Practical 4
Effect of concentration on viscosity

Name: ___________________________  Group: _______  Date: __________

AIM: To determine the effect of substance concentration on viscosity.

APPARATUS

• Beaker 250 mL
• Measuring Cylinder 1 x 100 mL
• Pipette 50mL
• Pipette filler
• Pipette with long spout
• Rubber tubing
• Stop watch
• Thermometer 0 -100 °C
• U-Tube viscometer size A
• Volumetric flask 200mL x 2
• Water bath maintained at 37 °C

MATERIALS

• Sucrose solution A (111 mg/mL)

WARNING: The viscometer is a very fragile instrument. Handle with utmost care.

METHOD

1. Fill the viscometer with sucrose solution ‘A’ via segment L using the pipette with the long spout up to a level a few mm above mark G – taking extra care to keep the sides dry
2. Gently clamp the viscometer by segment N in the water bath ensuring that marks E and F remain clearly visible and wait until the viscometer acclimatizes
3. Bring the meniscus to level G by removing the excess fluid using the long-spouted pipette
4. Fit the rubber tubing to part L and gently blow to push the level of the solution a few mm above mark E
5. Stop blowing, measure the time taken for the fluid to fall from mark E to mark F and record value
6. Repeat steps 4 and 5 one more time and document second value
7. Transfer 100 mL of solution ‘A’ to a 200 mL volumetric flask and make up with water to 200 mL while mixing
8. Empty the viscometer and rinse with a few aliquots of the solution prepared in step 7
9. Repeat steps 1 to 6 using the solution prepared in step 7
10. Transfer 100 mL of the solution prepared in step 7 to a 200 mL volumetric flask and make up to the mark with water while mixing
11. Empty the viscometer and rinse with a few aliquots of the solution prepared in step 10
12. Repeat steps 1 to 6 using the solution prepared in step 10
13. Transfer 100 mL of the solution prepared in step 10 to a 200 mL volumetric flask and make up to the mark with water while mixing
14. Empty the viscometer and rinse with a few aliquots of the solution prepared in step 13
15. Repeat steps 1 to 6 using the solution prepared in step 13
16. Empty the viscometer and rinse with water
17. Repeat steps 1 to 6 using water

RESULTS

Table 1: Tabulate time taken for fluid to fall from mark E to F

<table>
<thead>
<tr>
<th>Solution</th>
<th>$T_1$(s)</th>
<th>$T_2$(s)</th>
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CALCULATIONS

1. Determine the kinematic viscosity ‘\(v\)’ for each solution using the following formula:

\[ v = kt \]

Where: \(v\) = kinematic viscosity in area covered per second (mm\(^2\)s\(^{-1}\))

\(k\) = viscometer constant = 0.003mm\(^2\)s\(^{-2}\)

\(t\) = time in seconds (s)

Table 2: Average kinematic viscosity

<table>
<thead>
<tr>
<th>Solution</th>
<th>(v_1) (mm(^2)s(^{-1}))</th>
<th>(v_2) (mm(^2)s(^{-1}))</th>
<th>(v_{av}) (mm(^2)s(^{-1}))</th>
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2. Calculate the sugar concentration (mg/mL) for each solution

Table 3: Concentrations of each solution

<table>
<thead>
<tr>
<th>Solution</th>
<th>Concentration (mg/mL)</th>
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3. Using the following formula check if a plot of average kinematic viscosity versus concentration would fit a straight line

\[ R = \frac{\sum (x - x^1)(y - y^1)}{\sqrt{\sum (x - x^1)^2(y - y^1)^2}} \]

Where:

- \( x^1 \) = mean value for \( x \) (independent variable i.e. concentration)
- \( y^1 \) = mean value for \( y \) (dependent variable i.e. kinematic viscosity)

Table 4: Tabulate values for the calculation of regression analysis

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<tr>
<th></th>
<th>( (x - x^1) )</th>
<th>( (x - x^1)^2 )</th>
<th>( y )</th>
<th>( (y - y^1) )</th>
<th>( (y - y^1)^2 )</th>
<th>( (x - x^1)(y - y^1) )</th>
<th>( (x - x^1)^2(y - y^1)^2 )</th>
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4. What can you conclude from this?

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________________________________________________________________________
5. Plot a graph of kinematic viscosity \(y\) against sugar concentration \(x\)

Table 5: Values for graph: kinematic viscosity vs. sugar conc.

<table>
<thead>
<tr>
<th>Sugar conc. (mg/mL)</th>
<th>Kinematic viscosity (mm²s⁻¹)</th>
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QUESTIONS

1. List three (3) important precautions that have to be taken when conducting this test

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2. List one (1) source of error

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3. Discuss the outcome of this experiment – what can we state from our findings?

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4. What do you understand by the term ‘viscosity’?

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____________________________________________________________________
____________________________________________________________________

5. Define kinematic viscosity

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6. List two (2) examples of viscosity modifiers commonly used in modifying suspension viscosity

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7. Give one (1) example where the viscosity of a formulation is important in the administration of a drug

8. Why is it important to take two ‘time readings’ per concentration tested, and how can we ensure suitability of values?

9. List three (3) parameters that are kept constant in this experiment

10. Why are viscosity-increasing agents important in ophthalmic preparations? Give two (2) examples of such agents

11. What is the minimum number of data points one should take when testing a method for linearity?
12. How would viscosity impact on the bioavailability of drugs? Substantiate your answer by giving a suitable example

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13. Should the temperature be kept constant when measuring viscosity of fluids? Explain why

____________________________________________________________________
____________________________________________________________________

14. What do you understand by a Non-Newtonian liquid? Give a typical household example of such a liquid

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15. Would you expect the capillary (Ostwald) viscometer to be a suitable piece of equipment in determining the viscosity of non-newtonian liquids?

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REFERENCES


