Seal It
Insulation Systems
"Green and Growing in Maine"

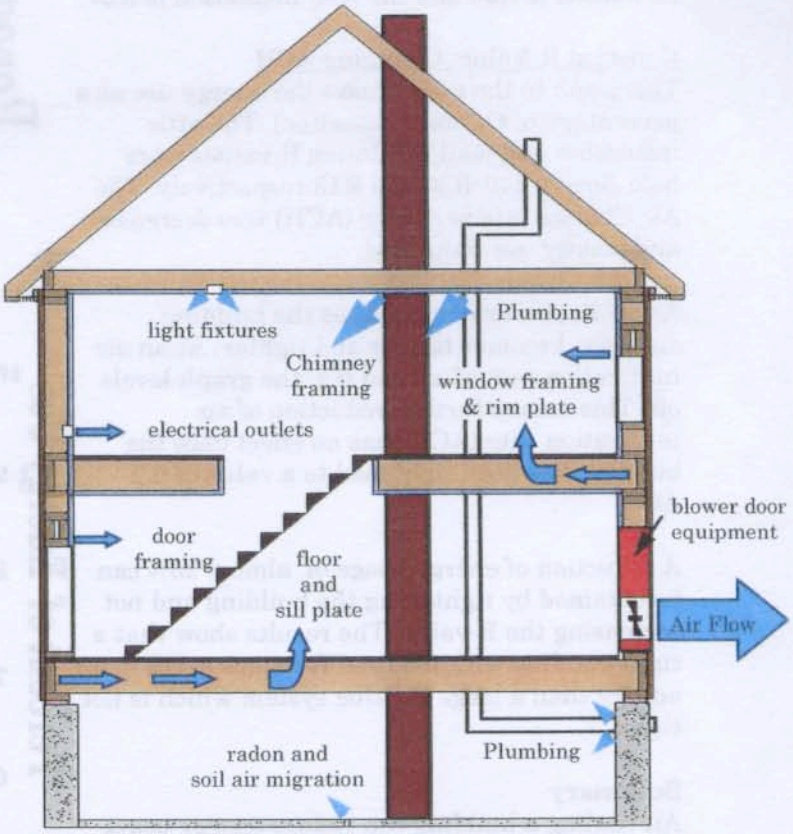
R-Value vs Infiltration Rate

The energy usage of a building assembly is related to the R-value of wall and roof portions as well as the air infiltration rate. Energy standards often specify required R-values for various building assembly sections. It is rare to find air infiltration specifications for buildings. This paper examines the importance of air infiltration in relation to R-value.

Air infiltration rate is a term used to describe the tightness of a building envelope. It is the rate at which air flows from a building. The most common term used to quantify air infiltration is Air Change rate per Hour or ACH. This is the rate at which is takes to replace all interior air with exterior air. For a building with an ACH of 1, it will take one hour to exchange interior air with exterior air.

Air change rates can be measured using a device known as a blower door. A blower door is a calibrated fan which accurately measures the air flow rate under measured pressure differences. The standard measure for comparing building envelope tightness is called the Air Changes per Hour at 50 Pascal or ACH_{50}. This scientifically measured value is used to estimate the the natural Air Change Rate (ACH).

The figure to the right shows common air infiltration leakage areas found using blower door testing equipment.



How important is Air Infiltration?

A simple test using a standardized building energy computation program such as REM/DESIGN answers this question.

Test Procedure

Step 1: Using REM/DESIGN, the design of a building is entered into the program. The natural air infiltration rate is specified and the R-values of all building components are entered into the program. The energy usage is then computed and used as the baseline for comparison.

Step 2: The air infiltration rate is held constant and only the R-value of roof and wall components are changed. The energy usage is computed for different R-value options when ACH is held constant

Step 3: The R-values of roof and wall components are held constant (at the levels of Step 1) and only the air infiltration rate is changed. The energy usage is computed for different values of air infiltration rate when R-Value is held constant.

Step 4: Compare results to see which is more energy efficient; Large R-values or Small Air Infiltration

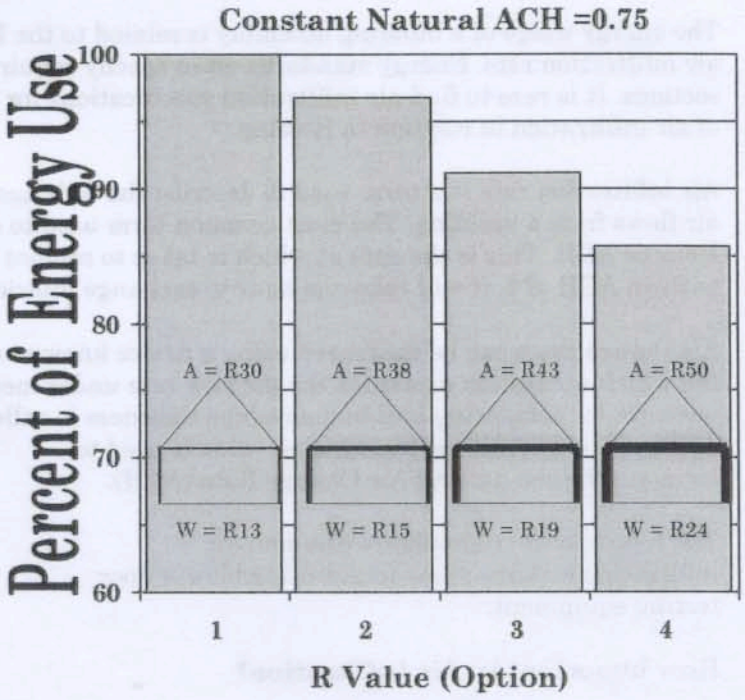
The Results

A small cape style home located in Minneapolis, Minnesota was selected as the sample building. The natural air infiltration rate (ACH) was set to 0.75. The attic insulation R-value was set at 30 (A=30). The wall insulation R-value was set at 13 (W=13). The computed peak energy use for heating was 91,000 BTU. This value was used as the basis for comparing changes in R-value and infiltration rate.

Constant ACH, Changing R-Value

The chart to the right shows the energy use as a percentage of Option 1 (baseline). The value of attic insulation R-value is labeled with (A=). The value of wall insulation uses the (W=) label.

In Option 2, the attic insulation is R38 and the wall insulation is R15. The results show a reduction of energy use by approximately 4%. Option 3 has an attic insulated at R43 and wall insulation at R19. It shows a reduction of energy use of approximately 9%. Option 4 shows almost a 15% reduction in energy use when the Attic insulation is R50 and the wall insulation is R24.

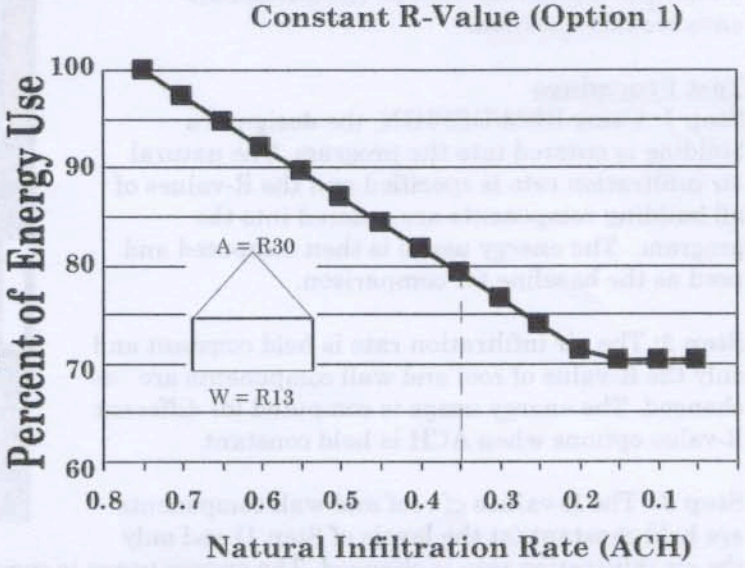


Constant R-Value, Changing ACH

The graph to the right shows the energy use as a percentage of Option 1 (baseline). The attic insulation and wall insulation R-values were held constant at R30 and R13 respectively. The Air Change rate per Hour (ACH) was decreased and energy use computed.

As infiltration rate decreases the building envelope becomes tighter and tighter. At an air infiltration rate of around 0.2, the graph levels off. This means further reduction of air infiltration rate (ACH) has no effect once the building has been tightened to a value of 0.2 ACH.

A reduction of energy usage of almost 30% can be obtained by tightening the building and not increasing the R-value. The results show that a tight building with nominal R-values saves more energy than a large R-value system which is not tight.



Summary

Air sealing a building can reduce energy usage by 30%. This is twice the reduction obtained by only increasing the R value.

** ASHRAE recommends mechanical ventilation at a rate of 0.35 ACH for indoor air quality. At an ACH of 0.35, energy usage is reduced by more than 20%. Therefore, a tight building with nominal insulation and an exhaust air exchange system will use less energy than a large R value system with ACH of 0.75*