Open Experiment: Measurement Of Convective Heat Transfer Coefficient Over a Flat Surface

Group-2

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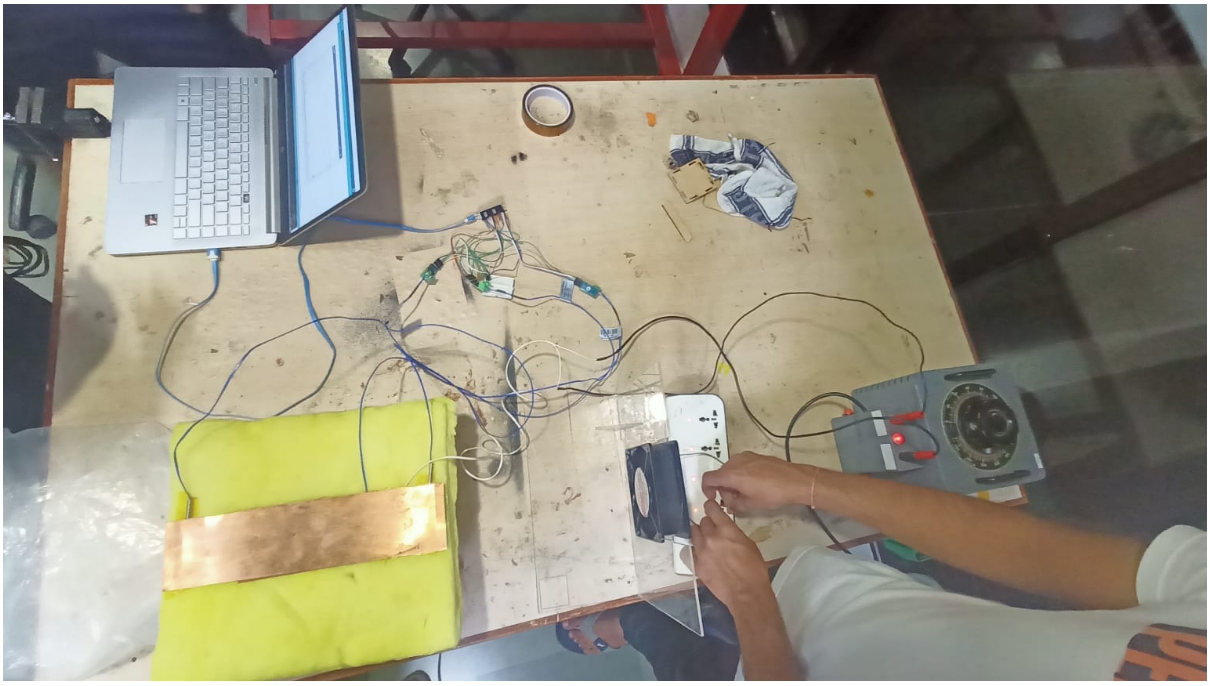
Bill Of Materials

BOM| ME Lab Open Experiment| Final

Sheet1 Proposed,Final Component,Specifications,Price (Per Peice),Quantity,Cost,Dealer,Status,Company,Expected Arrival,Ordered Price (Per Piece),Quantity,Cost,Delivery Silicone

https://docs.google.com/spreadsheets/d/1lgM_1tlKLjqt6ZRaXVtyFMK4Sk5S2AIKURmWIy-mzow/edit?usp=sharing

Setup



Theoretical Approach

Theoretically, we can find the average heat transfer coefficient for a given flow rate using the relation between Nusselt Number, Reynold's Number, and Prandtl Number.

Where,

$$Nu = \frac{h_l L}{k},$$
$$Re = \frac{\rho V L}{\mu}, \text{ and}$$
$$Pr = \frac{\mu C_p}{k}$$

For Laminar Flow

$$Nu = 0.664(Re)^{0.5}(Pr)^{0.33}$$
$$\implies h_l = 0.664\frac{k}{L}\left(\frac{\rho V L}{\mu}\right)^{0.5}\left(\frac{\mu C_p}{k}\right)^{0.33}$$
$$= 0.664 * \frac{(\rho * V)^{0.5} * C_p^{0.33} * k^{0.67}}{L^{0.5} * \mu^{0.17}}$$

For Turbulent Flow

$$Nu = 0.037(Re)^{0.8}(Pr)^{0.33}$$

Practical Approach

From experimental readings, we can find average heat transfer coefficient using,

$$\dot{q} = hA(T_s - T_\infty) = V * I$$

where,

T_s → Temperature of surface

T_∞ → Temperature of Air

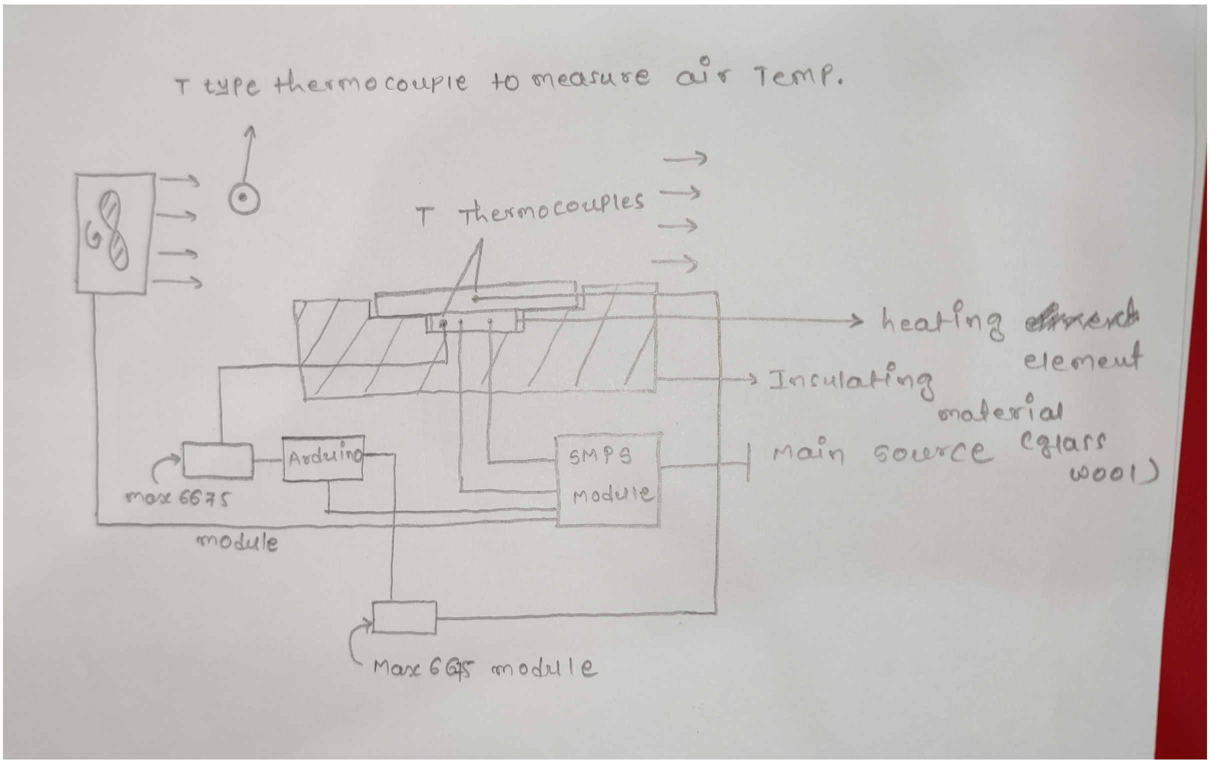
Estimation

(for deciding the power requirement for heating element)

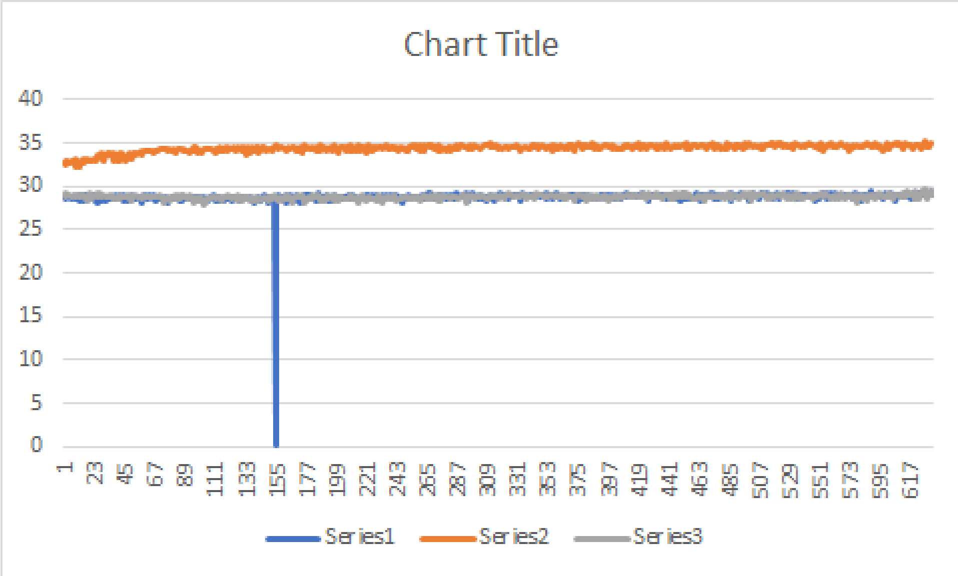
$$h \approx 2 - 100;\ T_s = 200^o C;\ T_\infty = 25^o C;\ A = 0.01 m^2$$
$$P = 20 * 0.01 * 175 = 35W$$

Thus, we need a heating element with variable power supply between 20-100 W.

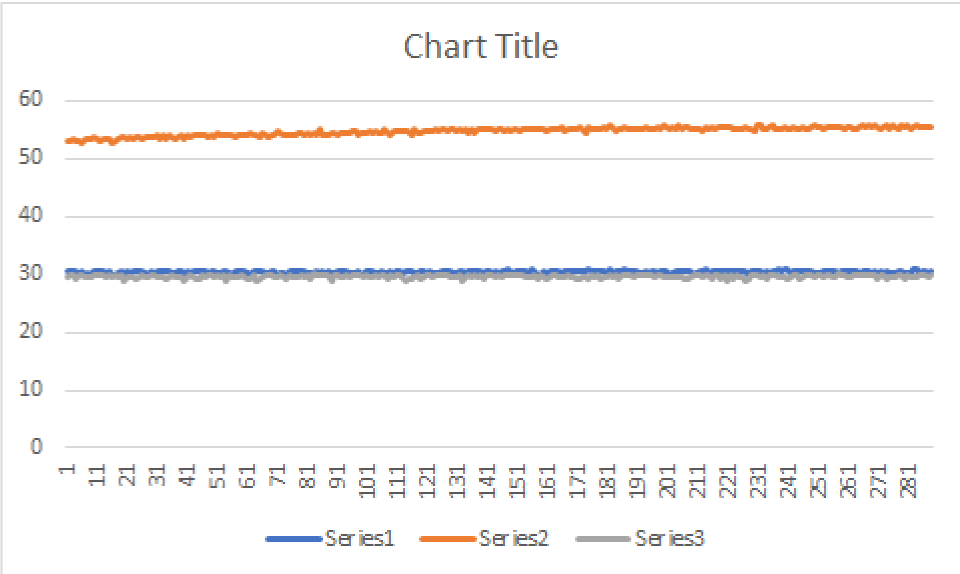
Schematic



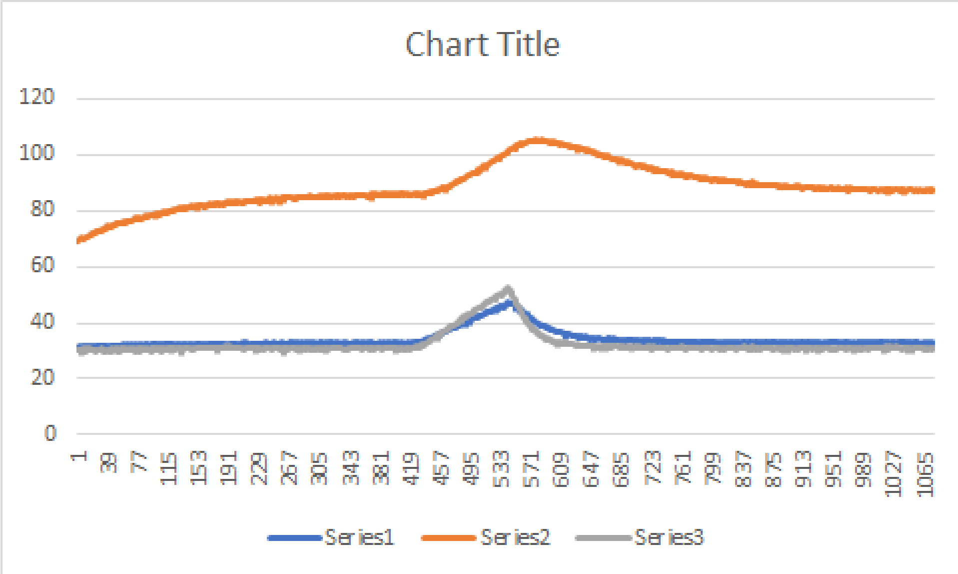
Data



40 Volt



80 Volt



120 Volt

V	T_1	T_2	T_3	T_{air}	T_{avg}	$h_{practical}$	$h_{theo.}$
40V	29	35	29.5	26.1	32.125	19.24	17.27
80V	29.75	55.5	30.75	26.1	42.875	27.52	17.27
120V	30.5	87.25	32.75	26.1	59.43	31.32	17.27