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Viscosity Analysis of Polymers

Objective:
The objective of this lab is to become familiar with the use of a viscometer in the determination of the extent of reaction in a polymerization reaction using a Brookfield Couette Viscometer (cup in bob viscometer). The experiment involves the condensation polymerization of hydroxyl terminated polydimethylsiloxane (PDMS) using a tin catalyst at 80 degrees C.

Instruments to be used:
Brookfield Viscometer (Departmental)
Viscometer is Located in Old SEM Lab Across From Doug's Office In Rhodes 5'th Floor

Materials:
Hydroxy- terminated PDMS, tin catalyst

Procedure:
1) Add 5% tin catalyst to PDMS and mix.
2) Pour the mixture into the viscometer cell and measure the viscosity as a function of time until termination of the reaction.
3) Repeat the experiment for several different concentrations catalyst and for several molecular weight partial condensates.
4) With the final polymer you should measure the viscosity at several different rotational viscosities (different shear rates).

Analysis:
1) Plot viscosity versus time for the reaction mixtures.
2) Use interpolations form the table of molecular weight versus melt viscosity at 80 degrees C to convert these plots to molecular weight versus time. (Doug or Sathish have this table).
3) Use the 3.4 power law dependence of zero shear rate viscosity versus molecular weight to determine the zero shear rate viscosity parameters for PDMS at high molecular weight.
4) Use the 1 power-law dependence in molecular weight at low molecular weight to determine the zero shear rate power law viscosity parameters.
5) Look up literature values for these power-law fluid parameters in PDMS (Polymer Handbook or Processing books).
6) Determine the time at which the entanglement molecular weight is reached for each reaction mixture.
7) From item #4 above construct a plot of viscosity versus rate of strain for the final polymer melt.

Questions:

1) Is the shear rate used in this experiment below the Newtonian plateau limit?
3) How is the melt viscosity determined in a Couette viscometer such as this Brookfield viscometer?
4) How does the melt viscosity of a polymer vary with shear rate?
5) What are the power-law fluid parameters for PDMS (viscosity versus shear rate)?