











Also, for a hot surface up or a cold surface down type of horizontal plate, exposed to natural convection,  $10^5 < Ra < 10^7$  and hence  $C=0.54$ ,  $m=1/4$  (These values have been taken from the reference [1] mentioned later).

Now, Rayleigh number is product of Grashof number and Prandtl number (which has value of .7 for air) and

$$Gr = \beta * g * (T_s - T_\infty) * L^3 / \nu^2 \quad (12)$$

$$\text{Also, } Nu = hL / K_g \quad (13)$$

Where  $K_g$  can be assumed as the conductivity of the gas i.e. air in this case.

The properties of air,  $K_g$  and  $\beta$  are determined at the film temperature i.e. average of  $T_s$  and ambient temperature.

$$K_g = 13.75 * 10^{-5} T_f^{0.92} \quad (14)$$

$$\nu = 1.13 * 10^{-9} T_f^{5/3} \quad (15)$$

Using the above relations, we get the required relation for the convective heat transfer coefficient as follows [7]:

$$h = 4.0 * \left( \left( \frac{T_s - T_\infty}{L} \right)^{.25} \right) * (T_s + T_\infty)^{-.16} \quad (16)$$

Using the above relation, we found the value of  $h$  at every time step, as we knew the ambient temperature and the surface temperature of the plate thermometer

#### 4. Discussions and Conclusions

It is shown in this report that incident radiant heat flux can be obtained indirectly from plate thermometer measurements. The PT was, however, designed for monitoring temperature in fire resistance furnaces and not for measuring incident radiant heat flux in air at ambient temperature as discussed here. Corrections are therefore needed as is outlined in this paper to compensate for conduction and convective errors.

Conduction losses could be substantially reduced by avoiding direct metal contact at the edges between the front and back sides of the PT and by using thicker and more effective insulation pads. The inertia could also be considerably reduced by using thinner steel plates and thereby getting much faster responses to thermal changes. Such modifications of the PT design for use in ambient air are possible. The PT does not normally need to be as robust when used in ambient air as when used in fire resistance furnaces.

#### 5. Other Recommendations

The above report explains the design and construction of a plate thermometer, and the way it is calibrated against a standard (a heat flux sensor in this case). In order to calibrate it more accurately, we could change the values of

the conduction correlation factor, and perform iterations until we get the closest fit with the measured values or we could also change the material or thickness of the plates used to manufacture it.

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