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EMCH 316
Lab #5

Steady State Creep

OBJECTIVE: To study Steady State Creep which is a material response which depends on time. As the time passes the specimen will go through plastic deformation.

PROCEDURE

1. Measure the width, thickness, and initial gauge length pf the polypropylene with the help of a metric micrometer.
2. Install the specimen in the Criterion machine and attach the extensometer on the specimen. Record the gauge length of the extensometer now.
3. Record the elongation readings every 15 minutes, and then every 5 minutes until a total 60 minutes has elapsed.
4. Combine all the data from all groups and find the material parameters.

DATA AND RESULTS

Table 1. Specimen dimensions.

Specimen dimension	Value (mm)
Width, w	**12.72**
Thickness, t	**3.23**
Gauge length, l_o	**93**

Table 2. Time, elongation, and strain data.

Time (min)	Elongation, ΔL (mm)	Elongation Corrected ΔL (mm)	Strain (mm/mm)
0	0	0	0
1	0.226	0	0
2	0.242	0.016	0.000172043
3	0.252	0.026	0.00027957
4	0.262	0.036	0.000387097
5	0.267	0.041	0.00044086
6	0.2736	0.0476	0.000511828
7	0.279	0.053	0.000569892
8	0.284	0.058	0.000623656
9	0.288	0.062	0.000666667
10	0.292	0.066	0.000709677
11	0.296	0.07	0.000752688
12	0.299	0.073	0.000784946
13	0.303	0.077	0.000827957
14	0.305	0.079	0.000849462
15	0.309	0.083	0.000892473
20	0.325	0.099	0.001064516
25	0.336	0.11	0.001182796
30	0.346	0.12	0.001290323
35	0.354	0.128	0.001376344
40	0.361	0.135	0.001451613
45	0.368	0.142	0.001526882

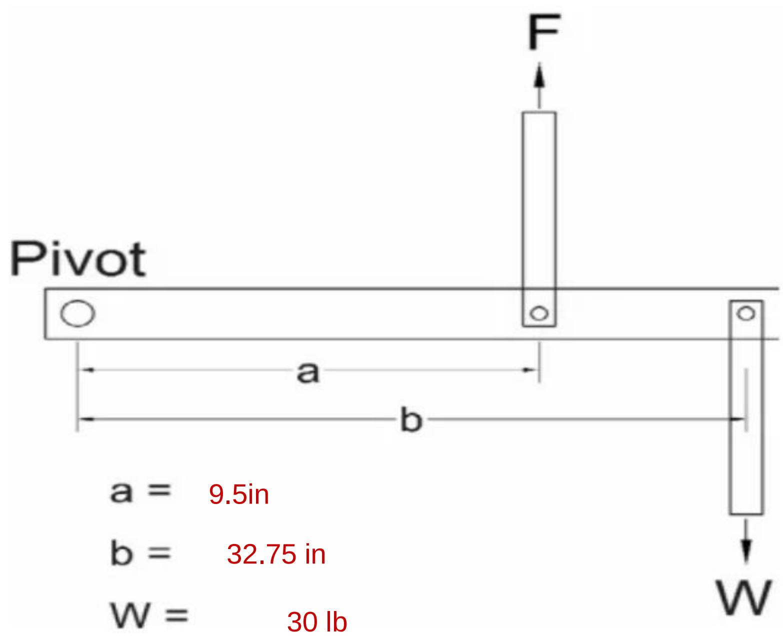


Figure 1. Loading frame with relevant dimensions.

ANALYSIS OF DATA

- Determination of specimen cross-sectional area and stress:

$$Area = width * thickness = 12.72 * 3.23 = 41.08mm^2$$

$$Stress = \frac{P}{A} = 11.197\ MPa$$

$$F = \frac{b * W}{a} = 460.04N$$

- Conversion of elongation to strain:

$$Strain = \frac{\Delta L}{L} = 0.001376344$$

- Graphical determination of $\dot{\varepsilon}_{ss}$:

$$\dot{\varepsilon}ss = \frac{\text{Strain1} - \text{Strain2}}{\text{Time1} - \text{Time2}} = 0.67 * 10^{-6}\ \text{sec}^{-1}$$

- Determination of material creep constants:

$$m=2.4435$$
$$B=0.0012$$

Table 3. Summary of shear yield strengths.

W (lb)	F (N)	Stress (MPa)	Strain(*10^-6)
20	284.74	7.14	0.11
30	460.04	11.197	0.67
35	505.7	12.31	1
40	578.3	13.96	0.3311

Figure 2. Team data plot

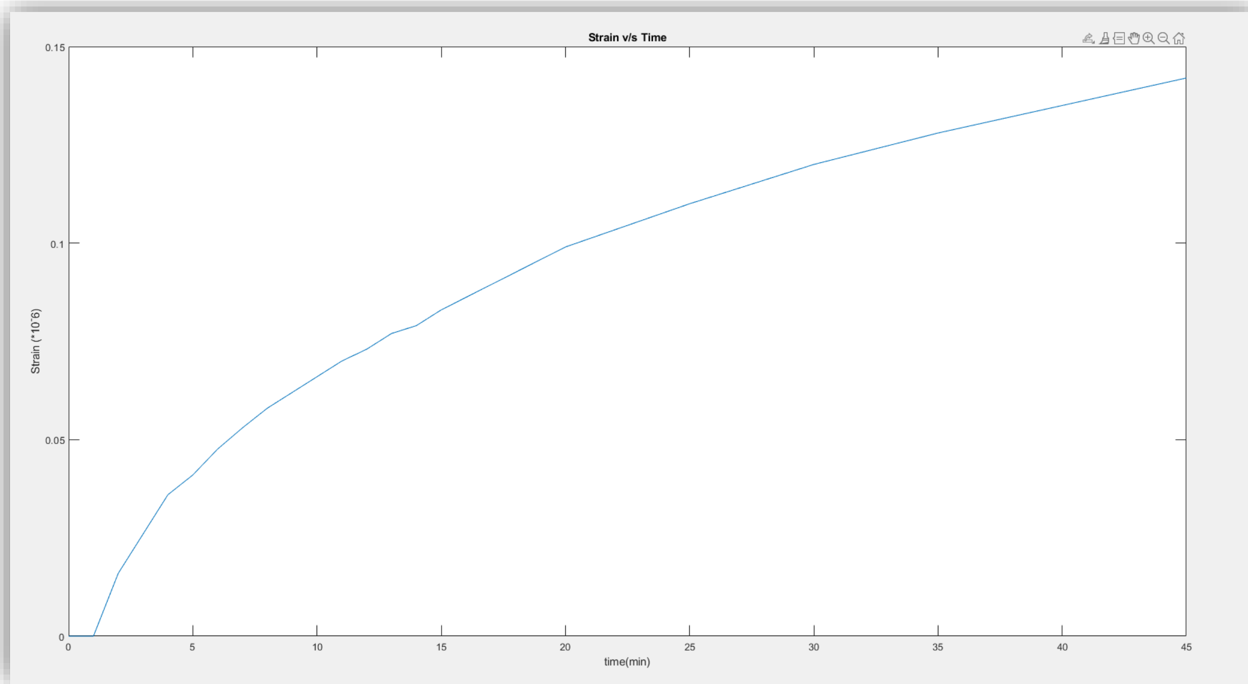
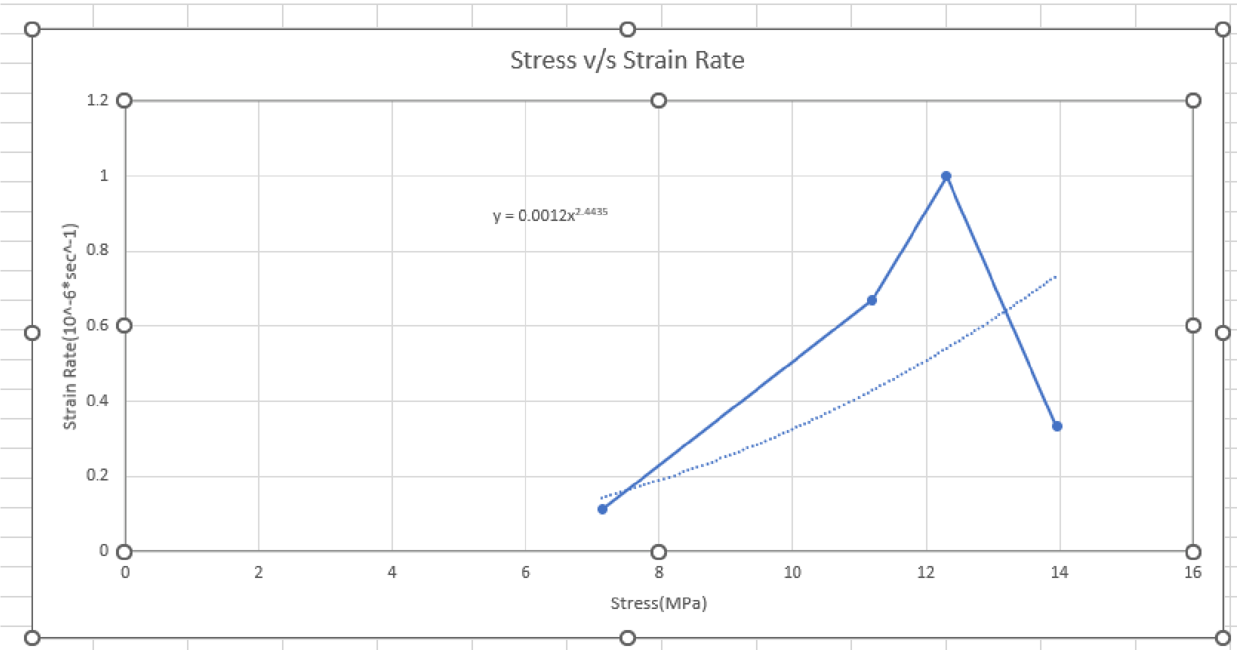


Figure 3. Logarithmic plot of Strain v/s Stress



DISCUSSION OF RESULTS

1. If polypropylene were a Maxwellian material, it would have an exponent (m) in the power law for creep prediction equation equal to 1. How does your value of the exponent compare?

After the experiment the value of the exponent came out to be which is greater than 1, about more than twice the Maxwellian material. This means that the material we had for the experiment creeps slower than the Maxwellian material. Higher the exponent value means its more unstable.

2. Explain two original examples where creep is an important design criterion. Do not use any examples already listed in the introduction or used by your table.

Creep is an important design in many applications, to name some; nuclear power generators and jet engine components, bridges are some applications. In these applications there are a high number of stresses which are still under the yield strength, but they are high and for extended periods of time which cause the material to creep, this is a permanent deformation, and those parts will require to be replaced after a certain time.

CONCLUSIONS

In this lab we tested a specimen of polypropylene in the MTS Criterion machine, we recorded how the material deforms under a constant load under yield strength which is known as creep. We recorded the elongation amount from the material by which we calculated the strain in the material and plotted the values on a graph and after some computing figured out the strain rate, stress, and other characteristics of the material. The power law gives an exponent value and a coefficient m and B respectively which tell us how the specimen will creep.