INSULATION

Insulation Overview

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Insulation is needed in warm climates to keep the heat outside and in cold climates to keep the heat inside. Insulation is used in a variety of locations in houses: inside walls and roof systems, under floors, and around foundations. Water heaters and ductwork are also commonly insulated. There are a variety of types and forms of insulation available, some of which are suited for use in specific parts of a house. Nearly every type of insulation has been linked to a potential health hazard, yet with care in installation and material selection, a healthy house can - and should - contain insulation.

Background

All materials resist the flow of heat to some degree. Dense, solid materials such as steel and concrete resist the flow of heat, but they do a poor job of it. Insulating materials tend to resist the flow of heat very well. Most insulating materials do so by trapping multiple tiny pockets of air within their structure.

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Insulations are commonly compared by their R-value (Resistance-value). The higher the R-value, the better the insulating ability. A common brick has an R-value of 0.20 per inch while fiberglass batt insulation has an R-value of 3.17 per inch. Both materials can be used to insulate a house, but fiberglass does a much better job; in fact, it is 15 times more effective than brick. Insulating houses makes sense because, according to the North American Insulation Manufacturer's Association (NAIMA), spending $1 on insulation will save $12 in energy costs.

Historically, natural materials such as cotton, straw, sawdust, feathers, moss, and cork were commonly used as insulation. Today, most commercially available insulations are man-made. Rock wool and fiberglass were two of the first to be developed. These were followed by perlite, cellulose, and various plastic foams. Asbestos was also used in the past in some insulations. It was not as widely used in residences as in commercial buildings; nevertheless, asbestos can be found in some houses, especially around older heating systems.

Health and safety concerns

Most of today's insulations can be used safely in a tightly constructed house where the insulation is well separated from the living space. Still, of all the health concerns related to building materials, insulation seems to have gotten the most press coverage. This attention dates back to the energy crisis of the 1970s when urea-formaldehyde-foam insulation was responsible for elevated formaldehyde levels in some homes. As a result of health impacts, this product was banned from use in houses. While the ban is no longer in effect, urea-formaldehyde-foam insulation has virtually disappeared from the market.

Also, many synthetic foam insulating materials release toxic substances when heated and burned. This is one of the reasons fire fighters routinely wear oxygen masks when entering a burning building. Since oxygen masks are rarely available to typical occupants of a burning house, inhaling smoke means breathing toxic gases. In most fires, deaths are not caused by flame contact, but rather due to inhalation of carbon monoxide and other toxics. Building codes require flammable foam insulation be separated from living spaces by fire-resistant materials such as drywall or plaster.

When installed improperly, insulation may also cause some electrical fixtures to overheat and start a fire. This is especially true when recessed ceiling lighting fixtures are covered with attic insulation. Instructions supplied with insulation typically specify the proper clearance to be maintained between the insulation and lighting fixtures, furnace flues, water heaters, etc. If a device is not specifically designed to be in direct contact with insulation, proper clearance should be provided to minimize the chance of fire.

Energy conservation—and insulation in particular—has often been blamed for poor ventilation, indoor air pollution and, consequently, ill health. In this context, ill health is not mainly due to the insulation, but a failure to specify low-emissions furnishings and materials and to incorporate mechanical ventilation as part of the system.

House "tightening" is not the problem; tight construction is desirable as long as the interior of a house is built with low-tox materials and the air is exchanged properly.

Batt insulation

Batt or blanket insulation is very widely used today. It is a fluffy product that can be purchased in different thicknesses and widths. There are three basic types available for residential use: fiberglass, rock wool, and cotton. While rock wool was very popular before World War II, fiberglass is now more popular in residential construction. Both are considered man-made mineral fibers and are referred to as mineral wool. Cotton-batt insulation is a relatively new product originally designed to appeal to the environmentally-conscious.

Residential batt insulation is usually sold either without facing, or with an asphalt-coated Kraft-paper or other facing. Some manufacturers offer plastic or aluminized-paper facings. These facings are designed to act as diffusion retarders. In some cases, builders will install a separate diffusion retarder over unfaced batt insulation.

Installers of both rock wool and fiberglass often suffer from itching and tiny cuts in the skin due to the fibers. Itching can also result from an allergic reaction to the binder used to hold the insulation together. Manufacturers recommend the following work practices related to such materials: wear a respirator; avoid contact with skin and eyes; wear long-sleeved clothing, gloves, and eye protection; wash with soap and water after handling; wash work clothes separately from other clothes; and wipe out the washing machine after washing exposed items.

In most modern houses, the migration of fibers into the living space is negligible. In tightly constructed houses, insulation of all types is well separated from the occupants.

Moisture in insulation can also lead to biological growth and reduced insulating ability. When done properly, tight construction minimizes these hidden moisture problems.

Fiberglass

Fiberglass insulation is manufactured by melting inorganic materials (often sand) and

spinning them into glass fibers. The fibers are usually held together in batt form by a formaldehyde-based binder. Fiberglass is generally contaminated with fewer impurities than rock wool and its cost is somewhat lower.

Most of the fiberglass insulation manufactured today is either pink or yellow, and the batts contain approximately 5% of the resin binder. The pink variety, made by Owens Corning, also contains less than 1% dye to give it the pink color.

Johns-Manville Corp. has a fiberglass insulation that uses an acrylic resin, rather than a formaldehyde-based resin. It is wrapped with a perforated polyethylene, which can minimize the release of fibers in applications such as above dropped ceilings.

During a fire, the fiberglass itself is fairly inert, giving off little in the way of toxic gases. The resin, however, can decompose in a fire and produce small amounts of ammonia, carbon dioxide, carbon monoxide, carbon particulates, and traces of hydrogen cyanide. The Kraft-paper facing material can produce oxides of sulfur, carbon, and nitrogen. If a plastic facing is used, it too can give off toxic gases in a fire.

It is very important to keep fiberglass insulation well separated from the living space. One report found that nearly all 13 workers in an office reported various symptoms apparently related to glass fibers entering the air due to improper construction methods. Symptoms included itchy rash, burning eyes, sore throats, coughing, and malaise. Eye complaints made it difficult to wear contact lenses. After the insulation was sealed behind plastic foil, the health complaints ceased.

Rock wool

Rock wool is produced by heating natural basalt rocks or industrial steel-mill slag in a furnace. As the material melts, it is drawn out into fibers and formed into felts, blankets, or batts. Today, rock wool has been generally replaced in residential construction with fiberglass insulation. While rock wool is better at reducing sound transmission and has better fire resistance, it is generally more costly than fiberglass.

Rock wool is often contaminated with lignite (a type of coal) and mineral oil to control dust. It is typically bound into batt form by the use of a phenolic resin. These materials can be bothersome to sensitive people who are directly exposed.

Cotton

The cotton insulation currently being manufactured by Inno-Therm Products, LLC is actually a blend of cotton and polyester fibers. (This product was formerly made by a company called Greenwood Cotton.) The polyester acts as a binder, holding the fibers in batt form. The cotton insulation manufactured by Bonded Logic uses a thermoplastic resin to hold the fibers together. A binder is necessary to give the fibers a springy quality. Neither company uses a formaldehyde-based resin.

Much of the cotton for insulation comes from recycled jeans, so it has a bluish color. The cost

is similar to fiberglass if you live near the manufacturer; however, if cotton insulation must be shipped across the country, it will be somewhat more expensive than fiberglass. Cotton insulation is available in several standard sized batts, but not in as many sizes as fiberglass or rock wool.

Although cotton insulation is billed as a healthy product, it is not perfect. In order to get building-code approval, it is treated with a boric acid-like substance to make it flame resistant. Placing a sample up to your nose and inhaling can result in sinus irritation.

Workers who inhale cotton dust in cotton-processing industries are at risk of contracting byssinosis, which is also known as brown lung disease. Although there is no evidence that cotton insulation installers would also be at risk, respiratory protection is recommended.

In the U.S., almost half of the pesticides used in agriculture are applied to cotton—far more than any other crop. Some of this residue remains in the cotton after processing, so it could result in some minor contamination of cotton insulation. Pesticide residues may explain why some chemically sensitive people are helped by wearing clothing made from organically grown cotton.

Even though it is not ideal, cotton insulation is a relatively healthy product. However, to be safe, it should be well separated from the living space, just like mineral fiber insulation.

Loose-fill and blow-in insulation

Loose-fill and blow-in insulations come in several forms. Some can be simply poured out of a bag while others are blown through a specially designed machine, then through an applicator hose. Cellulose and chopped fiberglass are the most common types. Both are generally blown in place but they can also be poured out and placed by hand.

Sometimes the only way to insulate the walls of an existing house is to drill holes in the walls and blow some type of insulation into the wall cavities. Existing attics can be insulated in a variety of ways, but blow-in insulations are often quicker and cheaper to install than batts. Some lumber yards rent blowing machines to do-it-yourselfers. When carefully blown into sidewalls, insulation can help to tighten a house, thus minimizing infiltration while maximizing energy efficiency and comfort.

For new construction, there is a Blow-In-Blanket system ("BIBS"), licensed by Ark Seal International, that uses either cellulose or chopped fiberglass. With this approach, a mesh is stapled up over the studs on the interior. This process takes place after the wiring and plumbing are in place, but before the drywall. Then cellulose insulation (or chopped fiberglass) is blown into the stud cavities. This will fill voids quite well around electrical boxes and plumbing pipes, and it is often faster than using batts.

Cellulose and chopped fiberglass are widely used in wood frame construction. Vermiculite, perlite, and polystyrene beads are more often found in masonry construction. They can

simply be poured into the inside of a concrete block wall as it is being built. Materials like shredded tree bark and sawdust have been used in the past as loose-fill insulation, but they are very susceptible to insect attack and fire, so they are almost never used today.

Cellulose

Cellulose insulation is a very popular product today. It is made by chopping old newspapers into a fine, fluffy material. Newspapers naturally come with an array of potential problems: they are very combustible; they can be eaten by insects, fungi, or bacteria; and they can be used as nesting material by rodents. Due to such reasons, cellulose insulation must be chemically treated. Approximately 20% of the final product consists of additives such as borax, boric acid, ammonium sulfate, aluminum sulfate, lime, ammonium phosphate, mono- and diammonium phosphate, aluminum hydrate, aluminum trihydrate, and zinc chloride. If used in improper amounts, these chemicals may not adequately control flammability, and they can corrode metal with which they come in contact. In attic areas, roof trusses are often held together with metal plates, and corrosion of these plates could eventually lead to deterioration of the roof system. Cellulose insulation standards today take these potential problems into consideration, but many older products could contain flammable or corrosive material. A sample of the insulation can often be obtained from the attic and placed near a flame to test for flammability, and an examination of any exposed metal will reveal any corrosion.

From a health standpoint, the various chemical additives can cause reactions in some sensitive occupants. Symptoms reported after the installation of cellulose insulation include rashes, hair loss, and digestive and respiratory disorders. Individuals with an intolerance to newspapers (either to the printing ink or to the paper) can easily be bothered by this insulation. Because cellulose insulation is so finely ground and powdery, it can filter through very small openings into the living space. Installers without protective clothing or respiratory protection can experience red and sloughing skin, lung irritation, coughing, bronchitis, and pneumonitis.

A 1993 paper (which was funded by the fiberglass-insulation industry) found few research reports directly related to health effects of cellulose insulation. However, some indirect evidence was reported. For example, excess cancers and pulmonary disease have been seen in paper-mill workers and cellulose insulation is made from paper. Sub-lethal doses of boric acid have caused symptoms of abdominal pain, and liver, kidney, and lung dysfunction. An experimental study in which rats inhaled cellulose insulation resulted in pulmonary damage.

Cellulose insulation is often installed in existing wall cavities through small holes drilled in the exterior siding, which are plugged after the cavities are filled. Small gaps around electrical outlets can be easy pathways for insulation to enter the living space of a house. Because of these types of risks, it is always a good idea for someone to be inside the house while the material is being installed. By taking this precaution, any problem will be noticed immediately—before an extremely difficult clean-up job is necessary.

In most cases, cellulose insulation is installed conscientiously and it remains inside building cavities, so it presents no health problems to the occupants. However, small amounts (sometimes large amounts) can be blown into the living space of an existing house during installation, and installers must be careful to minimize such occupant exposure, and then clean up thoroughly. New houses can also be insulated with cellulose, and if they are constructed tightly, the insulation will not be able to migrate into the living space.

There are many manufacturers of cellulose insulation, and it can be purchased through lumberyards or insulation contractors.

Chopped fiberglass

This material can be installed in a manner similar to cellulose. It is composed of small fibers of glass, similar to fiberglass batt insulation, but in a loose form so that it can be blown into wall cavities or attic spaces. Glass is inherently non-combustible and is not subject to being eaten by pests, so it does not need to be chemically treated like cellulose.

Several manufactures make a chopped fiberglass blowing insulation. Certainteed Corp. has a widely used product called Insulsafe that contains approximately 1% mineral oil and silicone to control dust. If it is adequately separated from the living space using tight construction techniques, the risk will be minimal for the occupants.

Much of the concern over the potential carcinogenic aspects of man-made mineral fibers relates to very small diameter fibers which can be inhaled.

Rock wool

Many older homes are insulated with loose rock wool, primarily in their attics. Installed by simply pouring it in place, its use today in the residential market is considerably less than it was in the past. It can be contaminated with the same materials that rock-wool batts contain, with the exception of the resin binder. Sensitive people should be concerned about its presence, but should keep in mind that old insulation will have outgassed over the years and may no longer be a problem. However, inhalation of the loose fibers can still be a health risk.

Vermiculite and perlite

These materials are usually poured-in-place, sometimes in attics, but more often inside hollow concrete blocks. Vermiculite is a mica-like mineral that contains both free and chemically bound water. When heated, it expands due to steam being driven off. This puffed-up product is then used for insulation. It is naturally resistant to fire, rot, vermin, and termites, but is sometimes treated chemically to make it water repellent.

There is some concern about vermiculite containing small amounts of asbestos; however, the temperatures used in heating and puffing it up may cause the asbestos to decompose, yielding a less toxic product. Still, it has been reported that one particular vermiculite mine produced vermiculite with up to 5% asbestos. It is estimated that 70% of the vermiculite in use today came from this single mine, with the asbestos-contaminated product being installed in 940,000 homes. Fortunately, this particular mine was shut down in 1990. The

Environmental Protection Agency ("EPA") suggests that vermiculite should be treated like any other asbestos-containing material.

Perlite is a naturally occurring silicate volcanic rock. When heated, it expands, like vermiculite, because of a small amount of water turning to steam. Perlite is also fireproof and resistant to vermin. It is a very dusty material, and is often treated with silicone to control the dust. Its use in attics is often discouraged because the dust can filter down into the living space through light fixtures or other small openings. This dust can be problematic to an asthmatic, as can the silicone to chemically sensitive individuals.

When these products are used inside masonry walls, there is little chance of them or their contaminants reaching the living space (unless the walls have cracks in them and air pressure differences cause air to move through those cracks). Unfortunately, older masonry walls are often cracked. In older attics, the possibility that these products can get into the living space is even greater because older attics are often not sufficiently sealed. In new construction, extra care should be taken to insure that they stay inside building cavities and remain well separated from the living space.

Polystyrene beads

Polystyrene beads, which are often used as stuffing in bean-bag chairs, can also be used as loose-fill insulation. The beads, when expanded, are approximately an eighth of an inch in diameter. As with many synthetic foam insulations, they are flammable and must be protected from fire. Like vermiculite and perlite, they are primarily used to insulate inside masonry walls, although they can also be used in attics and other locations. Related health concerns are similar to those posed by polystyrene board products (see below).

Board insulations

There are a number of different insulating boards. Those commonly used in residential applications include polystyrene, polyurethane, isocyanurate, cellular glass, rock wool, and glass fiber. Cork, phenolic foam, and rubber foam are also occasionally used.

One of the biggest issues with the synthetic foam insulations has to do with the gases used to manufacture them. In the past, some of these products used chemicals called chlorofluorocarbons ("CFCs") that were found to damage the ozone layer. Today, manufacturers have switched to less-damaging HCFCs. Although not as bad as CFCs, HCFCs may still damage the ozone layer.

Most board insulations are available in a variety of thicknesses and sizes. Four-foot by eight-foot sheets are common. They are often used as sheathing, underneath the siding of a house, or as foundation insulation.

Polystyrene

Polystyrene foam insulation is made in two types, expanded and extruded. Expanded polystyrene consists of small beads fused together inside a mold and is often called beadboard. Extruded polystyrene is made by pushing a chemical mixture through a rectangular die. Upon cooling, it is cut into sheets. Both types of polystyrene will deteriorate

when exposed to ultraviolet light, so they must be protected from sunlight. Both can emit noxious gases when burned.

Expanded polystyrene insulation has never used CFCs or HCFCs in the manufacturing process, but instead uses pentane. Pentane does not damage the ozone layer, but it does contribute to smog. Beadboard's R-value is slightly lower than extruded polystyrene and it is not as sturdy.

Extruded polystyrene is foamed by the use of the pressurized gas, usually a type of fluorocarbon. After foaming, it contains both air and the fluorocarbon gas within its pores. CFCs, which are implicated in damaging the ozone layer in the upper atmosphere, were widely used in the past, but most manufacturers are now using a less-damaging HCFC gas.

Both types of polystyrene insulation are commonly available at lumber yards. Styrofoam is a particular brand of extruded polystyrene that is manufactured by Dow Chemical Corp.

Polyurethane and polyisocyanurate

The basic ingredients of polyurethane foam are isocyanates, polyol resins, and an amine catalyst. Other additives can be used. A blowing agent causes the mixture to expand, creating a foam. Polyurethane can be made into flexible foam, as used in upholstery, or a rigid foam, as used in insulation, depending on the type of isocyanate used.

Health effects in factories that produce polyurethane include blurred vision, skin, eye, and respiratory tract irritation, asthma, chest discomfort, among others. Some of the chemicals causing these symptoms outgas rather quickly, but others do not. Isocyanates are sensitizers, which means that they can sensitize a person and, once sensitized, that person will react to lower levels. Once these foams are cured, they no longer act as sensitizers.

Polyurethane is flammable and must be separated from the living space by drywall or plaster. It burns rapidly and releases carbon monoxide, oxides of nitrogen, and hydrogen cyanide. Hydrogen cyanide is lethal (it is used in gas chambers), but so much carbon monoxide is released in a fire that it is of more concern. A group of firemen exposed to isocyanates reported numerous neurological symptoms such as euphoria, headache, difficulty concentrating, poor memory, and confusion.

Polyurethane insulation has a higher R-value than some other insulations because of the blowing agent trapped in its pores. Other insulations use trapped air to retard the flow of heat, but the gas used in polyurethane functions as a better insulator. However, as the material ages, the gas slowly escapes and is replaced with air. This results in decreased R-value as the insulation ages. The escape of gas can be largely prevented by coating the polyurethane with a dense skin, or a layer of metal foil. For example, polyurethane used inside a sealed steel entrance door would probably allow little gas to escape.

Polyurethane will degrade and fall apart in sunlight unless ultraviolet inhibitors are used in

the formulation. It will also take on water when in a damp environment or used underground, so it must be adequately protected with a suitable diffusion retarder.

Polyisocyanurate foam insulation is very similar to polyurethane, but is slightly more stable. It, too, must be protected from sunlight and moisture and it has similar characteristics when burned. It is often supplied with a foil facing to protect it from degradation.

While workers in manufacturing plants can be exposed to a variety of chemicals, polyurethane and polyisocyanurate insulations are fairly inert once cured. Thermax and Tuff-R are both polyisocyanurate insulations manufactured by Celotex Corp.

Cellular glass

Cellular glass insulation is a commercial product that is rarely used in residential applications because of its high cost. It is mentioned here because it will not burn and it is moisture resistant. It can be used in roof and wall systems as well as underground. Various thicknesses are available.

Foamed glass is basically composed of glass with no fillers or binders; however, it is not 100% safe. During the foaming process, carbon-monoxide and hydrogen-sulfide gases are trapped in each cell of the foam. Theoretically, they will not be released because each cell is totally surrounded by glass. Yet whenever the surface is scratched, or the material is flexed sufficiently, the characteristic rotten-egg odor of hydrogen sulfide can be released. Once incorporated into a building, it is doubtful if this will ever become a problem because, when installed, it is generally not subjected to abrasion and most buildings do not flex enough to allow the release of gas. Cellular glass costs approximately two to three times more than other foam insulations, and it has a lower R-value. It is manufactured under the name of Foamglas by Pittsburgh Corning Corp.

Rock-wool and glass-fiber

These insulation board products have the same basic health advantages and disadvantages as their batt counterparts. They are denser and more-rigid, but are made of the same materials as rock wool and fiberglass batts, although they may contain more resin binder.

Cork

Cork insulation is made by grinding up the outer bark of an evergreen oak tree that grows around the Mediterranean Sea. It is one of the few all-natural insulations still readily available, but it is often processed into sheets by adding a resin to hold the particles together. Sometimes instead of using a resin, manufacturers steam-bake the cork in molds. In this process, the natural resins in the cork hold the particles together, but the sheets end up with a burnt odor.

Sensitive people can react to cork held together with a resin or to steam-baked cork, but most healthy people are not negatively affected by either. It is sometimes possible to special order unprocessed raw cork granules directly from the tree, but the price can be high. The granules can be used as a pour-in-place insulation. Because there are only so many cork trees in the world, there is a limited supply of cork insulation. Cork can cost ten times as

much as fiberglass. Manufacturers of cork insulation include Technicor International (Rector brand), and WE Cork.

Spray-in-place insulation

There are several types of spray-in-place insulation available. The foam products tend to be about the consistency of shaving cream when applied. They can be injected through small holes in walls, like blow-in insulations, or they can be sprayed onto open walls or attic surfaces.

Urea-formaldehyde foam

In the 1970s, urea-formaldehyde-foam insulation ("UFFI") was installed in approximately 500,000 homes in the U.S. While there were no reported negative health effects among the majority of the occupants, there were still many instances where negative health effects were recorded. So many, in fact, that the CPSC banned its use in residences and schools in 1982. Even though the ban was overturned by a Court of Appeals, the CPSC feels that the decision was based on legal and factual errors, and they continue to warn consumers about its dangers. Even though it is again legal to use UFFI, it is rarely installed today. In fact, it is considered such a liability in houses that some real estate agencies require that its presence be disclosed to prospective buyers.

The primary problem with UFFI is that, if mixed incorrectly, it released excessive amounts of formaldehyde gas into the living space. This occurs more often in warm weather or in hot attics. Other gases given off include benzene, benzaldehyde, acetaldehyde, cresol, methylnaphthalene, acrolein, ammonia, and phenol.

Health effects include eye, nose, and throat irritation, cough, headache, dizziness, bronchopneumonia, pulmonary edema, asthma, dermatitis, rhinitis, conjunctivitis, and allergies. Some people were sensitized to many other chemicals as a result of the formaldehyde exposure, leading to a wide variety of symptoms.

Individuals interested in having UFFI removed from their homes are advised that it is very expensive and time consuming, involving major demolition and remodeling. Two Canadian publications are available describing the necessary procedures. Because it has been so long since UFFI has been in use, it is doubtful if any early applications are still problematic. Most of the formaldehyde has probably long since dissipated.

Polyurethane

Polyurethane insulation is sometimes sprayed in place in residences, but it is more often used in commercial applications. Disadvantages are similar to polyurethane board insulation. Most of these spray-in-place urethane foams use a chemical known as "MDI" (diphenylmethandiisocyanate). MDI should be treated with respect. It can sensitize a person by inhalation or skin contact, so it should be used with adequate ventilation, respiratory protection, and gloves. Once cured, products containing MDI are fairly inert and are often well tolerated by sensitive people.

There's a modified urethane spray-in-place insulation that uses MDI, but it is a water-blown

product (rather than CFC blown) called Icynene. It is produced by Icynene, Inc. and licensed to contractors throughout North America. It is sprayed onto wall surfaces as a two-part liquid before the drywall is installed. They also have a version that can be injected into existing wall cavities. The two components react, forming carbon dioxide, which expands the foam. If mixed and installed correctly, it sticks to everything and expands to fill all gaps and openings. Once the foam cures, the surface is trimmed flush with the wall studs and the drywall is installed over it. Once completely cured, this material is often tolerated by chemically sensitive people, and after 30 days there are no detectable emissions. Icynene costs roughly twice as much as fiberglass batt insulation, but it requires no diffusion retarder, and it results in a fairly tight structure. Installing Icynene correctly requires training, skill, and care. One contractor has described sloppy installations where wall cavities were not filled completely, leaving large uninsulated voids. But with a competent installer, Icynene can be a healthy choice.

Aerosol cans of single-component polyurethane insulation are widely available in hardware stores and lumber yards for general purpose use in houses. These products use MDI and cure by reacting with moisture in the air. They can be used to fill gaps around window or door jambs, and holes drilled for electrical wires or plumbing lines. This material does outgas MDI for a short period, so respiratory protection, ventilation, and skin protection are recommended.

Single-component urethane has been used successfully in healthy-house construction in a number of applications. For example, the gap between a window frame and the rough framing of the house can be filled with single-component polyurethane then, once the insulation is cured, and any excess is trimmed off with a knife, aluminum-foil tape is applied over the foam as a diffusion retarder to prevent any residual minor outgassing into the living space. This approach helps make the house airtight and protects the occupants from minor outgassing.

Many builders use canisters of a two-component urethane foam to fill gaps and cracks when they seal up a house. These products also use MDI, but they cure differently than single-component urethanes. They cure by means of a chemical reaction, rather than by reacting with the moisture in the air. Thus, they actually cure somewhat faster than single-component products. They are also often well tolerated by sensitive people after curing.

Some of these foams expand considerably when they cure—so much that they can warp a window or door jamb. Because of this, some window and door manufacturers do not recommend them. There are two solutions to this problem. You can partially fill a gap, let the foam cure, then fill the gap a little more, allow that to cure, and so on, until the gap is filled. This must be done with care to avoid excessive expansion. The other option is to simply use a foam that does not expand very much.

Aerosol foam manufacturers offer minimal-expanding products which comes in a variety of container sizes, such as smaller throw-way sizes and larger refillable contractor sizes with

application guns, both single- and two-component foams), Flexible Products Co. (Insta-Seal, a single-component foam in containers ranging from 12 oz. aerosol cans up to 12 lb. contractor-sized containers with application guns), and Macklanburg-Duncan (Polycel, in both consumer and contractor sizes). These manufacturers also offer expanding foams. Most of these products are generally well tolerated by sensitive people once cured.

Air-krete

Air-Krete has been widely reported to be a non-toxic insulating material. It is a foamed-in-place product and it must be installed by trained technicians because, if mixed imperfectly, it can shrink, reducing its insulating effectiveness. If installers are not careful, there can be uninsulated voids inside the walls.

The main ingredients in Air-Krete are magnesium oxychloride (a cementitious material), and sodium silicate (water glass). Both are fairly inert. Fluorescent dye is used to give it a pink color. Compressed air is used on the job to cause the liquid material to become a foam. Air-Krete contains no formaldehyde or asbestos and it has more insulating ability than fiberglass or cellulose.

In new construction, Air-Krete is installed in walls before the interior drywall or plaster is attached. In existing buildings, it is foamed into the wall cavities through holes drilled in either the exterior siding or the interior wall surface. The holes are then plugged or repaired. Attics and masonry walls can also be insulated. After installation, Air-Krete becomes semi-rigid within seconds. Final drying takes two to four weeks.

While Air-Krete seems to be one of the least toxic insulating materials on the market today, there are some sensitive people who report a minor odor even after several weeks. One extremely sensitive person had to resort to having the Air-Krete removed when she could not tolerate it. Most chemically sensitive people, however, tolerate Air-Krete quite well and report little or no odor after curing. Air-Krete was developed by Air-Krete Inc. and there are licensed installers around the country.

Fiberglass and cellulose

In new construction, chopped fiberglass or cellulose insulation can be mixed with a tiny amount of water or glue and sprayed into open wall cavities. Then, after a brief drying period (usually a few days) the walls are enclosed in a normal fashion. Fiberglass and cellulose dust can be a significant problem when these products are applied as “blow-in” insulations. Yet, because the insulation is slightly damp when sprayed in place, dust is not a problem. Thus, this is a healthier method of applying these materials.

One of the concerns with this wet-spray process of installing insulation is that the added moisture can sometimes result in mold growth. In some worst-case installations, there have certainly been serious problems, but in research carried out in Canada, there have not been any moisture problems as long as installers use the proper amount of water. Drying of the insulation begins immediately, but complete drying typically takes several months.

Reflective-foil insulation

Radiant energy can be reflected back where it came from by means of a shiny foil. The foil does not need to be exposed directly to the radiant source; it can be placed inside a wall cavity and still function. For example, radiant heat can pass through drywall, strike the foil, and be reflected back where it came from. The only requirement is that an air space exist in front of the foil. A layer of reflective aluminum foil inside a wall with a three quarter inch air space in the summer can have an R-value of 3.28 compared to 0.91 for a three quarter inch air space without aluminum foil. Some of the claims for much higher insulating values are based on theory, and can be difficult to achieve with conventional construction tolerances and practices.

Reflective-foil insulation is also called "builder's foil." As an insulation, it is only of minimal value in cold climates, but it can be cost-effective in hot climates to keep the radiant solar energy out of attics and air-conditioned spaces.

Reflective foils are made of a variety of shiny metals including aluminum foil, stainless steel, and foil-coated paper. They only reflect radiant energy when they are shiny, so they will not function when covered with dust. The dust factor can be difficult to determine when the foil is hidden inside the structure of the house. Dust is more of a problem in floor systems than in walls or ceiling systems, but it can coat a reflective foil in any location.

Reflective foil can function as a diffusion retarder, even when dusty. In such an application, it is generally called builder's foil. Some reflective-foil-faced cardboard sheathing materials can function both as a sheathing material, a diffusion retarder, and as reflective insulation.

Reflective-foil products are sometimes lightly perforated to allow moisture to pass through. The perforated products will function as reflective insulation, but not as a diffusion retarder. Moisture migration is an important issue with reflective-foil insulations, because if you choose the wrong product for a particular application, you can end up with a moisture-condensation problem hidden inside a wall cavity.

These materials rarely pose health problems, but some reflective foils are made of aluminized Mylar or aluminized polyethylene which could outgas slightly. On rare occasions a sensitive person will be bothered by printing ink from advertising that is printed on a reflective foil product, but in most installations, they are isolated from the living space.

Reflective insulations come in a variety of forms. The lightest-weight products consist of Kraft paper with aluminum foil on one or both sides. One manufacturer of a light-weight foil/Kraft-paper product is Denny Sales Corp. (Denny Foil). These types of materials are often not very sturdy, and they can get torn in some applications. Innovative Energy, Inc. has a very durable Heatshield product that is reinforced with plastic fibers, as does TVM Building Products. In addition, Advanced Foil Systems offers a durable Aluma-Foil product that is a light-weight foil-faced paper, and an Aluma-Foil Plus that is thinner and has nylon reinforcing. Parsec offers an aluminized mylar product.

Innovative Energy, Inc. (Astro-Foil), Reflectix, and TVM Building Products (rFoil) have foil-faced insulations that resemble bubble-pack packaging material. These products can be used in a variety of insulating applications, including around water heaters, pipes, and ducts.

Summary

Because there are no insulations available that are 100% safe, care should be taken to insure that they are well separated from the living space. Diffusion retarders help in this regard as far as outgassing is concerned, but tight-construction techniques are the most effective means of separation to prevent both gases and particles from entering the living space.

Of the readily available products, the foam insulations on the market today are often tolerated by sensitive people, especially Icynene and Air-Krete, but they can be expensive and they must be installed conscientiously. For someone with severe sensitivities, most insulations can be bothersome when there is direct contact, but tolerable when well separated from the living space. This has been demonstrated in a number of healthy houses in which fiberglass was effectively isolated from the occupants.

(This article is from the archives of the original Healthy House Institute, and the information was believed accurate at the time of writing.)

(Note: The views expressed in this article are those of the author, and do not necessarily represent those of The Healthy House Institute, LLC.)

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