

ALTERNATIVE ENERGY SYSTEMS
ME 4530/5530
Homework #4

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a) Blow-in insulation

b) Batt insulation

A truss attic in a small business building in downtown Rochester is comprised of the following layers (from the inside to the attic):

1. 1/2" Drywall (sheetrock)
 2. 3-1/2" x 1-1/2" Yellow Pine trusses placed on 24" center
 3. 14" Glass Wool Insulation
1. Draw and label a thermal resistance network if the insulation layer is loose blow-in insulation. (hint: draw a schematic of the cross-section first)
 - a) For the 3 1/2 inches just above the drywall, the 2x4 trusses are in parallel with insulation in between. Calculate the R-value for this layer only.
 - b) Calculate the R-value for the remaining insulation above that parallel layer, and then the total R-value of the entire ceiling structure assuming $h = 0.4 \text{ Btu/hrft}^2\text{oF}$ on both the ceiling and attic sides.
 - c) If instead of analyzing the parallel layer like in a) and b) above a Professor proposed that the wood 2x4 trusses can simply be neglected due to the fact that they are completely buried by the loose insulation anyway, calculate the total R-value of the ceiling structure and compare to b) above. How much error is there in making this assumption?
 2. Instead of loose blown-in insulation this building had batt insulation installed instead. In this case, draw and label the thermal resistance network. (hint: draw a schematic of the cross-section first 'looking' into the trusses)

- a) For the 3 ½ inches just above the drywall, the 2x4 trusses are in parallel with insulation in between. Is there any difference to 1a)? Explain.
 - b) Calculate the R-value for the remaining insulation above that parallel layer. (note: BE CAREFUL HERE! Look at the picture at the beginning of this homework, and hopefully the schematic you made at the beginning of this problem). Use $h = 0.312 \text{ Btu/hrft}^2\text{°F}$ for air.
 - c) Calculate the total R-value of the entire ceiling structure assuming $h = 0.4 \text{ Btu/hrft}^2\text{°F}$ on both the ceiling and attic sides.
3. Based on 1) and 2) above, which insulation is superior and why.
 4. For the case of blown in insulation and your answer in 1b) above, calculate the total heat loss in a deep winter month where the outside and attic temperature is 0°F (70°F inside). What would the cost be if 100% of that energy were converted from natural gas?
 5. Repeat 4) but calculate the total heat gain in a hot summer month where the attic temperature is 130°F (70°F inside). Use 2500 ft^2 for the attic area. What would the cost be if 100% of that energy were converted from natural gas?
 6. In analyzing a building with an attic, a Professor recommends that for cold winter months that the attic temperature be assumed the same as the ambient, but in the summer this cannot be so (consistent with the analysis of a building in lecture). Explain why this might well be so.