Problem :

With the current high cost of energy (in the form of gasoline, oil, and natural gas) people are redirecting their thoughts to the efficacy of nuclear energy. Many are afraid that the heat energy exhausted to nearby rivers (as the reactor uses the water for cooling the plant) will raise the river temperature too much for the survival of life in the river.

Consider a commercial nuclear plant. Let's say it is operating at, typically, 1200 MW (US-EIC) and with an efficiency of 30%. If the river water has an average flow rate of 651 thousand kg per second (USGS- a typically low rate for major US rivers), what is the average temperature change in the downstream side of the river?

Would the excess heat from a *non-nuclear* plant give any different result?

Solution :

The relation between heat output and temperature change is…

$$\Delta Q = M \times C \times (\Delta T)$$

Divide both sides by a time interval. That changes the heat output on the left side, to a power output, and it changes the mass on the right side, to a flow rate…

$$\frac{\Delta Q}{\Delta T} = \frac{\Delta M}{\Delta T} \times C \times (\Delta T)$$

… where the term on the left is the power level, and the first term on the right is the flow rate.

Since the efficiency is 30%, the power output to the river, is 70% of the given power level..

$$\frac{\Delta Q}{\Delta T} = 1200 \times 10^6 \times 0.70$$; or, Watts = 840× $10^6 \frac{J}{sec}$

The flow rate, is specified, as…

$$\frac{\Delta M}{\Delta T} =$$ 651 thousand kg/sec …

The specific heat of water, is…

$$C = 4186 \frac{J}{kg\ ℃}$$

We can get the temperature change in the river, by solving for (ΔT) …

$840 \times 10^6 = 650 \times 10^3 \times 4186 \times (\Delta T)$; and solve for (ΔT) …

$(\Delta T) = 0.3$ ℃. This corresponds to a temperature change of 0.5 ℉.

This temperature change is miniscule, in comparison to normal, seasonal changes in the temperatures of lakes and rivers- especially within the USA.

Notice that this calculation incorporated *no step involving nuclear processes*. Therefore the results would be identical for non-nuclear (i.e., oil-fired, coal-fired, natural gas-fired plants) and nuclear power plants.