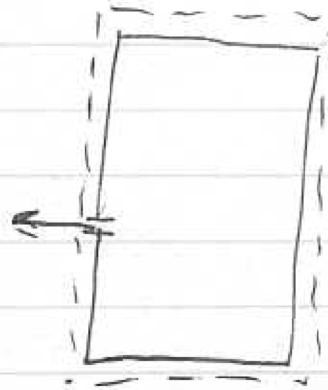
$\boxed{\text{M.S. } 4.97}$

$\forall = 1\,m^3$



①	②
$p_1 = 300\,kPa$	$p_2 = 100\,kPa$
$T_1 = 300\,K$	

process $\longrightarrow$ $pv^{1.2} = C$

$pv^{1.2}$ = constant, ideal gas, constant specific heats.

$Q = ?$

$$\frac{dE}{dt} = \dot{Q} - \cancel{\dot{W}} + \cancel{\dot{m}_i}\left(h_i + \cancel{\frac{V_i^2}{2}} + \cancel{g z_i}\right) - \dot{m}_e\left(h_e + \cancel{\frac{V_e^2}{2}} + \cancel{g z_e}\right)$$

$$\frac{dU}{dt} = \dot{Q} - \dot{m}_e h_e$$

For the tank, m, u, h are continuously changing

$$\left.\begin{aligned} U &= mu \\ \dot{m}_e &= -\frac{dm}{dt} \end{aligned}\right\} \quad \frac{d(mu)}{dt} = \dot{Q} + h\frac{dm}{dt}$$

$h_e \equiv h$ for the tank

$$m\frac{du}{dt} + u\frac{dm}{dt} = \dot{Q} + h\frac{dm}{dt}$$

$$\dot{Q} = m\frac{du}{dt} + u\frac{dm}{dt} - h\frac{dm}{dt}$$

for an ideal gas $h = u + RT$

$$\dot{Q} = m\frac{du}{dt} + \cancel{u\frac{dm}{dt}} - \cancel{u\frac{dm}{dt}} - RT\frac{dm}{dt}$$

$\boxed{\text{M.S. 4.97 (continued)}}$

$$\dot{Q} = m\frac{du}{dt} - RT\frac{dm}{dt}$$

$$\int \dot{Q}\,dt = Q = \int m\,du - RT\,dm$$

we need to integrate over $\underline{\underline{1}}$ variable, preferably one we have information on (i.e. pressure)

Express everything in terms of pressure.

$$m\,du - RT\,dm$$

$$du = c_v\,dT$$

$$\cancel{p\forall = mRT \Rightarrow RT = \frac{p\forall}{m}} = pv$$

$$m = \frac{\forall}{v} \qquad pv^{1.2} = C \Rightarrow v = \left(\frac{C}{p}\right)^{\frac{1}{1.2}}$$

$$\boxed{m = \frac{\forall}{(C/p)^{1/1.2}} = \frac{\forall}{C^{1/1.2}}\,p^{1/1.2}}$$

$$\therefore \boxed{dm = \frac{\forall}{C^{1/1.2}}\,\frac{1}{1.2}\,p^{\frac{1}{1.2}-1}\,dp}$$

$$p\forall = mRT \Rightarrow RT = \frac{p\forall}{m} = \frac{p\cancel{\forall}}{\cancel{\forall}\,p^{1/1.2}}\,C^{1/1.2} = pC^{1/1.2}p^{-\frac{1}{1.2}}$$

$$\boxed{RT = p^{1-\frac{1}{1.2}}\,C^{1/1.2}}$$

$\boxed{\text{M.S. 4.97 continued}}$

$$T = \frac{P^{1-\frac{1}{1.2}}\, C^{1/1.2}}{R}$$

$$\boxed{dT = \frac{C^{1/1.2}}{R}\left(1-\frac{1}{1.2}\right)P^{-\frac{1}{1.2}}}$$

$$\boxed{du = \frac{C_v\, C^{\frac{1}{1.2}}}{R}\left(1-\frac{1}{1.2}\right)P^{-\frac{1}{1.2}}\, dp}$$

$$\int m\,du - RT\,dm$$

$$du = \frac{C_v\, C^{\frac{1}{1.2}}}{R}\left(\frac{.2}{1.2}\right)P^{\frac{-1}{1.2}}\,dp$$

$$m = \frac{V}{C^{1/1.2}}\, P^{1/1.2}$$

$$RT = p^{\frac{.2}{1.2}}\, C^{1/1.2}$$

$$dm = \frac{V}{C^{1/1.2}}\,\frac{1}{1.2}\, P^{-.2/1.2}\, dp$$

COMBINE

$$\frac{V}{\cancel{C^{1/1.2}}}\,\frac{C_v\, \cancel{C^{1/1.2}}}{R}\left(\frac{0.2}{1.2}\right)\int p^{\frac{1}{1.2}}\, p^{\frac{-1}{1.2}}\,dp - \cancel{C^{\frac{1}{1.2}}}\,\frac{V}{\cancel{C^{\frac{1}{1.2}}}}\,\frac{1}{1.2}\int p^{\frac{.2}{1.2}}\, p^{\frac{-.2}{1.2}}\,dp$$

$\boxed{\text{M.S. 4.97 (continued)}}$

$$Q = \frac{\forall c_v}{R}\left(\frac{.2}{1.2}\right)\int_1^2 dp - \frac{\forall}{1.2}\int_1^2 dp$$

$$Q = \forall (p_2 - p_1)\left[\frac{c_v}{R}\left(\frac{.2}{1.2}\right) - \frac{1}{1.2}\right]$$

$c_v \cong 0.717\ kJ/kg\cdot K$

$R \cong 287\ J/kg\cdot K$

$$Q = (1\,m^3)(100\times10^3 - 300\times10^3\ Pa)\left[\left(\frac{717}{287}\right)\left(\frac{.2}{1.2}\right) - \left(\frac{1}{1.2}\right)\right]$$

$$\boxed{Q = +83400\ J}$$