

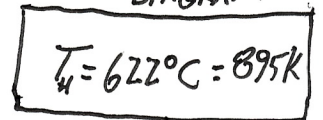
SOLUTION

NAME: _____

This is an open book quiz. You may use a four function calculator. An unsigned honors pledge will result in a zero.

1. Consider a coal-fired power plant that rejects heat to the environment at 25° and where the coal burns at a temperature of 622°C . The plant has an efficiency that is 61% of a perfectly reversible power plant. The plant rejects heat to the environment at a rate of 485 MW. What is the work in MJ delivered by the power plant during the course of a year if the plant is operational 48 weeks per year.

DIAGRAM



GIVEN: Power plant, $T_C = 25^\circ\text{C}$, $T_H = 622^\circ\text{C}$, $\dot{Q}_C = 485\text{ MW}$
 $\eta = 0.61\eta_{\text{max}}$

FIND: $W = ? \text{ MJ}$ for 48 weeks

ASSUME: The coal flame and environment are thermal reservoirs.

ANALYSIS: $\eta_{\text{max}} = 1 - \frac{T_C}{T_H} = 1 - \frac{298\text{K}}{895\text{K}} = 0.667$

$\eta = 0.61\eta_{\text{max}} = 0.61(0.667) = 0.407$

$\eta = 1 - \frac{\dot{Q}_C}{\dot{Q}_H} = 0.407 = 1 - \frac{485\text{ MW}}{\dot{Q}_H} \rightarrow \dot{Q}_H = 817.8\text{ MW}$

$\dot{W}_{\text{cyc}} = \dot{Q}_H - \dot{Q}_C = 817.8\text{ MW} - 485\text{ MW} = 332.8\text{ MW}$

$W_{\text{cyc}} = \dot{W}_{\text{cyc}} \cdot \text{time}$

seconds in 48 weeks = $48 \text{ wks} \cdot \frac{7 \text{ days}}{\text{wk}} \cdot \frac{24 \text{ hrs}}{\text{day}} \cdot \frac{3600 \text{ s}}{\text{hr}} = 29,030,400 \text{ s}$

$W_{\text{cyc}} = 332.8 \frac{\text{MJ}}{\text{s}} \cdot 29,030,400 \times 10^6 \text{ s}$

$W_{\text{cyc}} = 9,661 \times 10^6 \text{ MJ} \leftarrow \text{ANS.}$

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE