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6.0 CALCULATING OVERALL HEAT TRANSFER COEFFICIENT

A must have skill for the aspiring professional engineer is to be able to calculate the overall heat transfer coefficient (U-factor) for a wall, roof, duct or pipe. This skill will be described and explained through the following example.

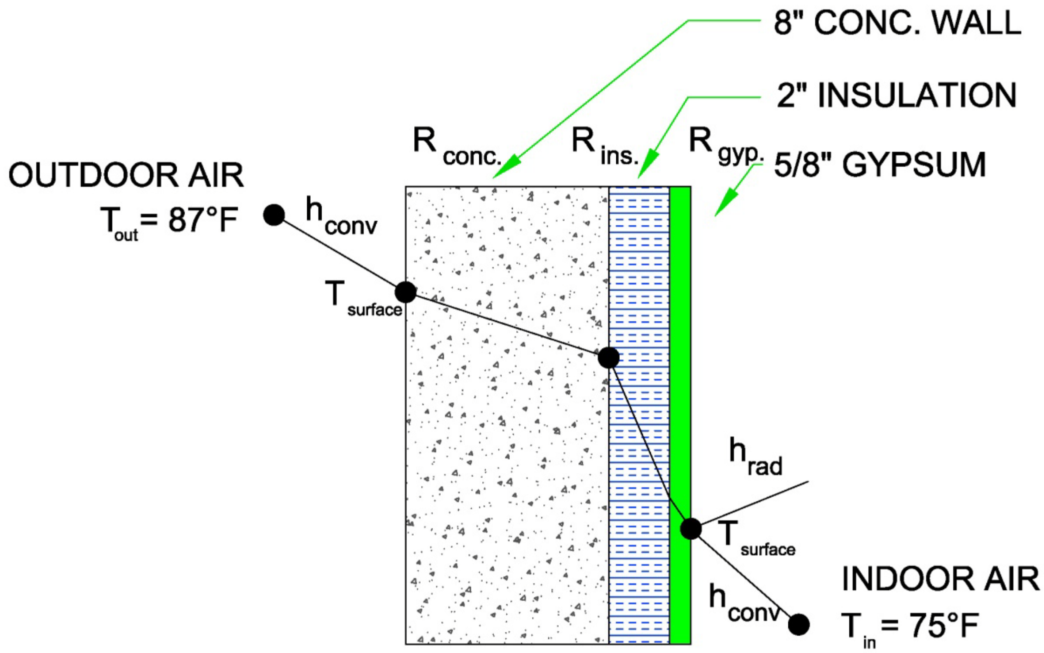

FIGURE 3: OVERALL HEAT TRANSFER COEFFICIENT

It is important to be able to follow the flow of heat from the beginning to the end of this diagram [from left to right]. The diagram shows how the temperature starts from a high temperature of 87 °F down to 75 °F.

(1) The first method of heat transfer is due to convection. Warm outdoor air moves across the outer surface of the concrete wall causing the outer surface of the wall to heat up. In reality, there would also be radiation loads acting upon the surface of the wall, but for simplicity it is assumed that there are no radiation loads.

(2) Next the heat travels from the outer surface of the concrete wall to the inside surface.

(3) The heat then moves from the outer surface of the insulation and through the insulation.

(4) Next, the heat moves from the outer surface of the gypsum board and through the board.

(5) Finally the outer surface of the gypsum board transmits heat via convection and radiation to the indoor air.

In order to find the overall heat transfer coefficient, all of the resistances must be summed. It is recommended that each method of heat transfer should be converted to its equivalent R-Value in order to simplify the calculation, because R-Values in series are simply added together.

$$R_{series} = R_1 + R_2 \dots + R_n$$

Practice Problem 5: Calculating Heat Load From Motors

There are 15 workers in a large air conditioned warehouse, which houses fruits and vegetables. The workers drive (2) 10 HP electric golf carts throughout the warehouse. The motor has an efficiency of 80% and the golf carts are only used 10% of the time, assume a 0.1 usage factor. In addition, the full capacity of the motor is not used. Assume an 80% load factor. What is the heat load from the golf carts alone?

a) $1{,}800\,\frac{Btu}{hr}$

b) $2{,}500\,\frac{Btu}{hr}$

c) $4{,}200\,\frac{Btu}{hr}$

d) $5{,}100\,\frac{Btu}{hr}$

Solution 5: Calculating Heat Load From Motors

There are 15 workers in a large air conditioned warehouse, which houses fruits and vegetables. The workers drive (2) 10 HP electric golf carts throughout the warehouse. The motor has an efficiency of 80% and the golf carts are only used 10% of the time, assume a 0.1 usage factor. In addition, the full capacity of the motor is not used. Assume an 80% load factor. What is the heat load from the golf carts alone?

The total heat load from the (2) golf carts can be found from the below equation:

$$Q = 2545 \frac{\frac{Btu}{hr}}{HP} * \frac{P}{\varepsilon_{motor}} * F_U * F_L$$

$$Q = 2545 \frac{\frac{Btu}{hr}}{HP} * \frac{10\ HP}{0.80} * 0.1 * 0.8$$

$$Q = 2545 \frac{Btu}{hr} per\ golf\ cart$$

$$Q_{total} = 5{,}090 \frac{Btu}{hr}$$