11/12/2014

Second Exam, 2014/2015
Engineering Measurements (0904422)
(Key Solution)

Q1) - For accuracy → check note / textbook
- Flow Prover / catch and Weigh.
- For Selection → check note/textbook.
- Vol^m flow rate $\dot{Q} = \frac{Y C_D \frac{\pi}{4} d_2^2}{\sqrt{1-(\frac{d_2}{d_1})^4}} \sqrt{2g \frac{\Delta P_{1-2}}{\gamma_f}}$

Solving we get $d_2 = 60\,mm$

- Pressure drop $\Delta P_{1-2} = \gamma_f h_m \left[\frac{SG_m}{SG_f} - 1\right]$

$\Rightarrow h_m = 2.87\,m$

- To find pump η we need to find
Pressure loss $\Delta P_{loss} = 75\% \Delta P_{1-2} = 266.7\,kPa$
Cost = time * Power * rate
$\Rightarrow$ Power = 23.82 kw
$\therefore$ Power $= \frac{\dot{Q}_{act} * \Delta P_{loss}}{\eta_p}$
$\Rightarrow \eta_p = 89.5\%$

- For Uncertainty $\dot{Q} = M Y C_D A_2 \sqrt{\frac{2}{\rho_f} \Delta P_{1-2}}$

If is Constant $= \Phi M C_D A_2 \Delta P^{\frac{1}{2}}$

$\therefore \frac{W_{\dot{Q}}}{\dot{Q}} = \pm \sqrt{\left(\frac{W_M}{M}\right)^2 + \left(\frac{W_{C_D}}{C_D}\right)^2 + \left(\frac{W_{A_2}}{A_2}\right)^2 + \left(\frac{1}{2}\frac{W_{\Delta P}}{\Delta P}\right)^2}$

$\therefore \frac{W_{\Delta P_{1-2}}}{\Delta P_{1-2}} = \pm 0.05 \Rightarrow W_{\Delta P} = \pm 18.35\,kPa$

Q2) - For factors check note / textbook.

(Static Press^r) $P_{static} = P_{atm} + \gamma_m h_{m_1}$ $\quad P_{atm} = 760\,mm\,Hg$

$= \frac{760}{1000} * 13600 * 9.81 + 9810 * \frac{10}{1000}$

$= 101.886\,kPa$

$P_{stagnation} = P_{atm} + \gamma_m h_{m_2}$

$P_{st} = 102.181\,kPa$

Flow velocity $(V_f) = C\sqrt{\frac{2}{\rho_f}\Delta P} = 22.3\,m/s$

Q3) - main Criteria $\delta_m < \frac{1}{2}t$ So that the deflection is linear and max^m at Center.

- Thickness $t = \sqrt{\frac{3D^2P}{16\sigma_m}} = 1.9413 * 10^{-3}\,m$

- Deflection $\delta_m = \frac{3(1-\nu^2)D^4P}{2\pi E t^3} = 1.1924 * 10^{-3}\,m$

$> \frac{1}{2}t$ hence the thickness must be changed. At $t = 2.1mm \Rightarrow \delta_m = 0.948mm$

$\frac{C_i}{C_f} = \frac{(\epsilon_0\epsilon_r)_i}{(\epsilon_0\epsilon_r)_f} \cdot \frac{A_i/d_i}{A_f/d_f} = \frac{d_i - \delta_m}{d_i}$

$\therefore C_f = 506.215\,PF$

Q4) - For qualities check note / textbook.
- Best mathematical law is the quadratic.

range -30 – 0

$$239.58 = 423.58\left[1+\alpha_1(-30-0)+\alpha_2(-30-0)^2\right]$$

range 0 – 110

$$6484.3 = 423.58\left[1+\alpha_1(110-0)+\alpha_2(110-0)^2\right]$$

Solving we get $\alpha_1 = 0.03925$

$\alpha_2 = 8.256 * 10^{-4}$

$\therefore R_T = 423.58\left[1+0.03925(T-0)+8.256*10^{-4}(T-0)\right]$

- At $R_T = 3848.242 \Rightarrow$ **T = 78 C°**

- 120C° is out-of-range.

Q5) - $V_{i\,max} = \sqrt{P R_1} = \sqrt{3*5200}$

$= 122.47$ Volts.

- Cermet, - Carbon film, - Hot moulded Carbon

Q6) - Wire, Foil, Semiconductor

- $\Delta R_{Nc} = R_i G G_f = +7.26*10^{-3}\,\Omega$

$\therefore R_{final} =$ **120.00726 Ω**

$\Delta R_{Nichrome} = -1.2*10^{-3}\,\Omega \Rightarrow R_{final} =$ **199.998 Ω**

Q7) - For Comparison check note/textbook

$$- R_{T_2} = R_{T_1} e^{\beta\left(\frac{1}{T_2} - \frac{1}{T_1}\right)}$$

$$\text{or } 10.17 = 8632.371\, e^{\beta\left(\frac{1}{413} - \frac{1}{283}\right)}$$

$$\therefore \beta = 3997.686\ K$$

- At $T = 80C^{\circ} \Rightarrow$ $\boxed{R_T = 524.3\ \Omega}$