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// 1st 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
L_1= 0.635/1000  // thickness of the main aluminum firewall base
k_6061 = 166 [W/K-m]
k_EG = 0.03 [W/K-m]

T_inf = 298.15 [K]
Ts_1= 402.59[K]
//Ts_2 =  333.15 [K]  = 60, anything beyond this is not acceptable
T_delta= Ts_1-T_inf
L_2 = 0.000787[m]  // = 0.031 in which is the purchased availble thicknesss of E glass

h_conv_air = 25 [W/m^2*K]
 emissivity = 0.9 // For conservatisim, we're using the
F_12 =1 // for conservatism, assume all heat radiated from the engine walls is absorbed by the firewall
h_rad_engine = emissivity* sigma#*(Ts_1^2+T_inf^2)*(Ts_1+T_inf)
//Thermal Resistances connected in series:
R_cond_6061 = L_1/(K_6061*A)
R_conv_air = 1/(h_conv_air *A)
R_cond_EG = L_2/( A*k_EG)
 R_rad_engine = 1/(h_rad_engine * A*F_12) // assume F_12=F_21
R_conv_rad_engine = (R_conv_air *R_rad_engine)/(R_conv_air+R_rad_engine)
 //  the sumation of the thermal resitsnaces in the wall
R_total_EG= R_cond_6061+ R_conv_air + ( 2*R_cond_EG) + R_conv_rad_engine // multiplied by 2 indicates that the firewall insulated from both side with equal thickness of carbon fiber layer

 // Heat Flux:
Q_EG= T_delta/ R_total_EG

 // Surfcae temperature 2:
Ts_2 =(-  (  2* R_cond_EG+R_cond_6061+ R_conv_rad_engine)*Q_EG ) +Ts_1
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$A = 0.422 \; [m^2]$

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

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

$k_{EG} = 0.03 \; [W/K\text{-}m]$

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

$Ts_1 = 402.59 \; [K]$

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

$L_2 = 0.000787 \; [m]$

$h_{conv,air} = 25 \; [W/m^2{*}K]$

$emissivity = 0.9$

$F_{12} = 1$

$h_{rad,engine} = emissivity \cdot 5.670E{-}08 \; [W/m^2\text{-}K^4] \cdot \left(Ts_1^2 + T_{inf}^2\right) \cdot \left(Ts_1 + T_{inf}\right)$

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

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

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

$$R_{rad,engine} = \frac{1}{h_{rad,engine} \cdot A \cdot F_{12}}$$

$$R_{conv,rad,engine} = \frac{R_{conv,air} \cdot R_{rad,engine}}{R_{conv,air} + R_{rad,engine}}$$

$$R_{total,EG} = R_{cond,6061} + R_{conv,air} + 2 \cdot R_{cond,EG} + R_{conv,rad,engine}$$

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

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

SOLUTION

Unit Settings: SI K Pa J mass rad

$A = 0.422$ [m^2]

$F_{12} = 1$

$h_{rad,engine} = 8.975$ [W/K-m^2]

$k_{EG} = 0.03$ [W/K-m]

$L_2 = 0.000787$ [m]

$R_{cond,6061} = 0.000009065$ [K/W]

$R_{conv,air} = 0.09479$ [K/W]

$R_{rad,engine} = 0.264$ [K/W]

$Ts_1 = 402.6$ [K]

$T_{\delta} = 104.4$ [K]

emissivity = 0.9

$h_{conv,air} = 25$ [W/m^2*K]

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

$L_1 = 0.000635$ [m]

$Q_{EG} = 361.5$ [W]

$R_{cond,EG} = 0.06216$ [K/W]

$R_{conv,rad,engine} = 0.06975$ [K/W]

$R_{total,EG} = 0.2889$ [K/W]

$Ts_2 = 332.4$ [K]

$T_{inf} = 298.2$ [K]

No unit problems were detected.