⁻¹	Viscosity (mPa·s)	Shear rate s ⁻¹
1000	1	19.1	52.94	57.5	22.93	134	10.71
	2	19.1	52.78	57.4	22.93	134	10.71
	3	19.1	52.78	57.6	22.78	135	10.68
	4	19.1	52.78	57.7	22.78	135	10.68
	5	19.1	52.78	57.5	22.93	135	10.65
	Ave	19.1	52.81	57.54	22.87	134.6	10.69
	SD	0.000	0.070	0.114	0.086	0.548	0.026
	CV	0.0%	0.1%	0.2%	0.4%	0.4%	0.2%

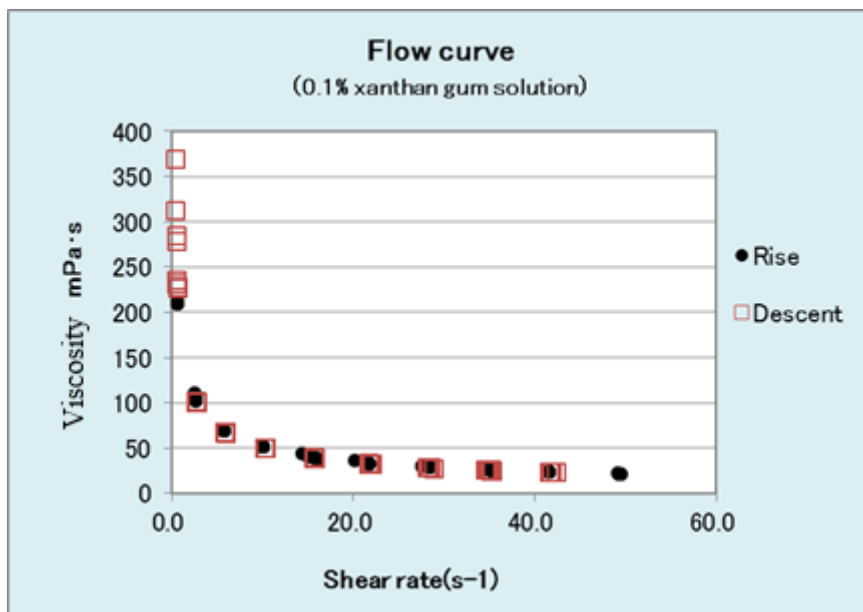


Figure 2. Flow curve of 0.1% xanthan gum solution (Sequence Mode Measurement)

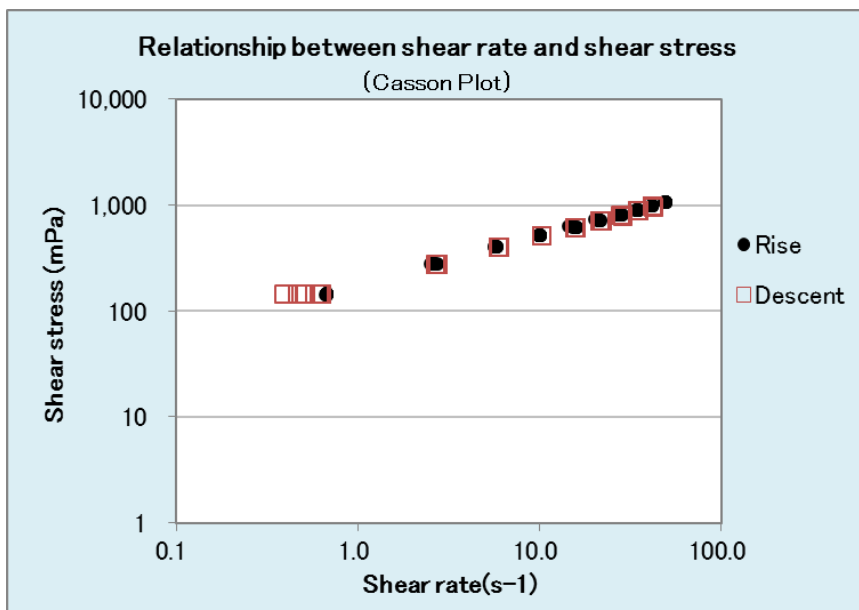


Figure 3. Casson plot for 0.1% xanthan gum solution (Sequence Mode Measurement)

Table 2. Measurement results for 0.1% xanthan gum solution (Sequence Mode Measurement)

	Motor rotation speed rpm	Measurement number (5 times total)					Ave (mPa·s)	SD	CV
		1	2	3	4	5			
Rise	100	210.0	209.0	210.0	210.0	211.0	210.0	0.707	0.3%
	200	106.0	109.0	110.0	108.0	108.0	108.2	1.483	1.4%
	300	69.9	69.7	70.0	70.1	70.1	70.0	0.167	0.2%
	400	50.9	50.8	51.0	50.8	51.1	50.9	0.130	0.3%
	500	41.0	41.2	41.0	41.6	41.0	41.2	0.261	0.6%
	600	32.5	32.9	32.7	32.7	33.0	32.8	0.195	0.6%
	700	29.1	29.1	29.1	29.0	29.0	29.1	0.055	0.2%
	800	25.7	25.7	25.8	25.7	25.7	25.7	0.045	0.2%
	900	23.3	23.3	23.2	23.3	23.2	23.3	0.055	0.2%
	1000	21.1	21.1	21.1	21.2	21.3	21.2	0.089	0.4%
Descent	900	23.4	23.3	23.3	23.3	23.2	23.3	0.071	0.3%
	800	25.0	25.1	25.0	25.0	24.9	25.0	0.071	0.3%
	700	28.4	27.9	27.3	27.9	27.9	27.9	0.390	1.4%
	600	31.8	31.8	31.7	31.6	31.9	31.8	0.114	0.4%
	500	38.6	38.7	38.7	39.0	38.7	38.7	0.152	0.4%
	400	49.5	49.5	49.4	49.7	49.7	49.6	0.134	0.3%
	300	66.7	66.6	66.4	66.3	66.2	66.4	0.207	0.3%
	200	100.0	101.0	101.0	102.0	102.0	101.2	0.837	0.8%
	100	235.0	228.0	232.0	228.0	227.0	230.0	3.391	1.5%

8. Summary

Repeat Mode viscosity measurement (n=5) took about 6 minutes for the 0.1%, 0.2%, and 0.3% xanthan gum solutions.

For the sequence mode measurement, it was observed that the viscosities of the sample at the same shear rate were roughly the same regardless of the measurement point being taken during the rising or descending point of the sequence. This indicates that the sample's higher-order structure was not compromised and that we can assume that the flow curve data is reliable.

9. References

None.