1) (50)
In the winter an automobile is driven into a well insulated garage with internal dimensions 4m x 5m x3m. The air in the garage is initially at 10^0C. The car is mostly steel with a mass of 1500 kg and a specific heat of 500 J/kg K. The car is initially at 0^0C except for the engine. The engine temperature is 100^0C and consists of 150 kg steel and 20 kg liquid water. Neglect heat transfer to the envelope and floor of the garage.

     (a) What is the final temperature of the garage when the car, engine and air in the garage reach a single uniform temperature?

     (b) If the engine has 10 kg liquid water and 10 kg saturated water vapor at 100^0C what is the final temperature if all of the water vapor has condensed to liquid?

2) (50)

A building uses cross flow natural ventilation to provide cooling. The building has two zones or rooms and the air flows at steady state through zone 1 and then flows through zone 2 in series. Each zone has the air well mixed so that each individual zone is at a uniform temperature. The outside air flow rate entering zone 1 is $\dot{m}_1$ and this equals the air flow rate leaving zone 2 that is exhausted to the outside. Each zone has a total rate of heat input $\dot{Q}_1$ that is the same for each portion of the problem.

Let $\Delta T_1 = \dot{Q}_1 / \dot{m}_1 \, c_p$.

(a)   If there is no back mixing between zone 2 and 1 so that the air flows in one direction as shown; first through zone 1 and then through zone 2, what are the temperatures of zone 1 and 2 in terms of ΔT_1 and T_{AMB}?

(b)   Now assume there is a large amount of back mixing between zones 1 and 2 so that they are both at the same temperature. The net air flow is still $\dot{m}_1$. What is the temperature of zones 1 and 2?

(c)   There is a limited back mixing from zone 2 to 1 so that there is a back flow of $0.5m_1$ from zone 2 to 1 while the net flow from zone 1 to 2 is still $\dot{m}_1$. What is the temperature of zone 2 for this case? Consider a method to find this without first evaluating T_1.

(d)   For case (c) what is the temperature of zone 1?

4.42J / 1.044J / 2.45J Fundamentals of Energy in Buildings
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