

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. One type of nuclear power plant utilizes what is called a Pressurized Water Reactor (PWR) which operates at a temperature of 315°C . Consider a power plant that uses a PWR, rejects heat to a lake at 25°C , and produces 1.2 GW of power. If the power plant has an efficiency that is 70% of the theoretical maximum efficiency, how much energy is rejected to the lake in one day in units of GJ?

GIVEN: $T_c, T_H, \eta = 0.7\eta_{\max}, \dot{W}_{\text{cyc}}$

FIND: Q_c for one day in GJ (not \dot{Q}_c)

ASSUME: S.S. operation

ANALYSIS: $\eta_{\max} = 1 - \frac{T_c}{T_H} = 1 - \frac{298\text{K}}{588\text{K}} = 0.493$

$\eta = 0.7(0.493) = 0.345$

$\eta = \frac{\dot{W}_{\text{cyc}}}{\dot{Q}_H} \Rightarrow 0.345 = \frac{1.2\text{ GW}}{\dot{Q}_H}$

$\dot{Q}_H = 3.48\text{ GW}$

$\dot{W}_{\text{cyc}} = \dot{Q}_H - \dot{Q}_c \Rightarrow 1.2\text{ GW} = 3.48\text{ GW} - \dot{Q}_c$

$\dot{Q}_c = 2.28\text{ GW}$

$Q_c = \int_0^t \dot{Q}_c dt$ \dot{Q}_c is constant, so $Q_c = \dot{Q}_c \Delta t$

$Q_c = (2.28 \frac{\text{GJ}}{\text{sec}}) (1 \text{ day}) (24 \frac{\text{hr}}{\text{day}}) (60 \frac{\text{mins}}{\text{hr}}) (60 \frac{\text{sec}}{\text{min}})$

$Q_c = 197,000\text{ GJ} \leftarrow \text{ANS.}$

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE _____

DIAGRAM

