



## Effects of the Thermal Envelope on Home Energy Efficiency

What's a thermal envelope? No, it's not a steaming hot letter you get from a bill collector. The thermal envelope is, according to the National Renewable Energy Laboratory, "everything about the house that serves to shield the living space from the outdoors. It includes the wall and roof assemblies, insulation, air/vapor retarders, windows, and weather stripping and caulking."

What's one of the major problems in old houses? And all too often it's a serious flaw in new homes? The answer is: a poor thermal envelope. When you think of an old house, you think of a drafty dwelling that's cold in the summer and hot in the winter. Any money spent on heating and cooling goes right out through the walls and ceiling. The thermal envelope is not designed or built properly.

For a home to have the maximum energy efficiency and comfort, the thermal envelope has to be a prime consideration before the first shovel of dirt is turned on the project.

It is possible to improve the thermal envelope of existing homes with air sealing, wall and attic insulation and high-performance windows and doors.

A new home typically delivers the best performance – and comfort—when it's designed for a tight thermal envelope from the ground up.



This white paper, sponsored by Fox Blocks, makers of insulated concrete forms, explores some of the building science behind creating an excellent thermal envelope for your home.

### Insulation value

Insulation is all about the R-value. Although there's a lot of science behind it, R-value is simply a measure of a material's resistance to heat traveling through it. The higher the number, the more resistance there is and the more energy efficient a material is when it is properly designed and installed.

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The requirements for R-value in walls and attics depend on the climate where the home is located. The walls in standard homes in average climate should have an R-value of around 13-15. Attic insulation should be around R-30, according to the Energy Star for Homes program. Depending on the location, the foundation such as a basement, slab or crawlspace should be insulated as well.

The greater the insulation level in a home, the better the home will perform in terms of energy use and comfort. There are other considerations, such as proper air ventilation, that also have to be considered in a home with a very tight thermal envelope.

There are a variety of building techniques and technology to ensure the proper R-value in the walls of a home. One building approach that is gaining popularity is the insulated concrete form.

Insulated concrete forms (ICFs) are rigid plastic foam forms that hold concrete in place during curing and remain in place afterwards to serve as thermal insulation for concrete walls. The foam sections are lightweight and result in energy-efficient, durable construction.

"The double insulation provided by the two polystyrene panels increases the year-round energy efficiency of a home and also lowers sound transmission from the outside, which results in a quieter living environment," said Mike Diamond, president of Diamond Custom Homes, a Florida home builder with extensive experience in ICF construction.

According to the National Association of Homebuilders Research Center, ICF construction offers insulation values ranging from R-17 to R-26, compared to between R-13 and R-19 for most wood-framed walls. The strength of ICF structures relative to lumber depends on configuration, thickness, and reinforcement. However, ICF walls are designed as reinforced concrete, having high wind and seismic resistance as well.

The Department of Energy's *Building America* testing indicates that there are few thermal bridges from the interior to the exterior on an ICF wall so heat does not travel through the wall as it does in a wood frame house. A 4" concrete core ICF form with 5 1/4" of encapsulated polystyrene has a whole-wall R-Value of approximately R-22. Additional R-Value is added when the drywall and exterior cladding are calculated as part of the whole wall assembly.

### **Air infiltration**

Another important and often overlooked aspect of the thermal envelope is air infiltration. This is the amount of air that moves into and out of the home in unplanned and unwanted ways. Air moves through joints in the walls, seams around doors and windows and other small avenues that may not be visible to the naked eye.

Air infiltration is measured in air changes per hour, usually using a blower door system. This system depressurizes the house and a contractor measures the amount of air loss through the home. The air infiltration is measured using air

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changes per hour, a measurement of how many times the air in the home is exchanged with outside air. Draft homes have a very high air change, and very tight homes have a low air change number. Home with low numbers may also need mechanical ventilation for proper indoor air quality.

A average home built to standard building codes has about seven air changes per hour, and an Energy Star rated home will have four air changes per hour. An ICF home with a tight thermal envelope, will have about 1 to 1.5 air changes with a wooden roof, and as low as .15 with a concrete roof.

A home built with insulated concrete forms typically has a very low level of air infiltration compared to a traditional wood frame home. There are very few seams for air to move through because the walls are solid concrete. Insulating around openings for doors, windows and utility access can block any air movement there.

So what role does the thermal envelope play in a home's energy use? In a recent study, *Energy Comparisons of Concrete Homes versus Wood Frame Homes*, the National Association of Home Builders, looked at energy savings that are possible with ICFs.

In this study, the energy use of 26 pairs of similar houses in the same climates was compared. An average energy savings of 44 percent for space heating and 32 percent for space cooling was found for ICF homes.

David Maher, an architect in Appleton, Wis., has seen interest in ICF homes grow as homeowners come to understand the benefits.

"ICF homes have well over double the insulation value and it's seamless from the footing to the rafter," he said. "There's no air exchange through the walls and they perform very well."

***About the Sponsor:*** *Fox Blocks is a leader in developing and manufacturing Industrial Strength Insulated Concrete Forms (ICF). As the fastest growing manufacturer in North America, Fox Blocks is known best for its ease of use, product engineering and speed of construction. Fox Blocks provides a complete range of products used in commercial and residential construction.*

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