10.302
Fall 2004
Discussion Problem for Recitation on
Tuesday, November 16, 2004

Exhaust gas from a furnace is to be used to preheat the combustion air supplied to the furnace burners. The gas has an inlet temperature of 1100K and the air has an inlet temperature of 300K. The heat capacity for each fluid is 1075J/kg.K. The overall heat transfer coefficient is 100 $W/m^2 \cdot K$.

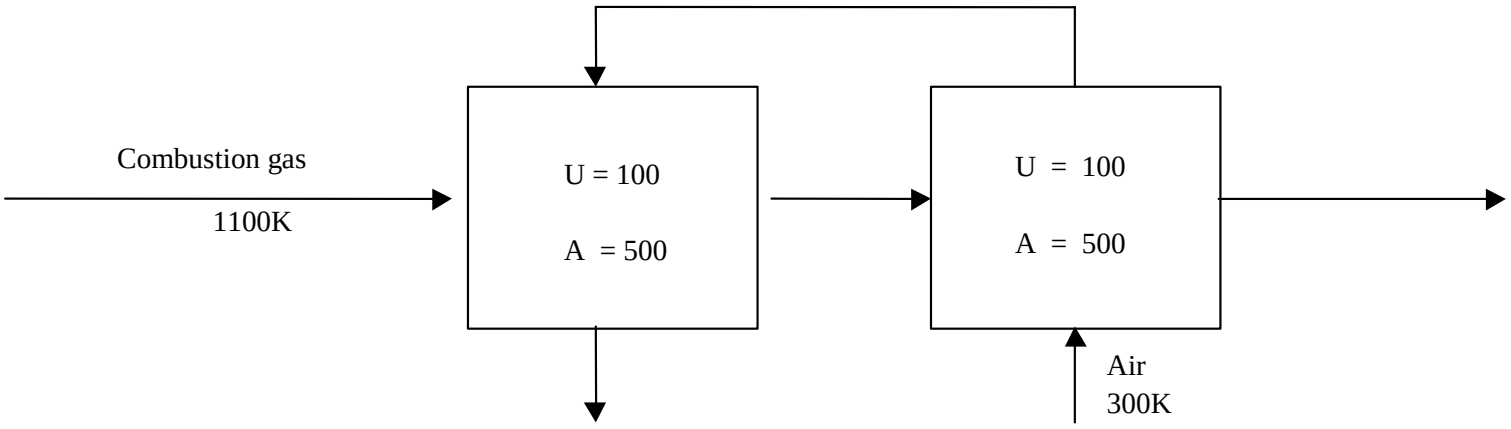
a. In one configuration that is contemplated, the flow rate of each fluid will be 15 kg/s and the exchange will occur in a single-pass crossflow exchanger (both fluids unmixed). What exit temperature will the air attain if the exchanger area is 500 m^2?

b. What exit temperature would the air attain if the heat exchanger were of the true counter-current variety and infinitely large?

c. Consider the situation described in Part (a) but permit the combustion gas flow rate to assume values other than 15 kg/s. What value of the combustion gas flow rate would be necessary if the desired exit temperature of the air were 1000K?

d. As another method of increasing the exit air temperature (without increasing the combustion gas flow rate as in Part (c)), it is suggested that it might be desirable to simply increase the heat exchange area. To this end, two configurations are under consideration:

   (i) A situation exactly as described in Part (a) except that the area of the single exchanger would be 1000m^2 rather than 500m^2.
   (ii) Two single-pass crossflow exchangers would be used. Each would be identical to the one described in Part (a), i.e., A = 500m^2, etc. The flow arrangement would be as follows:



Would scheme (i) or scheme (ii) give the higher air exit temperature? Why? What would the air exit temperature be?