

Application Note

Measurement of viscosity of xanthan gum solution and creation of flow curve

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

1. Scope

Xanthan gum is one of polysaccharides made by fermenting starch such as corn with bacteria (*Xanthomonas campestris*).

Since xanthan gum is viscous when mixed with water, it is used in foods as a thickener and thickening stabilizer for dressing, various sauces, retort pouch foods and frozen foods etc. for a wide range of applications.

An example of measuring Change in viscosity of the solution, containing xanthan gum, using an EMS viscometer that can be measured by sealing, sterilization and non-contact will be shown below.

2. Precautions

Although xanthan gum is soluble in water, it does not dissolve immediately after adding ion exchanged water, so it is necessary to sufficiently stir using Vortex etc. after establishing a sufficient swelling time.

In this measurement example, ion-exchanged water was added to xanthan gum weighed so as to have each concentration, and then allowed to stand at room temperature for about 14 hours or more to swell.

3. Post-measurement procedure

The sample container and the sample are discarded appropriately.

4. Apparatus

- EMS Viscometer
- Control Laptop PC

5. Reagents

- Sample :0.1%, 0.2%, 0.3% xanthan gum(Food additive grade) solution
- Ion exchanged water

6. Procedure

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

| | |
|--|--|
| ✧ Measurement mode | :Repeat mode, Sequence mode |
| ✧ Measurement 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) |
| ✧ Measurement time | :I (1 second)~III(10 seconds) |
| ✧ Repeat count | :I (5 times : repeat mode) II(5 times sequence mode) |
| ✧ Measurement interval | :5 seconds |
| ✧ Waiting time for temperature stability | :5 minutes |
- 2) Place an aluminum spherical probe of ϕ 2 mm and a sample of 300 μ L in a container, cover with a cap and packing, set the sample container in the EMS Viscometer, and click the measurement button.
- 3) Measure another samples on the same condition after the measurement of the first sample is completed.

7. Example

The measurement results of viscosity of each concentration of xanthan gum solution were shown in Figure 1, Table 1, flow curve of 0.1% xanthan gum solution was shown in Figure 2, Table 2(measurement results), and Casson plot was shown in Figure 3.

Although the coefficient of variation (CV) in the viscosity measurement of 5 times ($n = 5$) of 0.1%, 0.2%, 0.3% xanthan gum solution tends to increase as the concentration increases, in any sample 0.5% or less It was stable measurement result.

For reference, it was possible to measure the viscosity in about 6 minutes, including 5 minutes of temperature stabilization wait time by repeating measurement (5 times). In the sequencing measurement, it was possible to create a flow curve in about 40 minutes.

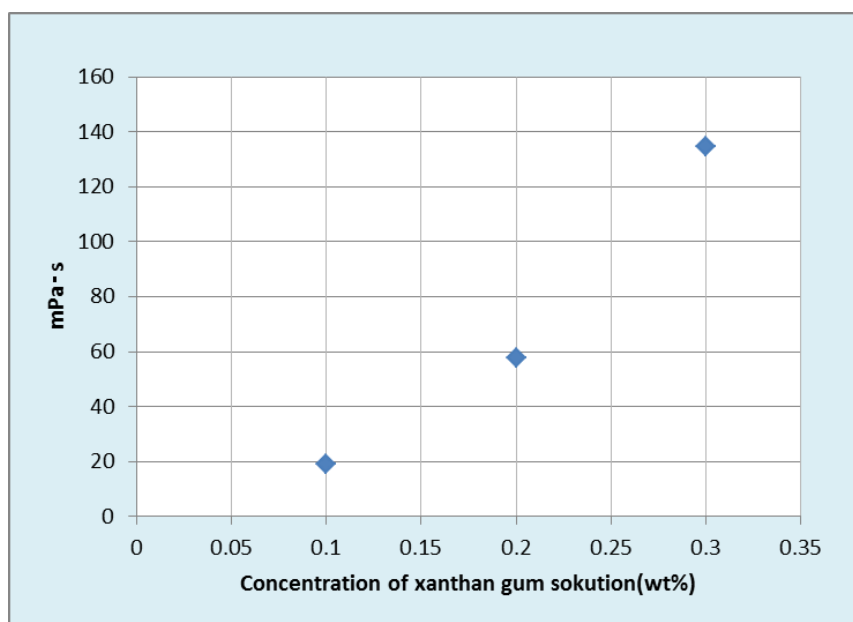


Figure 1. Measurement viscosity of xanthan gum solutions

Table1. Measurement results of xanthan gum solutions

| 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% |

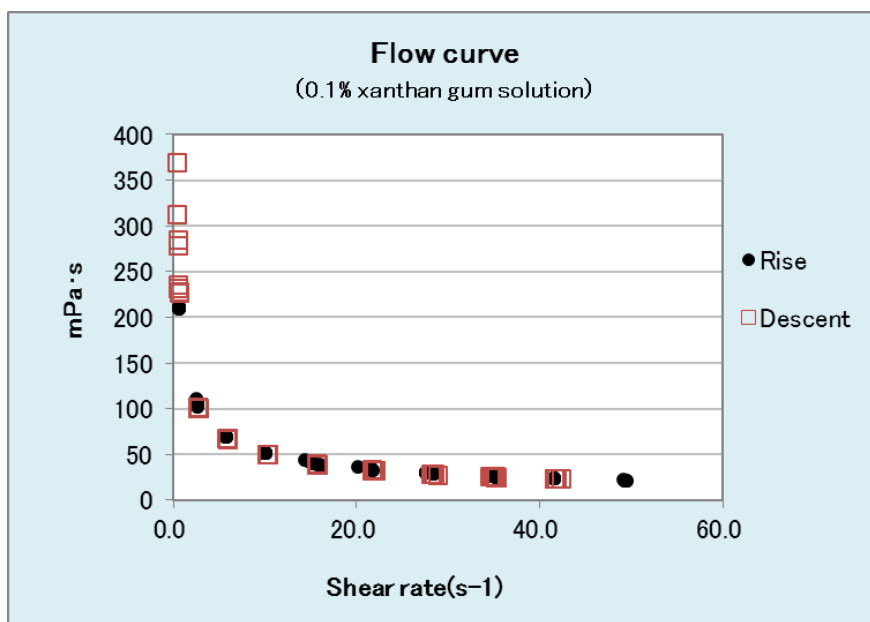


Figure 2. Flow curve of 0.1% xanthan gum solution

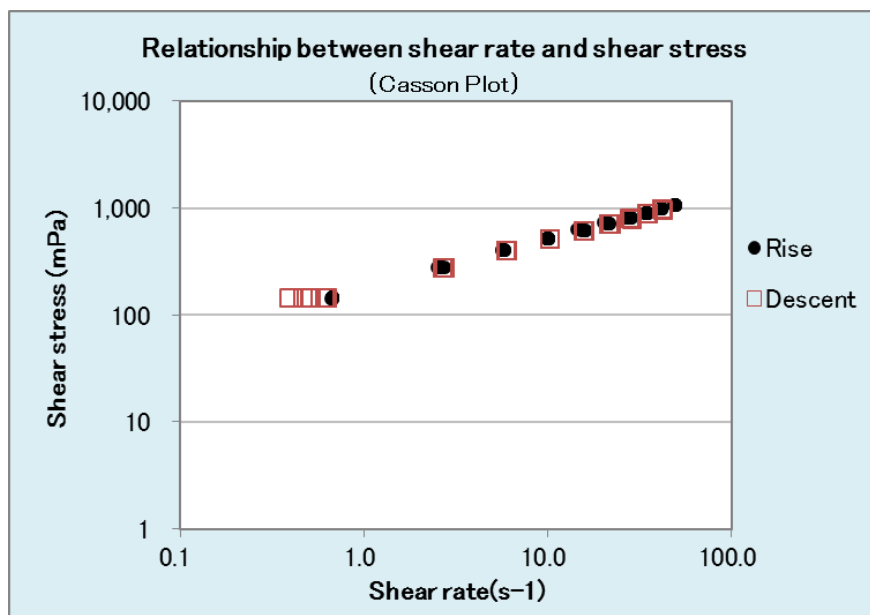


Figure 3. Casson plot of 0.1% xanthan gum solution

Table2. Measurement results of 0.1% xanthan gum solution

| | Motor rotation speed rpm | Measurement times | | | | | 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

The viscosity of 5 times ($n = 5$) of 0.1%, 0.2%, 0.3% xanthan gum solutions could be measured in about 6 minutes, and the coefficient of variation (CV) at that time was an accuracy of 0.5% or less.

In the measurement by the sequence mode, it was confirmed that flow curve could be created without breaking the higher-order structure of sample molecule, because the shear rate increased and the descending viscosity were almost the same.

9. References

None.