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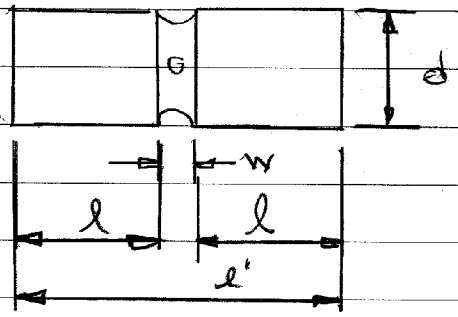
$l' = 55$ mm
$d = 50$ mm
$w = 5$ mm
$c = 42\,\mu$-m
$W = 10$ kN

SAE 30 0.1
$T_i = 55°C$
$p_s = 200$ kPa



$$l = \frac{l' - w}{2}$$

$$l = \frac{55 - 5}{2}$$

$l = 25$ mm
$r = 25$ mm

$l/d = 0.5$

$$\Delta T_c = \frac{1956\,(10)^6}{(1+1.5\epsilon^2)} \frac{\left[\left(\frac{r}{c}\right)f\right] S W^2}{p_s r^4}$$

$r \sim$ mm
$p_s \sim$ kPa
$W \sim$ kN
$\Delta T_c \sim C°$

We need T_{avg}; but, only have T_i
∴ We need to assume an initial μ or initial T_{avg}.

Remember

$$T_{avg} = \frac{T_i + T_o}{2}$$

$$\Delta T = T_o - T_i$$

$$T_{avg} = T_i + \frac{\Delta T}{2}$$

First "trial"

Assume $\mu_1 = 5 \times 10^{-3}$ m·Pa·sec
$\Rightarrow T_{avg_1} = 115°C$

$\Delta T_1 = 2(115 - 55)$
$\Delta T_1 = 120 C^\circ$ ~ first trial value

$$S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$$

$$P = \frac{\left(\frac{10{,}000}{2}\right)}{(.05)(.025)} \frac{N}{m^2}$$ ~ each side carries ½·W

$$P = 4 \times 10^6 \ \frac{N}{m^2}$$

$$S_1 = \left(\frac{.025\ m}{42\times10^{-6}\ m}\right)\frac{(5\times10^{-3})(48)}{4\times10^{6}}$$

$S_1 = 0.02$

$\left[\left(\frac{r}{c}\right)f\right] = 1.3$

$[\epsilon] = 0.92$

$\Delta T_{1,c} = 29c^\circ$

$\Delta T_{1,a} = 120c^\circ$

error = $91c^\circ$ ~ too high

Trial 2: $\Delta T_{2,a} = 30c^\circ$

$T_{avg,2} = T_2 + \Delta T_{2,a}/2$

$T_{avg,2} = 70\,^\circ C$

$\mu_2 = 1.6\times10^{-3}$

$$S_2 = (595)^2\frac{48}{4\times10^6}\mu_2$$

$\approx 4.25\,\mu_2$

$S_2 = 0.068$

$\left[\left(\frac{r}{c}\right)f\right] = 2.6$ $\quad [\epsilon] = 0.95$

$$\Delta T_c = \frac{1956\times10^6}{(200)(25)^4}(100)\frac{\left[\left(\frac{r}{c}\right)f\right]S}{(1+1.5\epsilon^2)}$$

$$= (2503.7)\frac{(2.6)(.068)}{[1+1.5(.85)^2]}$$

$\Delta T_c = 221\,C^\circ$
$\Delta T_2 = 30\,C^\circ$

	A	C	error
1	120	30	90
2	30	220	−190
3	70	81	−11
4	75	64	+6
5	73	→	

you complete!

Trial 3: $\Delta T_{3,c} = 70\,C^\circ$

$T_{avg,3} = 55+35$

$T_{avg,3} = 90^\circ C$

$\mu_3 = 8.5\times10^{-3}$

$S_3 = 0.036$

$\left[\left(\frac{r}{c}\right)f\right]_3 = 1.8$ $\qquad [\epsilon]_3 = 0.88$

$$\Delta T_c = (2503.7)\frac{(1.8)(.036)}{[1+1.5(.88)^2]}$$

$\Delta T_c = 81\,C^\circ$

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Trial 3 $\Delta T_{4,a} = 75C^\circ$

$T_{avg,3} = 93^\circ c$

$\alpha = 8 \times 10^{-3}$

$S_4 = 0.034$

$\left[\frac{F}{C_f}\right]_4 = 1.75$ $\quad [\epsilon] = 0.88$

$\Delta T_{4,c} = (203.7)\frac{(1.75)(.034)}{[1+(1.5)(.88)^2]}$

$\Delta T_{4,c} = 69C^\circ$

Does this satisfy the criteria of mathematical error less than 3 degrees? If not, carry the problem through until it does.