CH-107

Lecture

3

CHEMICAL ENGINEERING THERMODYNAMICS-I

Dr. Saud Hashmi
Associate Professor
Chemical Engineering Department
NEDUET

A balance similar to that above yields:

$$-\dot{Q} = \dot{n}_{air}(h_4 - h_3) \quad \text{(E2.20A)}$$

Note that we must be careful about signs. We have included a negative sign on $\dot{Q}$ since the heat that *enters* boundary 1 must leave boundary 2. Rearranging Equation (E2.20A) gives:

$$\dot{n}_{air} = -\frac{\dot{Q}}{(h_4 - h_3)} = -\frac{\dot{Q}}{\int_{T_3}^{T_4} c_{P,air}\, dT} = \frac{\dot{Q}}{R\left[A(T_4 - T_3) + \frac{B}{2}(T_4^2 - T_3^2) - D\left(\frac{1}{T_4} - \frac{1}{T_3}\right)\right]}$$

Looking up values for the heat capacity parameters in Appendix A.3, we get:

$$\dot{n}_{air} = \frac{(100{,}753\ [\text{J/min}])}{877\ [\text{J/mol}]} = 123\ [\text{mol/min}]$$

Alternatively, this problem could have been solved with a system boundary around the entire heat exchanger. In that case, a first-law balance would give:

$0 = \dot{n}_{CO_2}(h_2 - h_1) + \dot{n}_{air}(h_4 - h_3$ which could then be solved for $\dot{n}_{air}$.