Q.8

$B = 5\ mm$ $\quad P = 150N$

$W = 15\ mm$

$a = 1\ mm$

$S = 3.5\ W$

3 point bend test,

$$K_{IC} = f\left(\frac{a}{W}\right) \cdot \frac{P}{B\sqrt{W}}$$

$$f\left(\frac{a}{W}\right) = \frac{3\frac{S}{W}\sqrt{\frac{a}{W}}}{2\left(1+2\frac{a}{W}\right)\left(1-\frac{a}{W}\right)^{3/2}} \left[1.99 - \frac{a}{W}\left(1-\frac{a}{W}\right) \times \left\{2.15 - 3.93\left(\frac{a}{W}\right) + 2.7\left(\frac{a}{W}\right)^2\right\}\right.$$

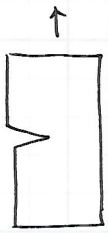
$$f\left(\frac{a}{W}\right) = 1.32 \times 1.87$$

$$= 2.48$$

$$K_{IC} = 2.48 \times \frac{150N}{5\times10^{-3}\sqrt{15\times10^{-3}}} = 6.07 \times 10^5\ Pa \cdot m^{1/2}$$

9.22

$K_{Ic} = 29\ MPa \cdot m^{1/2}$



200MPa

$$a \geq 2.5 \left(\frac{K_{Ic}}{\sigma_y} \right)^2$$

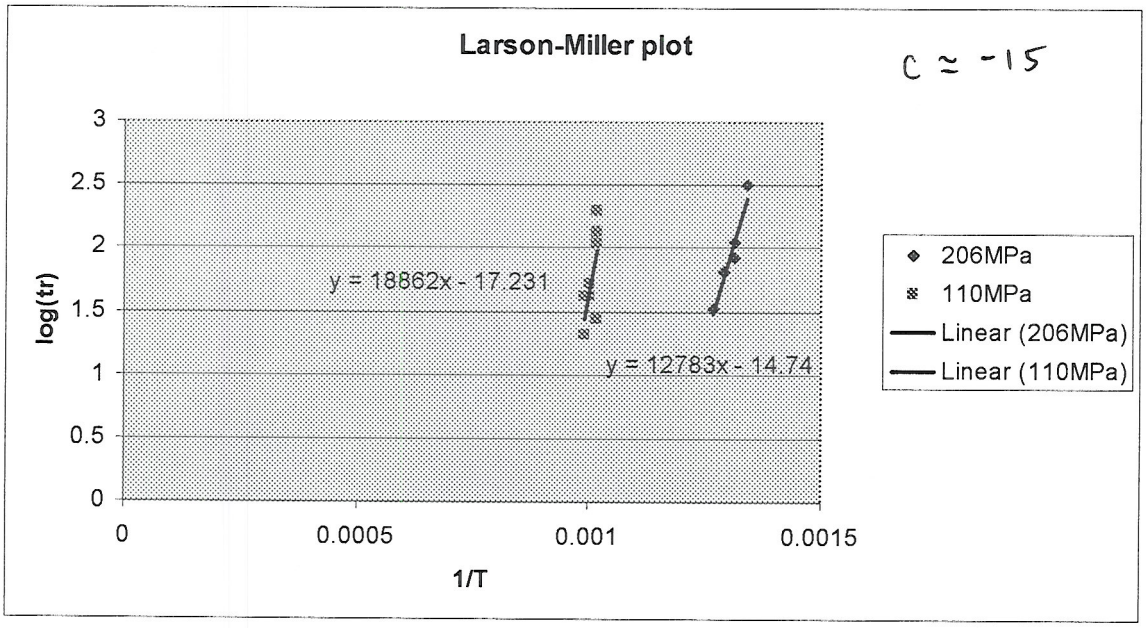
$$a \geq 2.5 \left(\frac{29\ MPa\ m^{1/2}}{200\ MPa} \right)^2$$

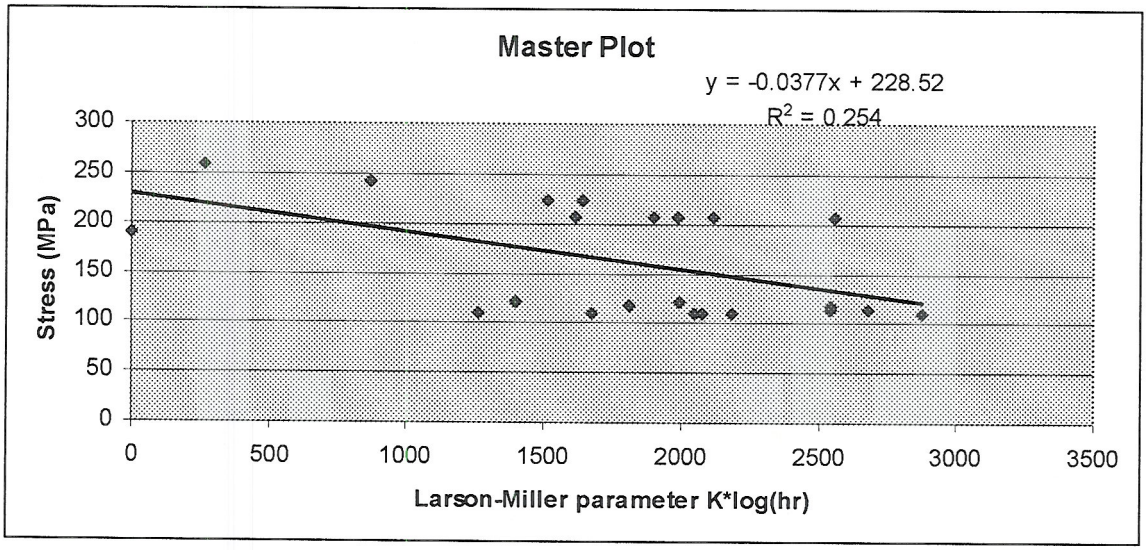
$$a \geq 0.053\ m$$

13.4

Temp C	App Stress MPa	Rupture life hours	1/Temp (1/C)	Log(tr)
760	189.7		0.001315789	#NUM!
760	206.9	83.9	0.001315789	1.923761961
760	206.9	111.2	0.001315789	2.046104787
760	224.2	38.6		
760	224.2	29		
760	241.4	6.9		
760	258.7	1.8		
746	206.9	320.8	0.001340483	2.50623436
774	206.9	65	0.00129199	1.812913357
788	206.9	33.2	0.001269036	1.521138084
982	110.4	195.1	0.00101833	2.290257269
982	113.8	136.6	0.00101833	2.135450699
982	113.8	106.9	0.00101833	2.028977705
982	116.5	27.6		
982	117.3	106.3	0.00101833	2.026533265
982	120.7	13		
982	120.7	39	0.00101833	1.591064607
996	110.4	52.6	0.001004016	1.720985744
996	110.4	41.3	0.001004016	1.615950052
1010	110.4	20.3	0.000990099	1.307496038
1010	110.4	41.7	0.000990099	1.620136055
1024	110.4	9.4		

Temp C	App Stress Mpa	Rupture life hours
760	189.7	
760	206.9	83.9
760	206.9	111.2
760	224.2	38.6
760	224.2	29
760	241.4	6.9
760	258.7	1.8
746	206.9	320.8
774	206.9	65
788	206.9	33.2
982	110.4	195.1
982	113.8	136.6
982	113.8	106.9
982	116.5	27.6
982	117.3	106.3
982	120.7	13
982	120.7	39
996	110.4	52.6
996	110.4	41.3
1010	110.4	20.3
1010	110.4	41.7





$T(\log tr + c) = m$

$-0.0377 = 1273(\log tr + c)$

$\log tr = -2.96 * 10^{-5} - 15$

$tr = 10 * 10^{-16}\, hr$

13.7

$$\log(t_r) - m = 0.43 \frac{Q_c}{RT}$$

$$R = 8.314 \ J/mol \cdot K$$

$$Q_c = 0.18 \ MJ/mol$$

Given at 300°C, $t_r = 2{,}000$ hr

$$\log(2{,}000) - m = \frac{0.43 \ (0.18 \ MJ/mol)}{8.314 \ J/mol \cdot K \cdot 573 \ K}$$

$$m = -12.95$$

Therefore, at 400°C, $t = ?$

$$\log(t_r) = m + \frac{0.43 \ (0.18 \ MJ/mol)}{8.314 \ J/mol \cdot K \cdot 673 \ K}$$

$$\log(t_r) = 0.887$$

$$t_r = 7.7 \text{ hr}$$