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Insulation as a Part of the Building System

If you are designing and constructing a house, a whole-house approach can help you develop a successful strategy for incorporating energy efficiency into your home's design. A whole-house systems approach considers the interaction between you, your building site, your climate, and all of the components of your home. These components include the appliances and home electronics; the insulation and air sealing; lighting and daylighting; space heating and cooling; water heating; and the windows, doors, and skylights.

Insulation is a critical part of your house. It provides resistance to heat flow. Heat flows naturally from a warmer to a cooler space. In the winter, this heat flow moves directly from all heated living spaces to adjoining unheated attics, garages, and even to the outside. If there is a great difference in temperature and pressure, heat can move indirectly through interior ceilings, walls, and floors.

During the cooling season, heat flows from the outside to the interior of the house.
By properly insulating your home, you can decrease the heat flow by providing an effective resistance to the flow. The insulation's resistance to heat flow is measured in terms of its thermal resistance or R-value. The higher the R-value, the greater the insulating effectiveness. In a house, there are several layers in the wall. Add the R-values of the individual layers to get your actual R-value.

Insulation's effectiveness is also affected by how and where the insulation is installed.

The amount of insulation, or R-value, you'll need depends on your climate, type of heating and cooling system, and the section of the house you plan to insulate. The attic is most accessible and therefore less expensive to insulate. Before you decide to add insulation, consider the air sealing, moisture control, and ventilation. Any air sealing efforts will complement your insulation efforts. Proper moisture control and ventilation strategies will improve the effectiveness of air sealing and insulation. The Department of Energy (DOE) website has more detailed information on how the whole-house system works.

DOE also has guidelines on how to determine the amount of insulation you might want to add to an existing house, as well as how to calculate the R-value of the insulation in relation to the other building components. This information can be located on the web at: http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11350.

When insulating your home, you can choose from many types of insulation. DOE provides a Consumer's Guide to help you in making your choice. The table below provides an overview of many of the available types of insulation. You can go to the DOE website and get detailed information about the various types of insulation.

Form	Insulation Materials	Where Applicable	Installation Method(s)	Advantages
Blanket: batts and rolls	Fiberglass Mineral (rock or slag) Plastic fibers Natural Fibers - wool	Unfinished walls, including foundation walls, and floors and ceilings	Fitted between studs, joists, and beams.	Do-it-yourself. Suited for standard stud and joist spacing, which is relatively free from obstructions.
Concrete block insulation	Foam beads or liquid foam: Polystyrene Polyisocyanurate or polyiso Polyurethane Vermiculite or perlite pellets	Unfinished walls, including foundation walls, for new construction or major renovations	Involves masonry skills.	Autoclaved aerated concrete and autoclaved cellular concrete masonry units have 10 times the insulating value of conventional concrete.
Foam board or rigid foam	Polystyrene Polyisocyanurate or polyiso Polyurethane	Unfinished walls, including foundation walls; floors and ceilings; unvented low-slope roofs	Interior applications: must be covered with ½ inch gypsum board or other building-code approved material for fire safety. Exterior applications: must be covered with weatherproof facing.	High insulating value for relatively little thickness. Can block thermal short circuits when installed continuously over frames or joists.
Insulating concrete forms (ICFs)	Foam boards or foam blocks	Unfinished walls, including foundation walls, for new construction	Installed as part of the building structure.	Insulation is literally built into the home's walls, creating high thermal resistance.
Loose-fill	Cellulose Fiberglass Mineral wool (rock or slag)	Enclosed existing wall or open new wall cavities; unfinished attic floors; hard-to-reach places	Blown into place using special equipment; sometimes poured in.	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions.

Form	Insulation Materials	Where Applicable	Installation Method(s)	Advantages
Reflective system	Foil-faced kraft paper, plastic film, polyethylene bubbles, or cardboard	Unfinished walls, ceilings, and floors	Foils, films, or papers: fitted between wood-frame studs, joists, and beams.	Do-it-yourself. All suitable for framing at standard spacing. Bubble-form suitable if framing is irregular or if obstructions are present. Most effective at preventing downward heat flow; however, effectiveness depends on spacing.
Rigid fibrous or fiber insulation	Fiberglass Mineral wool (rock or slag)	Ducts in unconditioned spaces and other places requiring insulation that can withstand high temperatures	HVAC contractors fabricate the insulation into ducts either at their shops or at the job sites.	Can withstand high temperatures.
Sprayed foam and foamed-in-place	Cemetitious Phenolic Polyisocyanurate Polyurethane	Enclosed existing wall or open new wall cavities: unfinished attic floors	Applied using small spray containers or in larger quantities as a pressure sprayed (foamed-in-place) product.	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions.
Structural insulated panels (SIPs)	Foam board or liquid foam insulation core Straw core insulation	Unfinished walls, ceilings, floors, and roofs for new construction	Builders connect them together to construct a house.	SIP-built houses provide superior and uniform insulation compared to more traditional construction methods; they also take less time to build.

Source:
http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11510?print

References:

U.S. Dept. Of Energy – http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11510

U.S. Dept. Of Energy Insulation Fact Sheet – "Determining the R-Value You Need for an Existing House" – http://www.ornl.gov/sci/roofs+walls/insulation/ins_05.html

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