Insulating to Save Energy in Heating, Cooling a Home

CONSERVING ENERGY used in home heating and cooling is of paramount importance to every homeowner and potential homeowner in America, since we are depleting our present sources of energy, primarily fossil fuels, at an alarming rate.

Proper use of insulation is the most positive and efficient means of conserving home conditioning energy.

This chapter is designed to give, in basic terms, information which will help you make better decisions on whether to insulate, and on choosing and installing insulation materials. But first off, let's briefly review some fundamental facts and terms from physics.

Heat energy always flows from a warm material, body, or space to a relatively cooler material, body, or space. In winter, heat energy flows from the warm interior of a house to the cooler exterior. This is referred to as "heat loss" when discussing heating systems. In summer, heat flows from the warmer exterior to the relatively cooler interior of a house. This is referred to as "heat gain" when considering air conditioning.

Heat is transferred in three basic ways:

By Conduction, heat passes through a dense material such as an iron skillet sitting on a hot stove or a steel rod held in a hot fire.

By Convection, heat is transferred by movement of air over a heated panel or radiator surface.

By Radiation, heat is radiated in the form of infra-red rays from one place to another, such as from the sun to the earth.

The term insulation used in this chapter refers to thermal insulation, not electrical insulation. Some very good electrical insulators, such as glass, are poor thermal insulators.

Thermal insulation materials are those developed specifically to reduce heat transfer materially. Insulation materials are generally very light in weight and are produced in four common forms. These are batts or blankets, loose fill or granulated, rigid boards, and reflective.

Batt and blanket insulation is made of matted mineral, glass, or cellulose fibers.

Insulation batts or blankets are usually encased in paper, one face of which is made to serve as a vapor barrier. This may be an asphalt paper or a paper with a reflective metal foil backing. Proper installation of this vapor barrier is very important.

Blankets and batts range in thickness from 1″ to 6″ and in widths to fit between joists, rafters, and studs spaced 12″, 16″ and 24″ on center. Blanket insulation may come in lengths of 50′ or more. Batts generally are between 2′ and 8′ in length. The batt and blanket type insulation is normally used during initial construction when it can be easily placed between structural members of the sidewall, ceiling and floor.

Loose fill or granulated insulation generally consists of mineral wool, vermiculite, treated cellulose fiber, granulated polyurethane and other material. It is usually sold in bags for easy storing and handling. Depending on the particular job, it can either be poured directly from the bag or blown in place by mechanical means.

Loose fill insulation is especially convenient for insulating the ceilings of existing houses where there is access to the attic. Granulated forms such as vermiculite are well adapted for placing in the cores of masonry blocks, thereby reducing heat loss through masonry walls considerably.

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Placing loose fill insulation into sidewalls and ceilings of existing houses by special blowers is about the only method of insulating when the spaces are inaccessible otherwise, but this can create moisture problems from a lack of proper vapor barriers. Please read the chapter on "Preventing Moisture Damage in Houses" by H. O. Fleischer—page 170 in *Handbook for the Home,* the 1973 Yearbook of Agriculture.

Rigid type insulation, commonly referred to as insulation boards, has many special uses. Its rigidity and strength give it advantages which other types of insulation do not have.

Rigid insulation boards are used on the outside of wall studs as sheathing or inside as a wall finish. Insulation board is relatively dense, and therefore less effective as an insulator than batt or blanket types of the same thickness.

Rigid insulation boards 1′ to 2′ wide and 1″ to 4″ thick are used as perimeter insulation around the outside edges of houses built with concrete slab floors. This insulation must be moisture resistant so it is generally made of foamed glass, or foamed plastic such as polyurethane.

Reflective insulation is made from reflective foils such as aluminum, or polished metallic flake adhered to a reinforced paper. It retards the flow of infra-red heat rays passing across an air space. To be effective the foil surface must face an air space of ¾″ or more. Reflective insulation is available in single sheets, strips formed to create 3 or 4 separated air spaces of ¾″, and as a combination vapor barrier and reflective surface attached to batts or blankets.

The critical factor to insure efficiency of reflective insulation is installing it so the reflective surface always faces an air space of ¾″ or more. Once the reflective surface touches surrounding materials it is ineffective as an insulator because it does not retard conducted heat or heat of convection.

Many types and forms of materials are used in manufacturing building insulation. Also, there are many building materials which are mistakenly assumed by the uninformed to have much more insulating value than they really have.

Because of these variations and misunderstandings, it is unrealistic to compare insulating values of materials by thickness in inches. For example many people are shocked when told that 1″ of mineral wool insulation has more insulating value than an 18″ masonry wall of common brick.

Fortunately for consumers, reliable standard rating methods have been developed to help you rate various insulations. Although the rating method is quite reliable, some of the terms used to explain it may be new and somewhat confusing to you at first. I will try to omit most of the technical details and present some guidelines in simple terms.

Effectiveness of insulation is specified in two ways. One is stated as the resistance offered by a material or materials to the flow of heat under known conditions. This "Resistance" is generally designated by the letter "R". The second specification is stated as the amount of heat that will pass through a material or materials under known conditions. This is designated by the letters "C" or "U".

Most manufacturers of insulation have adopted the "R" rating and stamp it on their product for easy evaluation by the purchaser. For example, a 3″ thick batt of one insulation might have an R10 rating, whereas a 3″ batt of another type might have an R12 rating. On the other hand a 2″ thick rigid foam material might have an R10 rating stamped on it.

In all cases when you are given the "R" rating it is a simple matter to evaluate and make comparisons.

When you are building a wall containing several materials and have the "R" values for each, you can determine the total "R" value or insulating value by simply adding them directly. For example: R4 + R10 + R5 = R19 total. Another example of how the rating can be used is in determining values of various thicknesses of materials. If 2″ of insulation "A" has a rating of R8 then 4″ would have a rating of R16, for all practical purposes.

You cannot add the "C" and "U"

INSULATING VALUES OF VARIOUS MATERIALS

Material	"R" per inch thickness
BATT OR BLANKET	
Wood or cellulose fiber with paper backing and facing	4.00
Mineral wool (rock, slag or glass)	3.80
LOOSE FILL	
Mineral wool (rock, slag or glass)	3.30
Vermiculite, expanded	2.08
BOARD OR RIGID	
Expanded Urethane, foamed in place, sprayed or preformed	5.88
Polystyrene foam, extruded or expanded	4.50
Glass fiberboard	4.34
CONSTRUCTION MATERIALS	
Wood fiberboard, laminated sheathing	2.90
Plywoods and Softwoods	1.25
Plaster, stucco, brick	0.20
DOORS	
Solid wood, 1"	1.56
Solid wood, 2"	2.33
WINDOW (Glass area only)	
Single glazing	0.88
Double glazing with ¼" air space	1.64
Single glazing with storm window	1.89

values directly. When you can only find the "C" or the "U" rating you change them to "R" before adding. Simply stated the procedure is this: when you know the "C" or "U" value, you divide one (1) by this value to get "R". Example: a "C" or "U" value is .5, then "R" = 1 ÷ .5 = 2.

Do not let these conversions confuse you. There are many tables in insulation publications which give the "C" value, the "U" value and the "R" value for various materials.

The most important thing for you to remember about the factor "R" and factors "C" or "U" is the simple fact that the *larger* the "R" the better the insulating qualities of the material, and the *smaller* the "C" or "U" the better the insulating quality.

These simple rating designations also make it easy to compare costs of insulations. If one insulation rated R13 meets your job requirements and costs 10 cents per square foot, and another is identical in every way except cost, your choice is positive. Also, you can easily determine the amount of insulation required for a desired "R" value for any type of construction.

Now you have to make the important decision on where to insulate and how much insulation to use.

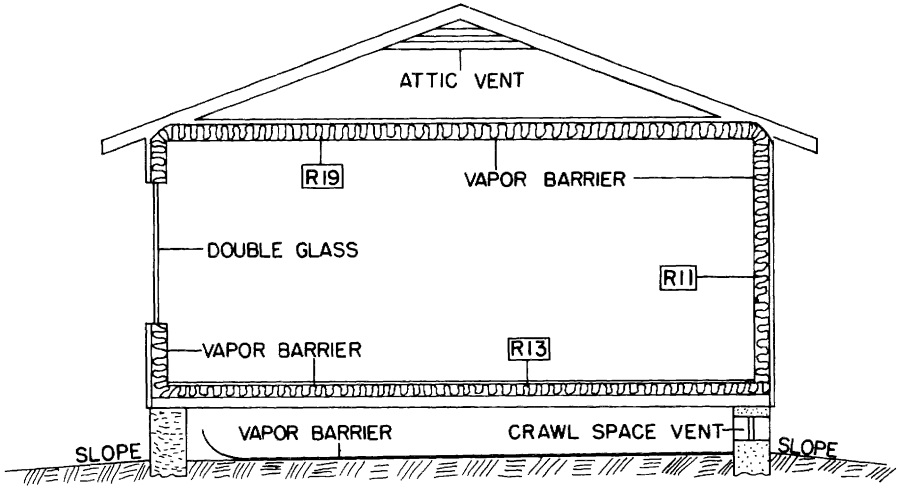
To determine the location for insulation, imagine the insulation as a blanket completely surrounding the living area of your home. This means all areas which are to be heated in winter and cooled in summer. For a complete job, insulation should be placed in the sidewalls, ceiling, and floors over unheated spaces.

Windows and doors are insulated by weather stripping, storm doors and windows, or double glazing. More details on these are given in another chapter of this 1974 Yearbook.

In answer to the question of how much insulation to use under present conditions of critical shortages and high costs of energy for heating and cooling, it is safe to say that you need not worry about over-insulating from an economic standpoint. Some general recommendations have been prepared which may be used as guidelines.

The standards most recommended now are those in the "All Weather Comfort Standard" prepared by electric power suppliers with the cooperation of material and equipment manufactures. This standard specifies these insulation "R" values: *Ceiling–R19, Walls–R11,* and *Floors–R13.*

Initially these values were specified for electrically heated and air conditioned homes. However, because of the present and projected energy situation,



I recommend that you use the "All Weather Comfort Standard" in any case if possible.

Another standard for insulation is The Department of Housing and Urban Development (HUD) Minimum Property Standards. In some areas the insulation requirements are higher than the "All Weather Comfort Standard." The HUD requirements are based on the number of winter degree days in an area.

Any amount of insulation used will generally pay for itself in a few years, not only by the savings from using less high cost fuel, but also because you can use smaller and less costly heating and cooling equipment.

Some characteristics or features of insulation materials besides "R" values and cost could influence your choice of materials used for particular conditions. A few of these are:

-Structural requirements, which must be considered when you want to use rigid insulation for such things as sheathing, plaster base, interior ceiling or wall finish, and roof decks.

-Fire resistance of any insulating material should be considered regardless of where it is used in the house.

-Effects of moisture on an insulation material sometimes determine whether or not it can be used for some jobs such as perimeter insulation under concrete slabs. When any insulation material becomes saturated, the insulating value decreases to practically nothing.

-Vermin resistance is an important consideration, but you must make relative evaluations. No material is absolutely vermin proof.

Here are a few summary guidelines on insulation:

Before you buy, know the insulation value of any material being considered, and make cost comparisons on the basis of cost per unit of resistance (Divide cost per sq. ft. by "R" value).

Follow manufacturers' directions for proper installation.

Adequate ventilation of the attic and crawl space is necessary for best results from use of insulation in these areas.

Following these simple recommendations will help you and your family save money and energy and have a more comfortable year-round home to enjoy.

FOR FURTHER READING:

Forest Products Laboratory. *Condensation Problems: Their Prevention and Solution,* FPL 132, Madison, Wisc. 53203, 1972.