// 1st solution solution: add 2 insulation layers of carbon fiber of L_2 meters thickness, the following calculations are done to find L_2 required to comply with the rules

//Knowns given:
A = 0.422 [m^2] // The total surface area on which we aim to insulate
L_1= 0.635/1000 // thickness of the main aluminum firewall base
k_6061 = 166 [W/K-m]
k_CF = 0.84 [W/K-m]

T_inf = 298.15 [K]
Ts_1= 402.59[K]
Ts_2 = 333.15 [K]
T_delta= Ts_1-T_inf

h_conv_air = 5 [W/m^2*K]

//Thermal Resistances connected in series:
R_cond_6061 = L_1/(K_6061*A)
R_conv_air = 1/(h_conv_air *A)
R_cond_CF = L_2/(A*k_CF)

// the sumation of the thermal resitsnaces in the wall
R_total_CF= R_cond_6061+ R_conv_air + (2*R_cond_CF) // multiplied by 2 indicates that the firewall insulated from both side with equal thickness of carbon fiber layer

// Thermal power:
Q_CF= T_delta/ R_total_CF

// Surfcae temperature 2:
Ts_2 =(- (2* R_cond_CF+R_cond_6061)*Q_CF) +Ts_1

$$A = 0.422 \quad [m^2]$$

$$L_1 = \frac{0.635}{1000}$$

$$k_{6061} = 166 \quad [W/K\text{-}m]$$

$$k_{CF} = 0.84 \quad [W/K\text{-}m]$$

$$T_{inf} = 298.15 \quad [K]$$

$$Ts_1 = 402.59 \quad [K]$$

$$Ts_2 = 333.15 \quad [K]$$

$$T_{\delta} = Ts_1 - T_{inf}$$

$$h_{conv,air} = 5 \quad [W/m^2*K]$$

$$R_{cond,6061} = \frac{L_1}{k_{6061} \cdot A}$$

$$R_{conv,air} = \frac{1}{h_{conv,air} \cdot A}$$

$$R_{cond,CF} = \frac{L_2}{A \cdot k_{CF}}$$

$$R_{total,CF} = R_{cond,6061} + R_{conv,air} + 2 \cdot R_{cond,CF}$$

$$Q_{CF} = \frac{T_{\delta}}{R_{total,CF}}$$

$$Ts_2 = -\left(2 \cdot R_{cond,CF} + R_{cond,6061}\right) \cdot Q_{CF} + Ts_1$$

SOLUTION

Unit Settings: SI K Pa J mass rad

$A = 0.422$ [m^2]
$h_{conv,air} = 5$ [$W/m^{2*}K$]
$k_{6061} = 166$ [W/K-m]
$k_{CF} = 0.84$ [W/K-m]
$L_1 = 0.000635$ [m]
$L_2 = 0.1667$ [m]
$Q_{CF} = 73.85$ [W]
$R_{cond,6061} = 0.000009065$ [K/W]
$R_{cond,CF} = 0.4701$ [K/W]
$R_{conv,air} = 0.4739$ [K/W]
$R_{total,CF} = 1.414$ [K/W]
$Ts_1 = 402.6$ [K]
$Ts_2 = 333.2$ [K]
$T_{\delta} = 104.4$ [K]
$T_{inf} = 298.2$ [K]

No unit problems were detected.