Insulation & Air Sealing

Introduction

Insulation and air sealing are important parts of a home's "thermal envelope," which separates outside conditions from inside. This envelope consists of the components of all six sides of the home—the four walls, roof, and foundation. The most important parts from a thermal point of view are the insulation and air-sealing materials, properly installed. All the components interact together as a system to affect the flow of heat, air, moisture, and sound into or out of the home. The better the thermal envelope does its job, the better the health and comfort of occupants and the lower their utility and maintenance bills.

Discussion

Insulation and R-value: Insulation is any material that does a good job of *resisting* the flow of heat. This is measured by R-value--the higher the number, the better. R-value is measured in a laboratory under ideal and controlled conditions, but actual or effective R-value is dependent on the quality of installation, the assembly within which the insulation is constructed and on the weather. Building codes require a minimum R-value in different parts of a house. These levels vary based on climate.

Insulation priorities: The roof or attic is the most important part of the home to insulate in all climates. In hot weather, the sun beats directly on the roof, creating a huge cooling load (need for cooling) inside the home. Even though heat moves in all directions by radiation, in cold weather, heat loss out of the attic is a particular problem because hot air rises. Attic hatches must be well insulated and weather-stripped, too. Wall insulation is far more important in a cold climate than a hot one. In a hot climate, wall insulation is needed mainly to keep indoor temperatures even: it will have much less effect on energy bills as opposed to in a cold climate. Thermal-envelope walls that separate the attic space from the living space (knee walls) must be carefully insulated in all climates because attics get much hotter than the outdoor temperature. Floor insulation is very important in areas where the ground freezes. Where it does not freeze, insulation is not needed under slab foundations, but is required under pier-and-beam foundations. It is also important under living areas over unconditioned spaces such as a garage/carport, which may become extremely hot or cold. Note that windows are part of the thermal envelope and should be selected and installed appropriately for a given climate.

Installation: Correct installation is critical if insulation is to perform to somewhere near its stated R-value. It must not be compromised by gaps or voids (a reason to avoid batt insulation). It should be encased on all six sides and must touch the surface of the side it is intended to insulate. It must not be compressed but must be dense enough to prevent air currents from passing through it (a problem with fiberglass batts in very cold climates).

To do a good job of controlling the flow of heat, air, moisture and sound, the thermal envelope must be *continuous and unbroken*: this can be more critical than R-value. Care must be taken to insulate at the tops of walls next to roof rafters where space is usually inadequate (unless *energy-heel trusses* are used). It must be installed in hard-to-reach places, such as at band joists and behind tubs and showers on exterior walls. A better insulation job can be accommodated by the Optimum Value Engineering (OVE) method of framing. This method requires less lumber and results in larger spaces and better accessibility. (See the Wall Insulation technical bulletin on the Southface Energy Institute's web site listed at the end of this fact sheet.) If metal framing is used, it is critical to reduce "thermal bridging" through this highly conductive material. This can be accomplished by installing foam board on the outside.

Any cracks or holes that cannot be filled with insulation must be sealed with caulk or foam to stop airflow. Note that air is not only a "conduit" for heat, but also for moisture in the form of vapor, which can cause discomfort, rot and mold problems. Air sealing also minimizes pest and dust entry and even fire passage.

Air tightness: Cracks and holes should not be relied on as a means to bring fresh air into the home, since this air cannot be controlled. The envelope should be made as tight as possible and then fresh-air ventilation should be under the control of the occupant. Operable windows and mechanical fresh air intakes into the heating and cooling systems, such

as heat/energy-recovery ventilators (HRVs or ERVs) serve this purpose.

Complexity: Be aware that the ideal level of insulation is actually more complicated than climate, even though codes address mainly climate at present. Proper levels depend also on house design, construction type and materials, ventilation, amount of moisture occupants produce inside the home (cooking, bathing, breathing, etc.), the temperature difference between inside and outside, and more.

Types and forms of insulation:

Insulations are made of many materials and in several forms. Suitability for a given application varies, as does cost, availability, and tradition in any given area. Some are now produced without harmful chemicals, such as formaldehyde and HCFC or CFCs and some are available with a high recycled content. Approximate R-values per inch are given in parentheses. "Total-fill" type insulations will provide a higher effective R-value.

Cellulose insulation (3.0-3.7 + total fill) is made of ground, recycled newsprint that has been treated with borates as a fire and pest retardant. It can be loose-blown into attics or damp-blown into walls.

Fiberglass insulation (2.2-4.0) is made from spun glass and is available in faced or unfaced batts or loose-fill. Recycled-content and "no added formaldehyde" products are now readily available.

Mineral wool (2.8-3.7) is produced as batts or loose-fill made from rock wool (from natural rock) or slag wool (iron ore blast furnace waste product).

Cotton insulation (3.0-3.7) is available in faced or unfaced batts. It is manufactured from post-industrial recycled content fibers from the textile industry (jeans factories), with some polyester fiber for strength and "loft." Unlike fiberglass and mineral wool, it is not irritating to handle. It should be torn, not cut to fit. **Cork** and **wool** insulation are now available if one is looking for other products made from rapidly renewable, natural sources.

Foam board is produced with various components and typically has a higher R-value per inch than batt and loose-fill products (e.g., expanded polystyrene: 3.8; extruded polystyrene: 5.0; polyisocyanurate: 5.8--7.0). Well-installed foam board (taped at the seams) helps create a good air barrier. Look for products that use water or pentane as the blowing or foaming agent (not HCFC, since this chemical contributes to destruction of the ozone layer).

Spray-in place foams (3.9-4.3 + total fill) have excellent air-sealing properties, high R-values and most of them can easily be installed anywhere, including overhead. They are a particularly effective choice for "cathedralized" attics (insulation is installed at the rafters, so the attic is within the thermal envelope--a good approach if ductwork is placed in the attic). Most of these foams are low-density, open-cell polyurethane or polyicynene. HCFC-free foam is available, as is soy-based foam. Spray foams are newer in the market, so installers may be hard to find and costs may be high.

Green Building Benefits

Saves Energy and Promotes Cleaner Air

Insulation and air sealing saves energy, reduces monthly utility bills, and provides better occupant comfort. It reduces electric and gas use at the point of consumption. Due to the inefficiency of energy production and transmission, the small amount of electricity that is saved at the home reduces a larger amount of power needed to be produced at the power plant thus reducing air pollution associated with the production of electricity.

Recycled Content

Some insulations offer added environmental benefits of reducing waste that goes into our landfills. The typical recycled content of various insulations is as follows:

Fiberglass (0-30%) mostly post-industrial, some post-consumer
Cellulose (75-95%) mostly newspapers
Mineral Wool (0-90%) rockwool – 0%, slag – 90%
Cotton (75-95%) post-industrial fabric trimmings
Foam board (0-50%) post-industrial foam
Spray foam (0-15%) post-industrial chemicals

Durability

All insulation products are very durable and do not degrade under normal conditions. Some loose fill insulations may settle somewhat over many years, especially in attics, so it may become necessary to "top off" some more 10-20 years down the line. If insulation becomes wet, it will lose much of its insulation value and it may permanently degrade somewhat. Keeping all building materials dry is always a concern in all areas of the home.

Bay Area Suppliers

There is a vast array of insulation suppliers in all parts of the area too long a list to mention. Traditionally, fiberglass is the default insulation as it is the cheapest, but there is a growing supply of and market recognition of better insulations such as cellulose, cotton, rigid foam board, and spray foam. A wise consumer will do research on the various options, installers, costs, and benefits available with each product. Remember that your investment in insulation will only allow you a one-time decision that you will have to live with for the lifetime of your home.

- Search the **Materials Database** from Bay Area Build It Green to find local suppliers and services: www.build-green.org

For More Information

- **Southface Energy Institute:** (www.southface.org) A number of great fact sheets, technical bulletins, and more information on insulation, air sealing, and testing, as well as green homes, workplaces, and communities
- **Insulation Materials, Environmental Comparisons:** (www.buildinggreen.com/features/ins/insulation.cfm) Building Green site provides detailed information about different types of insulation products
- **Consumer Guide to Home Energy Savings:** (www.aceee.org/consumerguide/index.htm) from ACEEE, helps consumers find the most energy efficient practices and products and how to use them effectively.
- For more information about Green Building, visit our website at: www.greenaffordablehousing.org or call Bruce Mast at 510-271-4785.