## PTC° Mathcad°



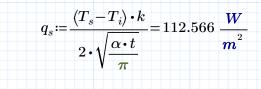
A high-intensity infrared ceiling heating system is employed to keep a factory floor warm. If the heating system is switched on with the floor initially at temperature  $T_i$ , determine the radiant heat flux intensity on the floor required to warm the floor surface to a temperature  $T_s$  after time t. What is the floor temperature at the bottom surface of the concrete slab?

Assume that the concrete floor slab is 20 cm thick and that the semi-infinite model applies.

Concrete properties (assume medium density):

$\rho \coloneqq 1500 \ \frac{kg}{m^3}$	density
$k \coloneqq 1.2 \ \frac{W}{m \cdot \Delta^{\circ} C}$	thermal conductivity
$c \coloneqq 800 \cdot \frac{J}{kg \cdot \Delta^{\circ}C}$	specific heat capacity
$\alpha \coloneqq \frac{k}{\rho \cdot c}$	thermal diffusivity
$T_i \coloneqq 7 \ \Delta^\circ C$	initial floor temperature
$T_s \coloneqq 18 \ \varDelta^{\circ}C$	final floor surface temperature after time t
$t \coloneqq 3 hr$	

For a semi-infinite slab with constant surface heat flux  $q_s$  after time t = 0, we have

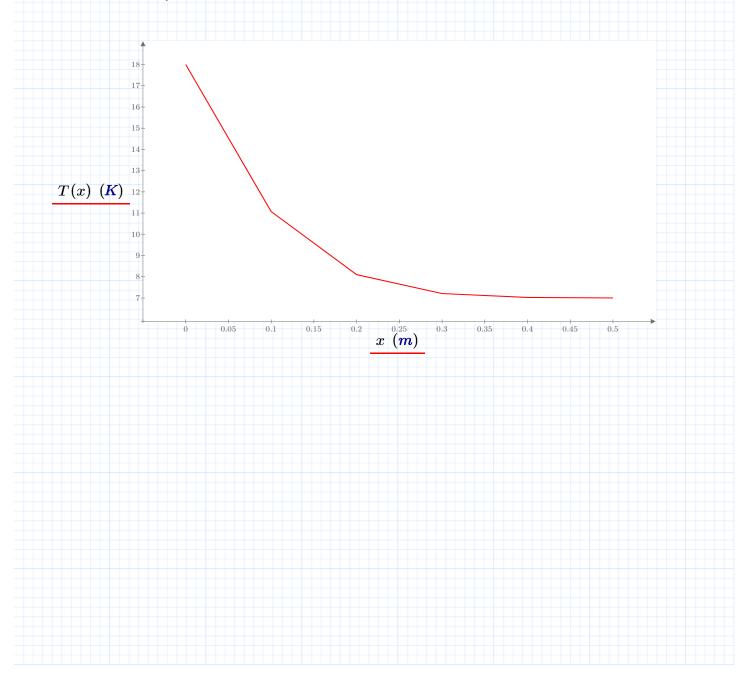


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We will determine the temperature at different depths for a semi-infinite model to see how accurate it is for the present case:

$$x \coloneqq 0.0 \ m, 0.1 \ m..0.5 \ m$$
$$T(x) \coloneqq \left(2 \cdot \frac{q_s}{k} \cdot \sqrt{\frac{\alpha \cdot t}{\pi}} \cdot \exp\left(-\frac{x^2}{4 \cdot \alpha \cdot t}\right) - \frac{q_s \cdot x}{k} \cdot \left(1 - \exp\left(\frac{x}{2 \cdot \sqrt{\alpha \cdot t}}\right)\right)\right) + T_i$$

Examination of the temperature variation with depth at t = 3 hours shows that the heat flux on the surface has no significant effect below a depth of 0.2 m. Therefore, the present model is satisfactory. Note that if there was a significant heating of the lower boundary of the slab then heat loss through this boundary would have to be included in the analysis.



<sup>2.3</sup>\_Semi-Infinite\_Slab\_-\_Radiant\_Heat\_Flux\_on\_Floor.mcdx