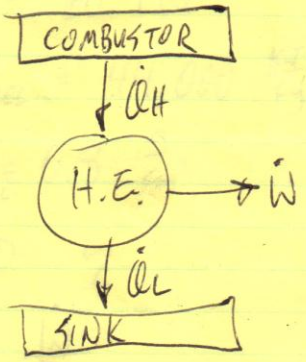
RETURN TO DR. THOMAS

HOMEWORK #6: ~~5.22, 5.25, 5.37E, 5.52, 5.60, 5.84, 5.118~~
5.18, 5.21, 5.34E, 5.50, 5.59, 5.81, 5.116

PROB. ~~5.14~~ 5.18



$$\dot{Q}_H = \left(280 \frac{GJ}{HR}\right)\left(\frac{HR}{3600s}\right)\left(\frac{1000\,MJ}{GJ}\right)\left(\frac{MW}{MJ/s}\right) = 77.78\ MW$$

$$\dot{Q}_L = \left(8 + 145 \frac{GJ}{HR}\right)\left(\frac{HR}{3600s}\right)\left(\frac{1000\,MJ}{GJ}\right)\left(\frac{MW}{MJ/s}\right) = 42.5\ MW$$

FIND $\dot{W}$, η

@ $\dot{W} = \dot{Q}_H - \dot{Q}_L = (77.78 - 42.5\,MW) = \underline{35.28\ MW}$

$$\eta = \frac{\dot{W}}{\dot{Q}_H} = \frac{(35.28)}{(77.78)} = \underline{0.453}$$

PROB. ~~5.25~~ 5.21

$\dot{V}_{FUEL} = 28 \frac{L}{HR}$

$\dot{W} = 60\ KW$

$u_{FUEL} = 44{,}000 \frac{KJ}{kg}$

$\rho_{FUEL} = 0.8 \frac{g}{cm^3}$

FIND η

$\eta = \frac{\dot{W}}{\dot{Q}_H}$

$\dot{Q}_H = \dot{m}_{FUEL} \cdot u_{FUEL}$

$\dot{m}_{FUEL} = \rho_F \dot{V}_F$

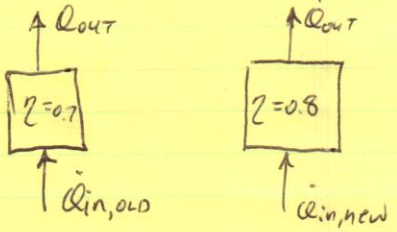
$$\eta = \frac{\dot{W}}{\rho_F \dot{V}_F u_F} = \frac{(60\ KW)}{(0.8 \frac{g}{cm^3})(\frac{1000\ cm^3}{L})(\frac{kg}{1000\ g})(\frac{28}{3600 s})(\frac{L}{HR})(\frac{HR}{3600 s})(44{,}000 \frac{KJ}{kg})}$$

$\eta = \frac{0.3068}{} = 0.2191$

PROB. ~~5.37E~~ 5.34E

BOILER COMBUSTION EFFICIENCY = $\frac{\text{BOILER OUTPUT}}{\text{BOILER INPUT}}$

$$\eta = \frac{\dot{Q}_{out}}{\dot{Q}_{in}}$$



$$\dot{Q}_{in,current} = 3.6 \times 10^6 \ \frac{Btu}{HR}$$

$$\dot{Q}_{out} = \eta_c \dot{Q}_{in,c} = (0.7)(3.6 \times 10^6 \ \frac{Btu}{HR}) = 2.52 \times 10^6 \ \frac{Btu}{HR}$$

(REQUIRED HEAT OUTPUT)

$$\dot{Q}_{in,new} = \dot{Q}_{out} / \eta_{new} = (2.52 \times 10^6 \ \frac{Btu}{HR}) / 0.8 = 3.15 \times 10^6 \ \frac{Btu}{HR}$$

$$\dot{Q}_{in,saved} = \dot{Q}_{in,current} - \dot{Q}_{in,new} = (3.6 - 3.15) \times 10^6 \ \frac{Btu}{HR}$$

$$\dot{Q}_{in,saved} = 0.45 \times 10^6 \ \frac{Btu}{HR}$$

ENERGY SAVINGS = $\dot{Q}_{in,saved} \cdot$ (OPERATION HOURS) = $(0.45 \times 10^6 \ \frac{Btu}{HR})(1500 \ \frac{HR}{YR})$

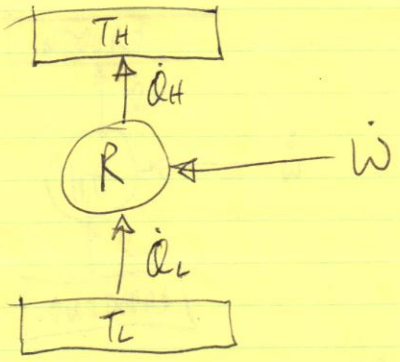
$$E.S. = 6.75 \times 10^8 \ \frac{Btu}{YR}$$

COST SAVINGS = (E.S.)(ENERGY COST)

$$C.S. = (6.75 \times 10^8 \ \frac{Btu}{YR})(\frac{\$4.35}{10^6 \ Btu})$$

$$C.S. = \$2936 \ \frac{\$}{YR}$$

PROB. ~~5.52~~ 5.50



$COP_R = \frac{1.5}{\cancel{1.8}}$

$\dot{Q}_L = \left(\frac{60}{\cancel{90}} \frac{KJ}{MIN}\right)\left(\frac{MIN}{60\,s}\right) = \frac{1.0}{\cancel{1.5}}\ KW$

FIND $\dot{W}$, $\dot{Q}_H$

$COP_R = \frac{\dot{Q}_L}{\dot{W}}$

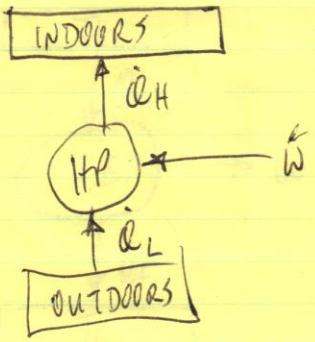
$\dot{W} = \frac{\dot{Q}_L}{COP} = \frac{\left(\frac{1.0}{\cancel{1.5}}\ KW\right)}{\left(\frac{\cancel{1.8}}{1.5}\right)} = \underline{\frac{0.667}{\cancel{0.833}}\ KW}$

$\dot{W} = \dot{Q}_H - \dot{Q}_L$

$\dot{Q}_H = \dot{W} + \dot{Q}_L = \left(\frac{0.667}{\cancel{0.833}} + \frac{1.0}{\cancel{1.5}}\ KW\right) = \underline{\left(\frac{1.67}{\cancel{2.33}}\ KW\right)\left(\frac{60\,s}{MIN}\right)}$

$= 100\ \frac{KJ}{MIN}$

PROB. ~~5.60~~ 5.59



Q_H ~~$\dot{Q}_H$~~ $= (1200\ \text{KW-HR})\left(\frac{\text{KJ/S}}{\text{KW}}\right)\left(\frac{3600\ \text{S}}{\text{HR}}\right) = 4.32\times10^6\ \text{KJ} =$ ~~Q_H~~

$COP_{HP} = 2.4$

COST ~~OF~~ ELECTRICITY $= 8.5\ \frac{¢}{\text{KW-HR}}$ FIND SAVINGS

$COP_{HP} = \frac{\dot{Q}_H}{\dot{W}}$

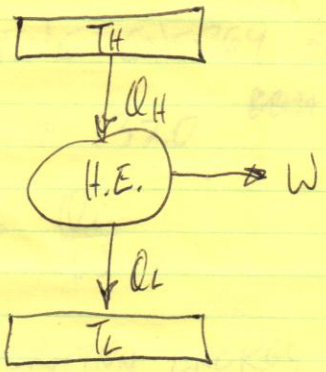
~~$\dot{Q}_H$~~ $W = \frac{Q_H}{COP} = \frac{(1200\ \text{KW-HR})}{2.4} = 500\ \text{KW-HR}$

ENERGY SAVINGS $= 1200 - 500\ \text{KW-HR} = 700\ \text{KW-HR}$

COST SAVINGS $=$ (E.S.)(ENERGY COST)

C.S. $= (700\ \text{KW-HR})(8.5\ \frac{¢}{\text{KW-HR}}) = 5950¢ =$ $\$59.50/\text{MON}$

PROB. ~~5.84~~ 5.81



CARNOT HEAT ENGINE

$Q_H = \overset{650}{\cancel{700}}$ KJ, $T_H = ?$

$Q_L = 200$ KJ, $T_L = 17°C$

FIND T_H, η

$$\left(\frac{Q_H}{Q_L}\right)_{REV} = \left(\frac{T_H}{T_L}\right)$$

$$T_H = T_L\left(\frac{Q_H}{Q_L}\right) = (17+273\ K)\left(\frac{\overset{650}{\cancel{700}}}{200}\right) = \overset{942}{\cancel{725}}\ K$$

$$\eta = 1 - \frac{T_L}{T_H} = 1 - \frac{(17+273\ K)}{942\ \cancel{725}\ K} = 0.692$$

PROB. ~~5.115~~ 5.116

LIGHTING ENERGY SAVED = $(40-18\ W)(60\ \frac{HR}{YR})$

L.E.S. = $1320\ \frac{W-HR}{YR} = 1.32\ \frac{KW-HR}{YR}$

$COP = \frac{Q_L}{W}$

REFRIGERATION ENERGY SAVED = $\frac{\text{LIGHTING ENERGY SAVED}}{COP}$

RES = $\frac{1.32\ \frac{KW-HR}{YR}}{1.3} = 1.015\ \frac{KW-HR}{YR}$

COST SAVINGS = $\left(1.015 + 1.32\ \frac{KW-HR}{YR}\right)\left(8\ \frac{¢}{KW-HR}\right) = 18.7\ \frac{¢}{YR}$

COST OF LIGHT = $\$25.00$

YEARS TO PAY FOR BULB = $\frac{(\$25.00)}{(18.7\ \frac{¢}{YR})(\frac{\$}{100\ ¢})} = 133.8\ YR$

NOT JUSTIFIED