HT Lab Experiment-2: Radiation Heat Transfer Fundamentals

Group 2

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Q. Measure the light intensity variation with distance from the lamp source. How does the light intensity reaching the sensor depend on distance from the lamp? Use a high lamp light intensity and turn off other lights if they affect the readings.

We know that,

$$I \propto \frac{1}{r^2}$$

$$I = \epsilon \sigma A \frac{T^4}{4\pi r^2}$$

$$\implies I = \epsilon A * \frac{\sigma T^4}{4\pi} * \frac{1}{r^2}$$

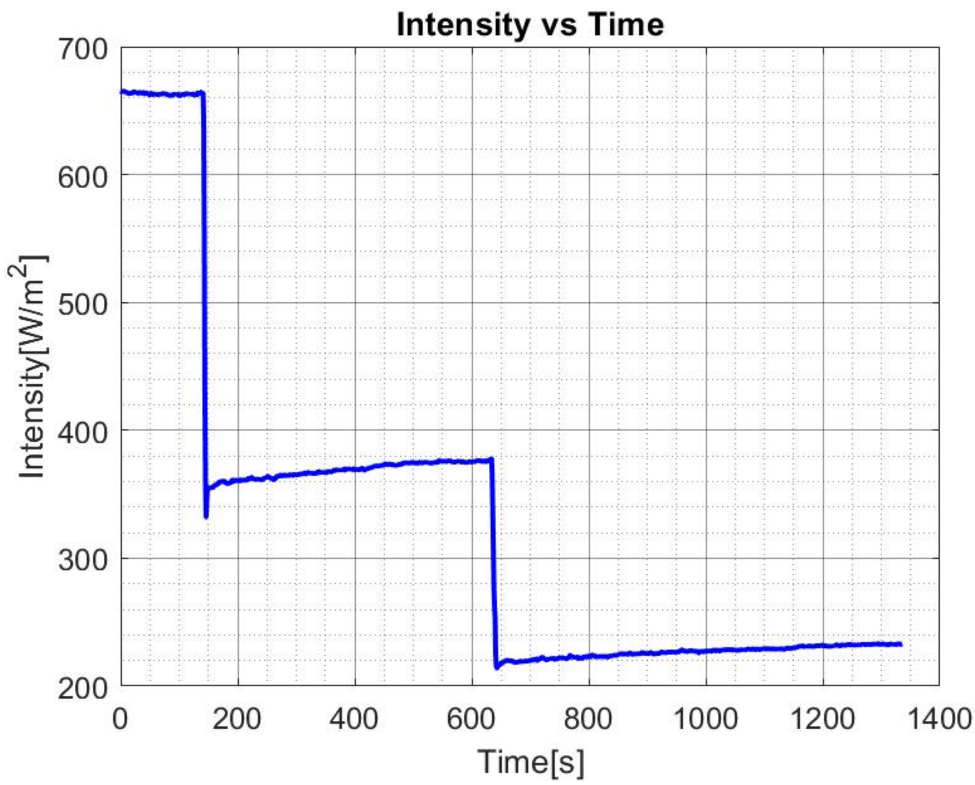
where,

A → surface area of the source

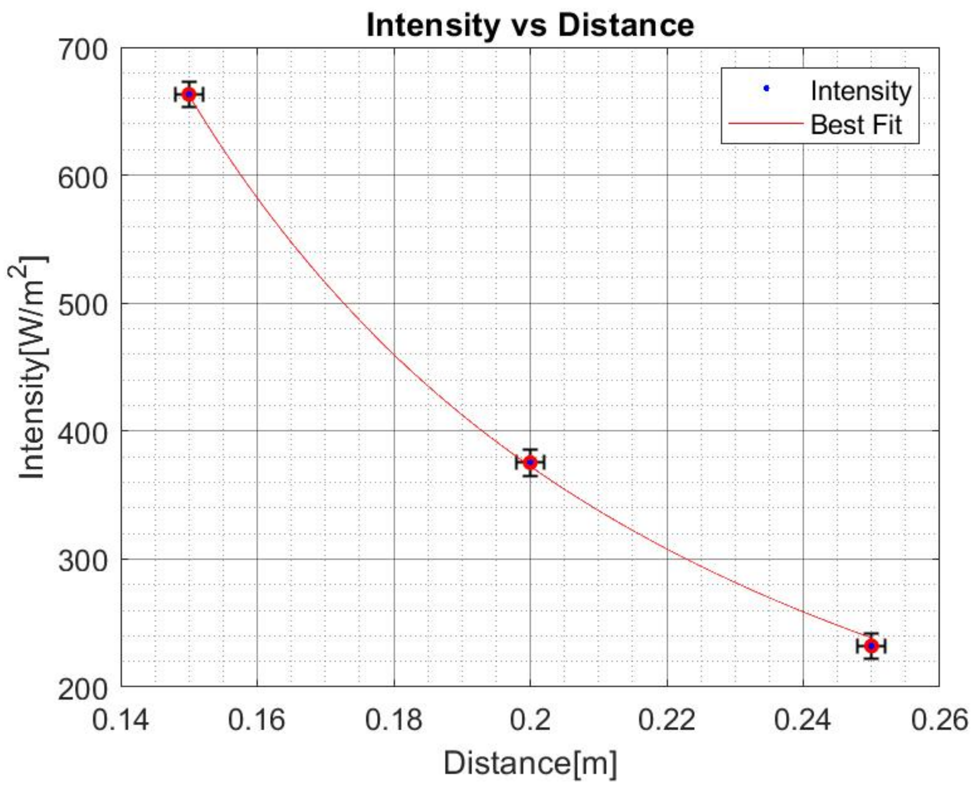
ϵ → source's emmissivity

σ → $5.67 * 10^{-8} W/m^2K^4$

From the experiments, we get



for distances 15, 20 and 25 cm respectively



From the curve fitting, we also get

$$\epsilon A = 0.2565$$

Also from the data,

$$T_{source} = 61.01^oC$$

> ⚠️ **Note:** The values used for intensity were calculated by finding the mean of last few values within 5% of the final value for each cliff.

Q. How does the radiated energy depend on the temperature of the radiation source?

By Theory,

$$\begin{gathered}\text{Energy Radiated} = \epsilon\sigma AT^4 \\ \text{or, } I * 4\pi r^2 = \epsilon\sigma AT^4 \\ \implies I = \epsilon A * \frac{\sigma}{4\pi r^2} * T^4\end{gathered}$$

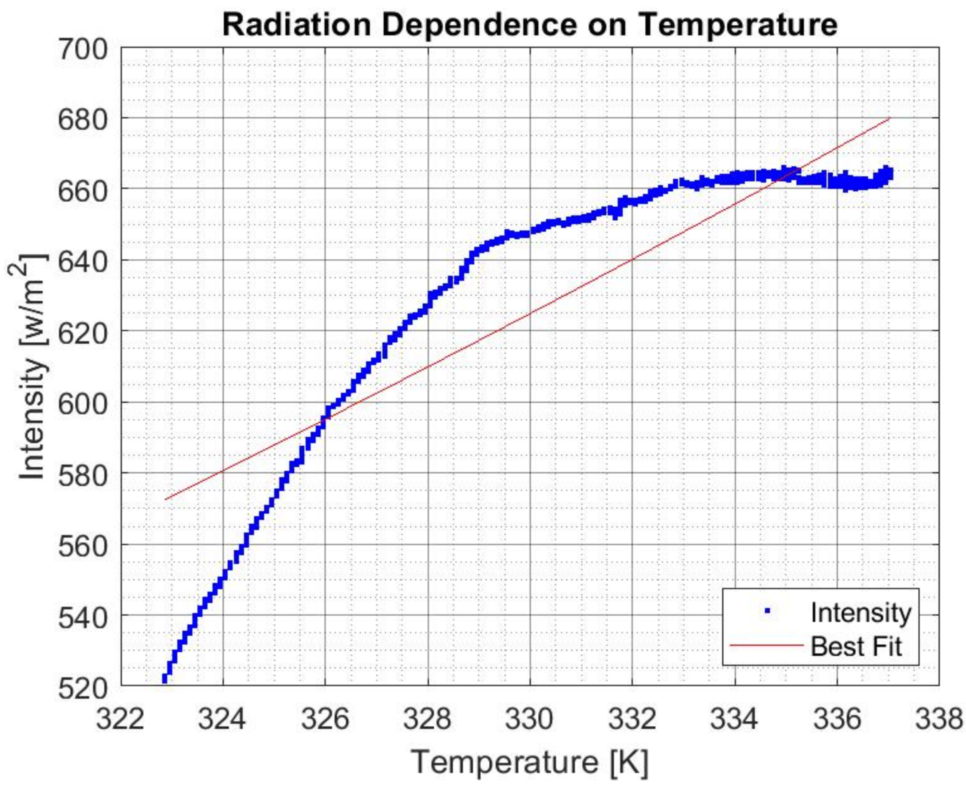
r = 20 cm = 0.15 m;

$\sigma = 5.67 * 10^{-8} W/m^2K^4$

Thus,

$$I = 20.05 * 10^{-8} * \epsilon A * T^4$$

But when we plot intensity with respect to temperature. The graph shows mostly linear and in later stage even logarithmic relation with temperature. The only good reason behind this can be experimental errors.



From the cruve fitting this time, we get $\epsilon A = 0.2628$. Though it's totally not reliable at all.

Q. How does the 'emissivity' of the surface affect its effectiveness as a radiation shield between the heat source and the radiation meter?

From first question, we know that

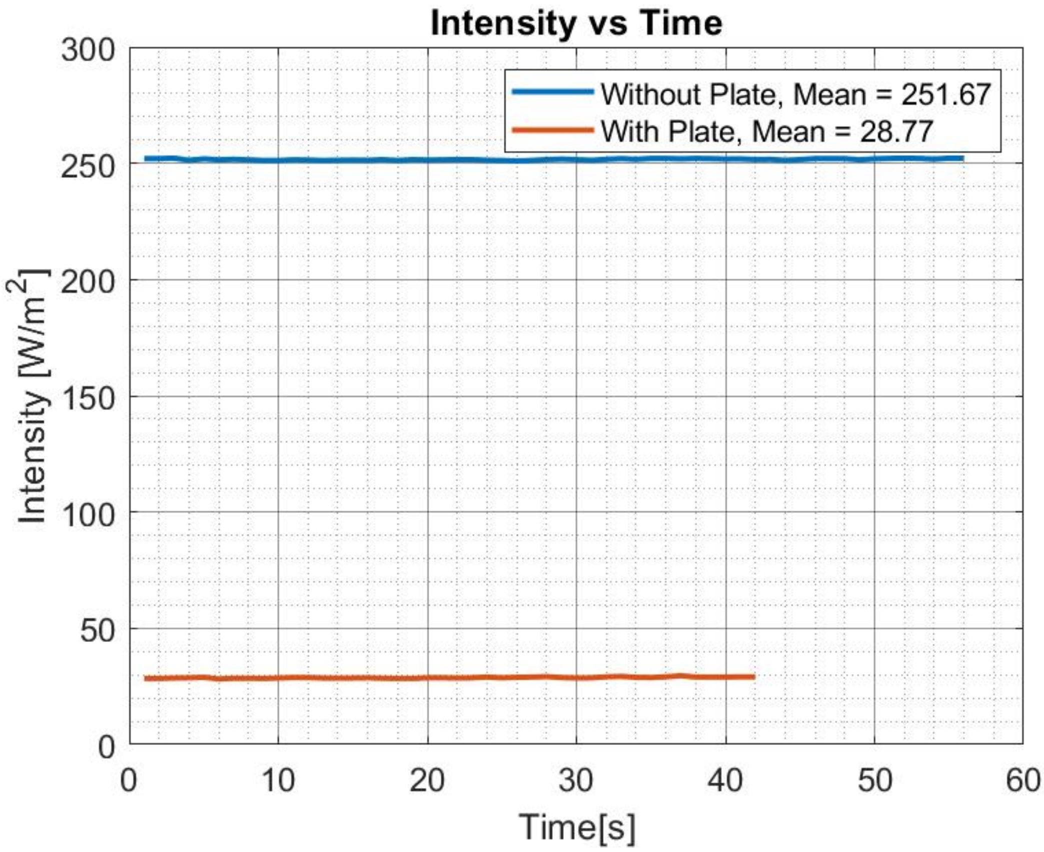
$$I = \epsilon A * \frac{\sigma T^4}{4\pi} * \frac{1}{r^2}$$

If we add a surface between the source and radiation meter then it absorbs it's emissivity times the radiation that's coming on it. And it emits the whole of it back to the other side. Thereby acting as a radiation sheild. Thus,

$$I' = \epsilon_{plate} * I$$
$$\implies I' = \epsilon_{plate} * \epsilon A * \frac{\sigma T^4}{4\pi} * \frac{1}{r^2}$$

For this question, I'll use $\epsilon A = 0.2565$ from Q1.

Using these, we get $r = 22.42cm$ from the first equation. Which means ϵA was a little less than Q1 (probably around 0.24 or 0.22) as the distance was actually 20cm. More importantly, we get $\epsilon_{plate} = 0.1076$



$$\epsilon_{plate} = 0.1076$$

The difference in temperature of the source was also kept in mind while calculating the emissivity of the plate.

From the data,

$$T = 50.2107^oC$$
$$T' = 55.1452^oC$$