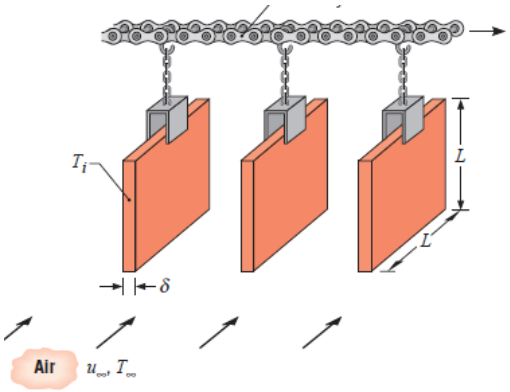
Birzeit University
Mechanical & Mechatronics Engineering Department
Heat Transfer ENME 431
Homework # 6 Chapter 7 External Convection
Instructor: Dr. Afif Hasan

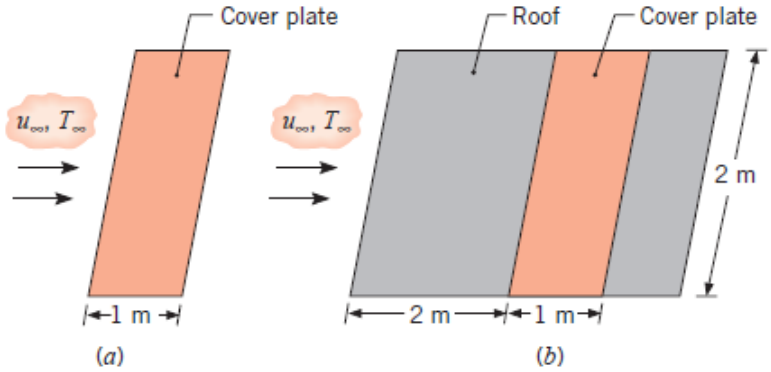
7.18 The surface of a 1.5 m long flat plate is maintained at 40 ^{o}C and water at a temperature of 4 ^{o}C and velocity of 0.6 m/s flows over the surface.

a. Calculate the heat transfer rate per unit width of plate.
b. If a wire were placed near the leading edge of the plate to induce turbulence over the entire plate what would be the heat transfer rate?

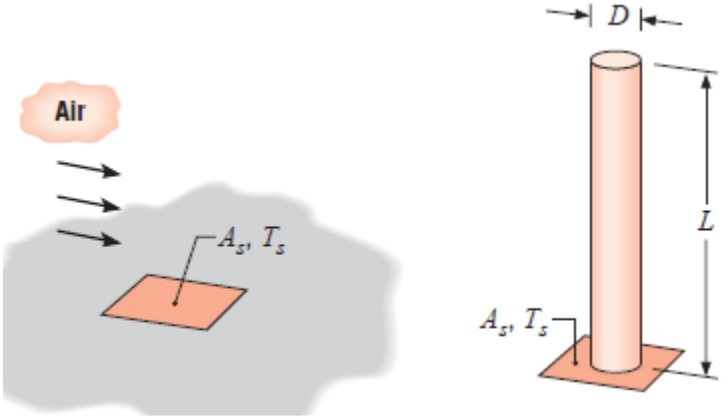
7.24 Steel (AISI 1010) plates of thickness δ= 6 mm and length L =1 m on a side are conveyed from a heat treatment process and are concurrently cooled by atmospheric air of velocity $u\infty$ =10 m/s and $T\infty$= 20^{o}C in parallel flow over the plates. For an initial plate temperature of Ti =300^{o}C, what is the rate of heat transfer from the plate? What is the corresponding rate of change of the plate temperature? The velocity of the air is much larger than that of the plate.



7.43 The cover plate of a flat-plate solar collector is at 15^{o}C, while ambient air at 10^{o}C is in parallel flow over the plate, with $u\infty$ =2 m/s. (a) What is the rate of convective heat loss from the Plate? (b) If the plate is installed 2 m from the leading edge of a roof and flush with the roof surface, what is the rate of convective heat loss?



7.53 Air at 27°C and a velocity of 5 m/s passes over the small region *As* (20 mm x 20 mm) on a large surface, which is maintained at *Ts* = 127°C. For these conditions, 0.5W is removed from the surface *As*. To increase the heat removal rate, a stainless steel (AISI 304) pin fin of diameter 5 mm is affixed to *As*, which is assumed to remain at *Ts* = 127°C. (a) Determine the maximum possible heat removal rate through the fin (b) What fin length would provide a close approximation to the heat rate found in part (a)? *Hint*: Refer to Example 3.9. (c) Determine the fin effectiveness, εf. (d) What is the percentage increase in the heat rate from *As* due to installation of the fin?



7.90 A preheater involves the use of condensing steam at 100°C on the inside of a bank of tubes to heat air that enters at 1 atm and 25°C. The air moves at 5 m/s in cross flow over the tubes. Each tube is 1 m long and has an outside diameter of 10 mm. The bank consists of 196 tubes in a square, aligned array for which *ST* =*SL* =15 mm. What is the total rate of heat transfer to the air?