Heat Sink Sizing Calculations

In order to calculate the heat transfer characteristics of the heat sink the convection coefficient (h) must be calculated. The flow between the fins of the heat sink will the modeled as internal, fully developed flow.

$$h = .023(Re)^{\frac{4}{5}}(\mathrm{Pr})^{0.3}$$ For air at STP Pr=.707

In order to use this equation the Reynolds number for the flow across our heat sink must be calculated.

$$Re_D = \frac{4\dot{m}}{\pi D_h \mu}$$

Hydraulic diameter is calculated as such:

$$D_h = \frac{4A_c}{P} = \frac{4(6.45E^{-4})}{.1372} = .0188\text{m}$$

For flow rate:

$$20 \text{ CFM} = 0.730 \text{ kg/min} = .0122 \text{ kg/s} = \frac{.0122\ kg/s}{7\ (channels)} = .00174 \text{ kg/s}$$

The Reynolds number can now be calculated.

$$\mu=208.2E^{-7} \text{ N*s/m}^2$$

$$Re_D = \frac{4(.00174\frac{kg}{s})}{\pi(0.188\ m)\mu}$$

$$Re_D = 5660$$

Now that we have a Reynolds number the ‘h’ value can be calculated

$$h = .023(5660)^{\frac{4}{5}}(.707)^{0.3}$$

$$h = 20.85\ \frac{W}{m^2K}$$

The equations for calculating the thermal resistance of the heat sink are as follows:

Lc=L+(t/2)
Ap=t*L
Af=2*W*Lc
Ac=W*t

Ab=Total Area-(N*Ac) (Area of the base)
At=(N*Af)+Ab

P=(2*W)+(2*t)

m=sqrt((h*P)/(K*Ac))

Nf=((tanh(m*Lc))/(m*Lc))

No=1-(((N*Af)/At)*(1-Nf))

The thermal resistance of the given heat sink is calculated as:

Rh=1/(No*h*At)

The proposed heat sink:

Fin height: 2.5 in.
Fin length: 4.0 in.
Fin thickness: 0.124 in.
Fin spacing: 0.400 in.
Fins: 7
Heat sink dimensions: 4 in. x 3.15 in.

R_T=0.52

Final Size: 3.15" X 4" X 2.875" 7 Fins