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AE 608 A

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COMPUTATIONAL PROJECT

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① TIME OF EXPOSURE - 720 seconds

MATERIAL USED

Density = 1600 kg/m^3

Thermal Conductivity = 1-10 W/mK

So, thermal conductivity of

K = 1 [Chosen]

C_p = 500 Kg/m^3

Melting Point = 2200 K

Max temperature < 2200 K.

$\alpha = 1.25 \times 10^{-6}$

The Material above is "Re-inforced Carbon Carbon".

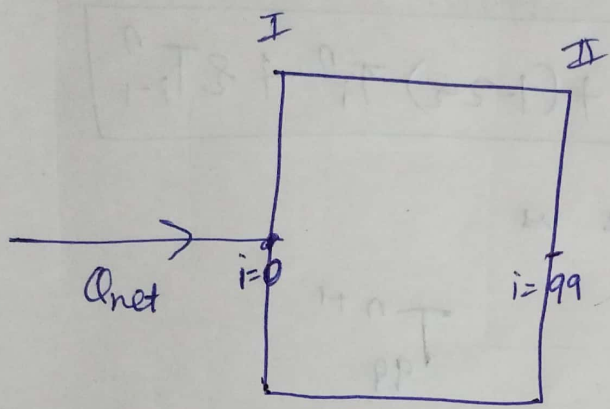
It is chosen because, we have conditions of

$T_{ambient}$ = 310 K on backend & On the exposed side we have the surface radiating to temp of 0 K, ⇒ Outer-Space is Assumed.

~~This MATERIAL~~ :

These conditions, suggest that it might be used for Heat Sheild of "Re-entry vehicle"

For Heat Shield, the best material is RCC as when other material Li 900 was used, the maximum temperature exceeded [2100°C (approx)] its Melting Temp [1264°C]



Assumption :- Let thickness is 10 cm, discretization into 10 division; $\Delta x = 0.01 m$

$\Rightarrow$ $\frac{\alpha \Delta t}{(\Delta x)^2} \leq \frac{1}{2}$ $\Rightarrow$ time step $\leq$ 40 seconds

$\boxed{dt = 1}$ assumed

Boundary Condition at exposed end

$$① \quad q_{incident}(t) - \varepsilon \overset{5.67\times10^{-8}}{\sigma} [T(0,t)]^4 = \rho c_p \frac{dT}{dt} - k \frac{dT}{dx}\Big|_{x=0}$$

$$② \quad T(x=L) = T(x=L-dx) \text{ (All times)}$$

Initial Condition $\Rightarrow$ $T(x,0) = 300K$

Governing $Eq^n \Rightarrow \frac{\partial^2 u}{\partial t^2} = \frac{1}{\alpha}\frac{\partial u}{\partial t}$; $u = temp = T$

Applying Euler FTCS scheme

We get

$$\boxed{T_i^{n+1} = \lambda T_{i+1}^n + (1-2\lambda)\, T_i^n + \lambda T_{i-1}^n}$$

this will give us

T_1^{n+1} ———— T_{99}^{n+1}

$T_{100}^{n+1} = T_{99}^{n+1}$

& T_0^n = will be found from Boundary condition ①

~~this~~ After Simulation, we found that this thickness is optimum as the back end temp doesn't exceed 310 K.

It is between $307\,K < T_{(x=L)} < 310\,K$

Weight	m^2 = 160 kg/m^2

10 cm $\longrightarrow$ 5cm, 2.5 cm, 1.25 cm, 1 cm, 0.5 cm, 0.4 cm, 0.25 cm

elements 2, 4, 8, 10, 20, 25, 40

From the plot attached, we see, that grid independence is achieved for 20 division, $\therefore dx = 0.5$ cm $= 0.005$ m for our length of 10 cm.