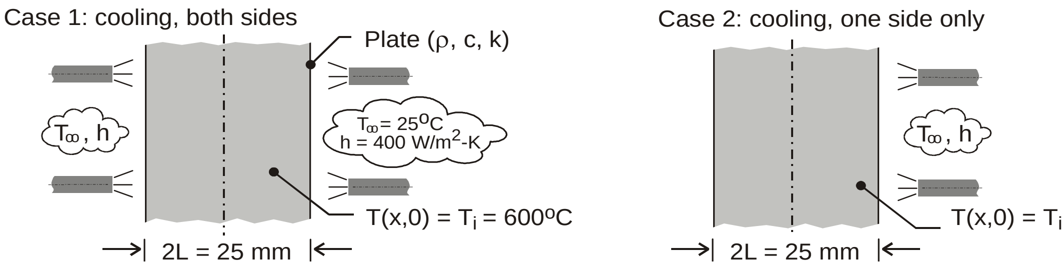
# PROBLEM 5.54

**KNOWN:** Plate of thickness 2L = 25 mm at a uniform temperature of 600°C is removed from a hot pressing operation. Case 1, cooled on both sides; case 2, cooled on one side only.

**FIND:** (a) Calculate and plot on one graph the temperature histories for cases 1 and 2 for a 500-second cooling period; use the *IHT* software; Compare times required for the maximum temperature in the plate to reach 100°C; and (b) For both cases, calculate and plot on one graph, the variation with time of the maximum temperature difference in the plate; Comment on the relative magnitudes of the temperature gradients within the plate as a function of time.

**SCHEMATIC:**



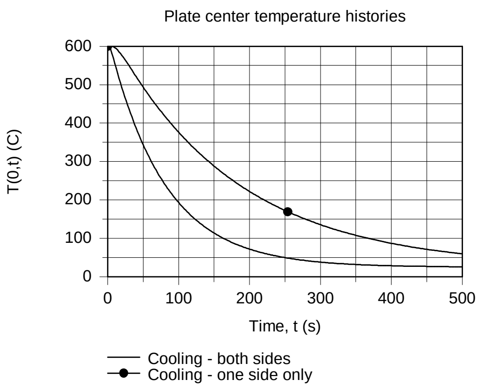

**ASSUMPTIONS:** (1) One-dimensional conduction in the plate, (2) Constant properties, and (3) For case 2, with cooling on one side only, the other side is adiabatic.

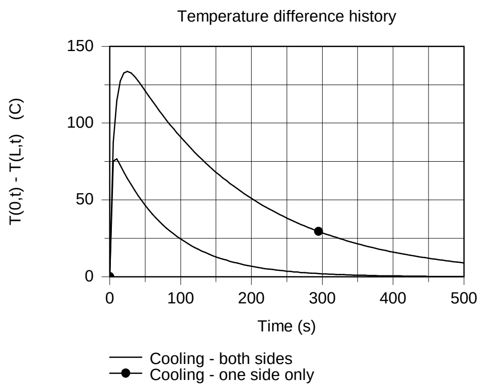
**PROPERTIES:** Plate (*given*): $\rho = 3000\ kg/m^3$, $c = 750\ J/kg\cdot K$, $k = 15\ W/m\cdot K$.

**ANALYSIS:** (a) From *IHT*, call up *Plane Wall, Transient Conduction* from the *Models* menu. For case 1, the plate thickness is 25 mm; for case 2, the plate thickness is 50 mm. The plate center (x = 0) temperature histories are shown in the graph below. The times required for the center temperatures to reach 100°C are

$t_1 = 164$ s $\qquad\qquad t_2 = 367$ s $\qquad\qquad$ <

(b) The plot of T(0, t) – T(1, t), which represents the maximum temperature difference in the plate during the cooling process, is shown below.




**COMMENTS:** (1) From the plate center-temperature history graph, note that it takes more than twice as long for the maximum temperature to reach 100°C with cooling on only one side.

(2) From the maximum temperature-difference graph, as expected, cooling from one side creates a larger maximum temperature difference during the cooling process. The effect could cause microstructure differences, which could adversely affect the mechanical properties within the plate.