MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

Polyethylene glycol/oxide viscosity

By: Jan Schlegel

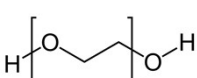
Department of Mechanical Engineering

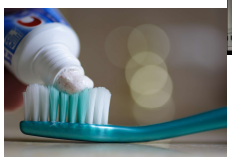
1

MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

PEG is a special polymer





Department of Mechanical Engineering

2

MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

Lab Objectives

- Test for the viscosities of PEG at different molecular weights and concentration
- Graph the intrinsic viscosity for each molecular weight vs is molecular weight
- Find the alpha value of the solution and check tabulated values to see if it is correct

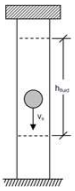
Department of Mechanical Engineering

3

MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

Experimental theory



Summation of Forces

$F_D = W - F_B$

$W = V\gamma_s$

$F_B = V\gamma_l$

Stokes' Law

$F_D = 3\pi\mu v_s d$

$\mu = K(\rho_s - \rho_l)t$

Department of Mechanical Engineering

4

MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

The K value needs to be calibrated for

Viscosity → $\mu = K(\rho_s - \rho_l)t$

Department of Mechanical Engineering

5

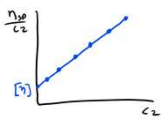
MECH202: Polymer and Composite Materials

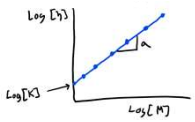
PEG's Viscosity Lab

Theory from Polymers

$$\eta_{sp} = \frac{\eta}{\eta_0} - 1$$

$$[\eta] = \lim_{c_2 \to 0} \frac{\eta_{sp}}{c_2}$$





$$[\eta] = KM^a$$

Department of Mechanical Engineering

6

MECH202: Polymer and Composite Materials

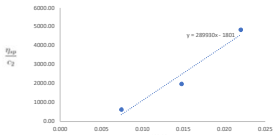
PEG's Viscosity Lab

Good Results, Bad graphs

	600000		
viscosity cP	27.42	147.82	528.28
specific viscocity	4.59	29.15	106.74
concentration	0.01	0.01	0.02
x-axis sp/c	616.36	1970.23	4845.88
	100000		
viscosity cP	6.15	14.59	34.56	87.63
specific viscocity	0.25	1.97	6.05	16.87
concentration	0.01	0.02	0.04	0.06
x-axis sp/c	34.01	89.66	140.31	266.55
	8000		
viscosity cP	10.04	13.82	20.59	31.81
specific viscocity	1.05	1.82	3.20	5.49
concentration	0.07	0.11	0.14	0.17
x-axis sp/c	14.99	16.95	22.56	31.59

Finding Intrinsic Viscosity

600000



$$[\eta] = \lim_{c_2 \to 0} \frac{\eta_{sp}}{c_2}$$

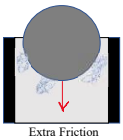
Department of Mechanical Engineering

7

MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

Theory on why the linear interpolation does not work

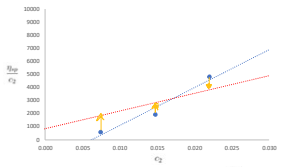


Extra Friction

Ideal

Finding Intrinsic Viscosity : Incorrect fit : Corrected fit

600000



Referenced tabulated values of $\frac{\eta_{sp}}{c_2}$ for M=600000 are 4500-8800 at 5% concentration in water

Department of Mechanical Engineering

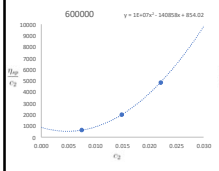
8

MECH202: Polymer and Composite Materials

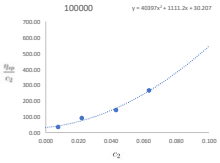
PEG's Viscosity Lab

In the interest of time I took the second order polynomials instead

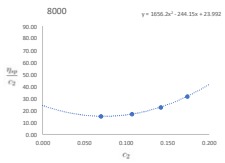
600000



100000



8000



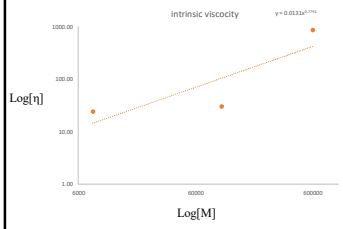
Department of Mechanical Engineering

9

MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

The intrinsic viscosity vs molecular weight with the corrected values



intrinsic viscocity	23.99	30.20	854.02
molecular weights	8000	100000	600000

$$[\eta] = KM^{a}$$

From data
α=0.7791

Tabulated value
α=0.79

Department of Mechanical Engineering

10

MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

Take away from this lab

-It is possible to find the viscosities if the proper calibration fluid is used for the different viscosities measure in the viscometers.

-The calculated alpha value is very reasonable making this a viable method for testing viscosities.

-It is cheap and affordable compared to other industrial methods.

Department of Mechanical Engineering

11

MECH202: Polymer and Composite Materials

PEG's Viscosity Lab

Acknowledgements

1. Website where the viscosities are found
https://www.sigmaaldrich.com/catalog/product/aldrich/181986?lang=en&region=US

2. Website for the tabulated values of ethylene glycol
https://sites.google.com/site/miller00828/in/solvent-polarity-table

3. Dr. Steimel

4. Dr. Saviz

Department of Mechanical Engineering

12