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2/18/24
MET 350 HW 1.2

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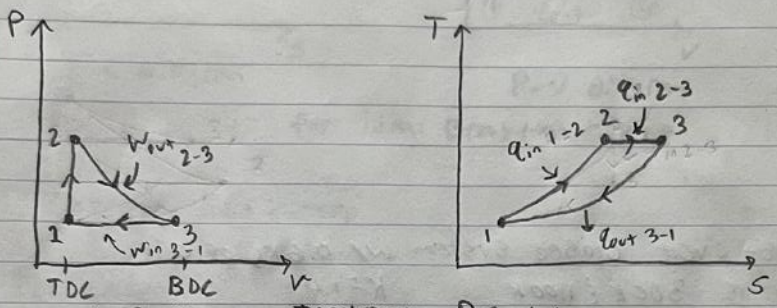
Const $C_V = 0.718$ KJ/kg·K $R = 0.287$ KJ/kg·K
Const $C_P = 1.005$ KJ/kg·K $k = 1.4$

9-13 - air standard cycle closed piston-cylinder system and consists of 3 processes
1-2 V=Const heat add. from 100kPa and 27°C to 850 KPa
2-3 Isothermal expansion until $V_3 = 7V_2$
3-1 = P = Const heat rejection to the initial state
27°C = 300 K



V Const → Isothermal → P Const

1	2	3
$P_1 = 100$ kPa	$V_1 = V_2$	$V_3 = 7V_2$
$T_1 = 300.15$ K	$P_2 = 800$ kPa	$P_3 = 100$ kPa
$V_1 = \frac{RT_1}{P_1}$	$T_2 = T_3$	

$V_3 = 7V_2$

$W_{2-3} = RT_2 \ln\left(\frac{V_3}{V_2}\right)$
$W_{2-3} = 0.287\,(KJ/kg\cdot K)(2,550)(7)$
$= 1,424.11\ (KJ/kg)$
$Q_{2-3} = 1,424.11\ (KJ/kg)$

$\frac{P_1}{T_1} = \frac{P_2}{T_2} = \left(\frac{850}{100}\right)\cdot 300 = 2,550\ (K)$

$Q_{1-2} = U_{1-2} + W_{1-2}$
$Q_{1-2} = C_V(T_2 - T_1)$
$= 0.718\ KJ/kg\cdot K\,(2,550-300)$
$= 1,615.5\ (KJ/kg)$

$W_{3-1} = P_3(V_1 - V_3)$
$= R(T_1 - T_3)$
$= 0.287\,(KJ/kg\cdot K)(300-2,550)$
$W_{3-1} = -645.75\,(KJ/kg)$

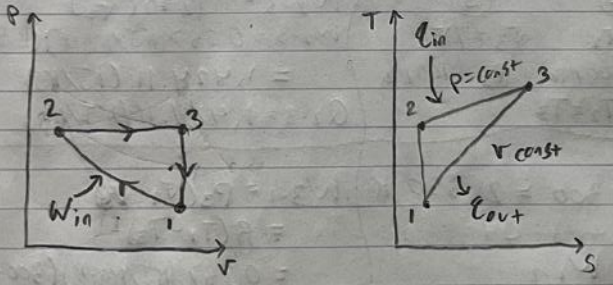
$B.W.R. = \frac{W_{3-1}}{W_{2-3}} = \frac{645.75\,(KJ/kg)}{1,424.11\,(KJ/kg)} = 0.453$

$W_{net} = W_{2-3} - W_{1-3} = 1,424\,(KJ/kg) - 645.75\,(KJ/kg) = 778.36\,(KJ/kg)$
$Q_S = Q_{1-2} + Q_{2-3} = 1,615.5\,KJ/kg + 1,424 = 3,039.61$ $\eta_{th} = \frac{778.36}{3,039.61} = .256 \cdot 100$
25%

S.I WH

9-31c The difference between is how the explosions occur. Gas engines use a mixture of fuel and air and it is compressed to hit spark plugs and ignite. In diesel the process of compression is before fuel is added into the chamber.

9-22 Carnot cycle closed system w/ 0.6 kg of air.
Temp limits 300 K & 1100 K $k = 1.4$
Min pressure = 20 kPa max pressure = 3000 kPa



$T_1 = 300$ K $T_2 = 1100$ K $P_2 = P_3\left(\frac{T_2}{T_1}\right) = (20\text{ kPa})\left(\frac{1100\text{ K}}{300\text{ K}}\right)^{4} = 1,888$ kPa
$P_3 = 20$ kPa $P_1 = 3000$ kPa

$\Delta s = C_p \ln\left(\frac{T_2}{T_1}\right) - R \ln\left(\frac{P_2}{P_1}\right) = -(0.287)(\text{kJ/kg·K}) \ln\left(\frac{1888}{3000}\right) = 0.1329$ kJ/kg·K

$q_{in} = m T_2 \Delta s = (0.6\text{ kg})(1100\text{ K})(0.1329\text{ kJ/kg·K}) = 87.73$ kJ

$\eta_{th} = 1 - \frac{T_L}{T_H} = 1 - \frac{300}{1100} = 72\%$ $W_{net} = \eta_{th} \cdot q_{in} = (0.723)(87.73) = 63.4$ kJ