CH EN 3453 – Heat Transfer

Conduction: The Plane Wall

Reminders

- Homework #2 due Friday
  - Help session today 4:30 pm in MEB 2325
- TA office hours
  - Bethany Tuesdays 11:45-12:35 in ICC
  - Cody Thursdays 10:30-11:30 in ICC
- ExxonMobil recruiting for internships
  - Email Geoff Silcox (geoff@che.utah.edu) if you are interested
  - Need at least a 3.0 GPA
  - Career fair Sept 23
- Wednesday is the last day to drop classes

Heat Transfer through a Wall

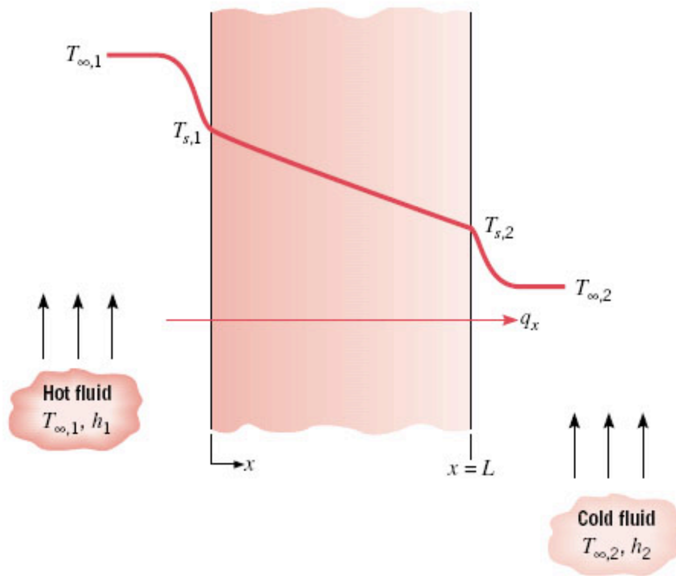
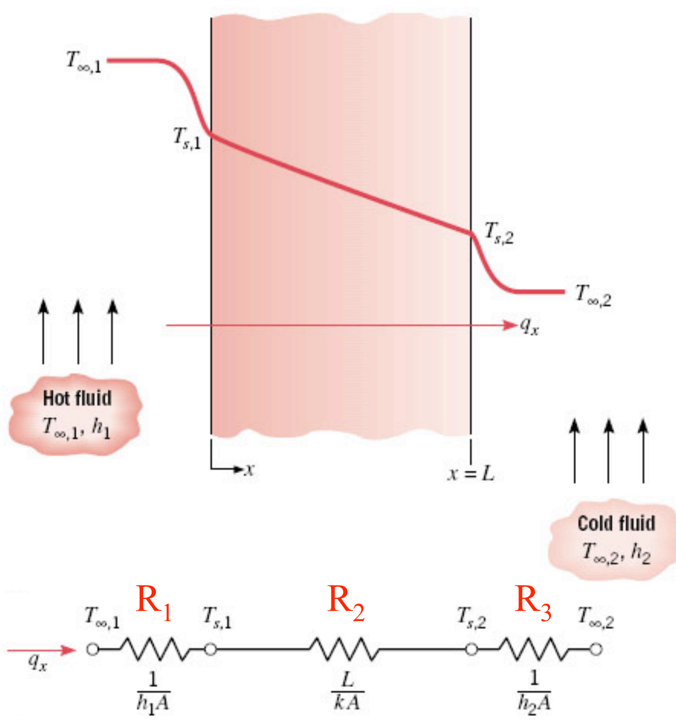


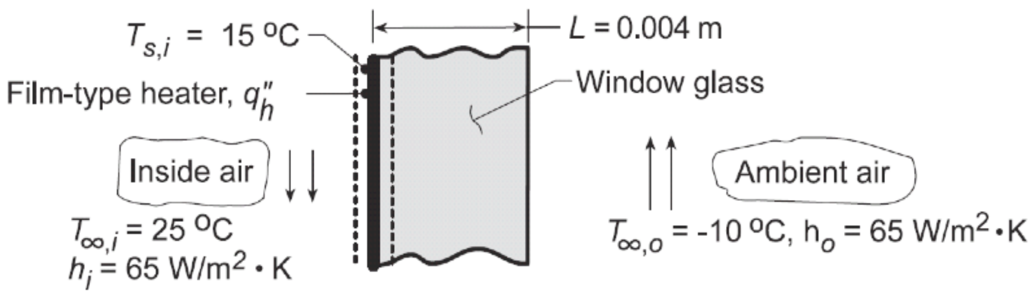
Figure 3.1 Heat transfer through a plane wall.

Heat Transfer through a Wall



Example – Book Problem 3.3a

The window of a car is defogged by attaching a transparent, film-type heating element to its inner surface. For 4-mm-thick window glass, determine the electrical power required per unit window area to maintain an inner surface temperature of 15°C when the interior air temp is $T_{\infty,i}$ = 25°C and the convection coefficient h_i = 10 W/m²·K while the outside air temp is $T_{\infty,o}$ = –10°C and h_o = 65 W/m²·K.



Complex Heat Transfer

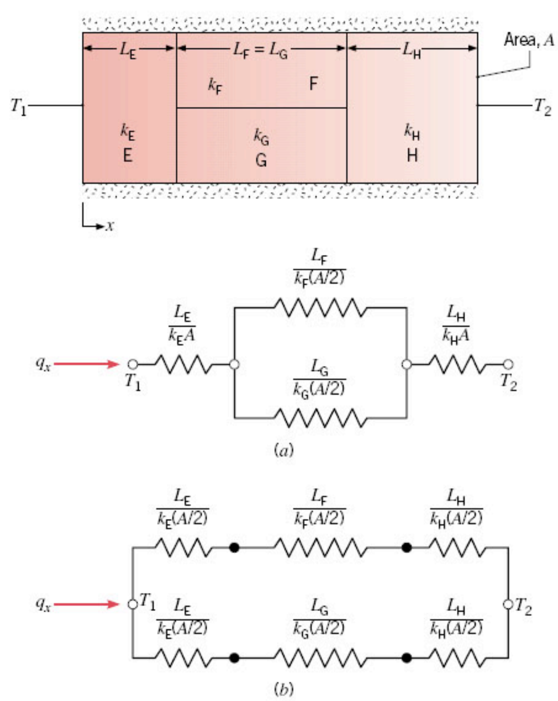


FIGURE 3.3 Equivalent thermal circuits for a series–parallel composite wall.

Contact Resistance

Table 3.1 Thermal contact resistance for (*a*) metallic interfaces under vacuum conditions and (*b*) aluminum interface (10-μm surface roughness, 10^5 N/m^2) with different interfacial fluids [1]

Thermal Resistance, $R''_{t,c} \times 10^4$ (m$^2 \cdot$ K/W)

(*a*) Vacuum Interface			(*b*) Interfacial Fluid	
Contact pressure	100 kN/m^2	10,000 kN/m^2	Air	2.75
Stainless steel	6–25	0.7–4.0	Helium	1.05
Copper	1–10	0.1–0.5	Hydrogen	0.720
Magnesium	1.5–3.5	0.2–0.4	Silicone oil	0.525
Aluminum	1.5–5.0	0.2–0.4	Glycerine	0.265

Example – Book Problem 3.28

A power transistor is encapsulated in an aluminum case attached to a square aluminum plate (k = 240 W/m·K) which is 6 mm thick and 20 mm square. The transistor and plate are screwed in so the contact pressure is 1 bar and the air-filled interface has a roughness of 10 microns and a contact area of 0.0002 m^2. The back side of the plate is exposed to air ($T_\infty = T_{sur}$ = 25°C) and all heat is removed here by convection (h = 4 W/m^2·K) and radiation (ε = 0.9). What is the maximum power dissipation if the case surface temperature should not exceed 85°C?