edcetera | Architects

Energy Concerns: Roofs, Windows, Doors and Skylights

Course Number: AIAPDH257
1 LU|HSW

PO Box 449 Pewaukee, WI 53072 (888) 564-9098 arch-support@edcet.com

ANSWER SHEET

First Name: ______________________ Last Name: ______________________ Date: ____________

Address: ______________________ City: ____________________ State: ______ ZIP: ________

Phone: ______________________ Email: ____

AIA #: ____

** See instructions on the cover page to submit your exams and pay for your course.

Energy Concerns Roofs, Windows, Doors and Skylights **Final Exam**

1. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓐ Ⓑ Ⓒ Ⓓ
5. Ⓐ Ⓑ Ⓒ Ⓓ
6. Ⓐ Ⓑ Ⓒ Ⓓ
7. Ⓐ Ⓑ Ⓒ Ⓓ
8. Ⓐ Ⓑ Ⓒ Ⓓ
9. Ⓐ Ⓑ Ⓒ Ⓓ
10. Ⓐ Ⓑ Ⓒ Ⓓ

Energy Concerns Final Exam

1. Standard, dark roofs can reach _____ Fahrenheit in the summer.
   a) 50 Degrees
   b) 75 degrees
   c) 100 degrees
   d) 150 degrees

2. Cool roofs are best used in ________ climates. In cool climates, they can increase energy costs by reducing the solar gain through a roof that would have been beneficial for heating.
   a) Humid
   b) Dry
   c) Hot
   d) Snowy

3. Green roofs are used to manage ______________ and create enjoyable open spaces on rooftops.
   a) Storm water
   b) Pollen
   c) Weather
   d) Insects

4. ______________ plays a large part in heat transfer in both heating and cooling scenarios, even with typical temperatures involved and no sunlight in play.
   a) Oxygen
   b) Flooring
   c) The ceiling
   d) Radiation

5. What are some effects of poor roof ventilation?
   a) Rot damage
   b) Structural damage
   c) Ice dams
   d) All of the above

6. Compared to old buildings, newer, tighter buildings have _________________ rates of infiltration and therefore fewer natural air exchanges.
   a) Lower
   b) Higher
   c) The same
   d) Double

7. When selecting new windows, you should take into consider the following items:
   a) Frame materials
   b) Glazing or glass features
   c) Gas fills and spacers
   d) All of the above

8. What type of window does not open?
   a) Hopper window
   b) Sliding Window
   c) Fixed Window
   d) Awning Window

9. A skylight's area should not be more than _________ percent of the room's floor area in spaces with few windows.
   a) 15
   b) 20
   c) 5
   d) 10

10. _______________ lose far more heat than other door types, because glass is a poor insulator.
   a) Swinging doors
   b) Sliding glass doors
   c) Fiberglass-clad entry doors
   d) Foam insulation core doors

Energy Concerns: Roofs, Windows, Doors & Skylights

Course Description: Many steps can be taken, both during the design process and after structures are completed to reduce the use of energy. These include passive steps like insulating and tightening the building envelope. In line with this is installing more efficient doors, windows and skylights which are normally holes in those envelopes. This course will explore the general energy concerns to think about when deciding what type of roof, doors, windows, and skylights to use in your design and also encourages and examines the impact of decisions and methods to conserve energy. All such actions ultimately result in a desirable preservation of natural resources for the security of generations to come.

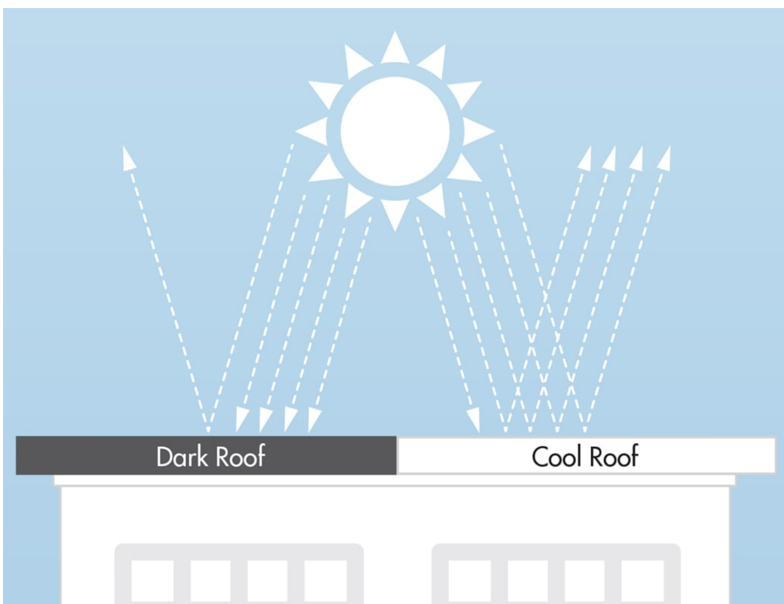
General Energy Concerns: Part 1 - Roof Considerations

This section of the course explores roof specific considerations that help with energy conservation. In Part 1 we will explore the following topics:

- Cool Roofs
- Making Roof Types Cool
- Avoiding Thermal Bridging

Cool Roofs

Cool roofs are best described as roofs made of reflective materials, designed to reflect sunlight and absorb less of its heat. This keeps buildings below them cooler during hot weather. These roofs use highly reflective paint, a reflective surface ply or highly reflective tiles or shingles to repel light.



Climate will be a large factor in deciding whether to install one. Standard, dark roofs can reach 150° Fahrenheit in the summer. Changing the surface to make them a cool roof can drop surface temperature by up to 50°, reducing the air conditioning load inside.

Cool roofs can not only reduce air conditioning loads but improve comfort levels in rooms like garages that are not served by air conditioning. They can also extend roofing material life before replacement.

These types of roofs are best used in hot climates. In cold climates, they can increase energy costs by reducing the solar gain through a roof that would have been beneficial for heating.

Cool roofs can benefit a microclimate as well, when widely used in one area. They do this by reducing local air temperatures in an urban island, lowering peak power demand to help avoid outages and reducing demand on power plants supplying the area. This results in fewer emissions of carbon dioxide, sulfur dioxide, nitrous oxides and mercury.

In warm, moist locations, cool roofs where moisture can condense are more susceptible to algae or mold growth. Some coatings include special chemicals inhibiting surface mold or algae growth for a few years. Care must also be taken in design and construction to ensure moisture does not accumulate in the assembly below the roof surface.

Cool Roofs Review

1. Cool roofs are best described as roofs made of ________materials, designed to absorb sunlight and absorb less of its heat.
   a) Wood
   b) Reflective
   c) Dark
   d) None of the above

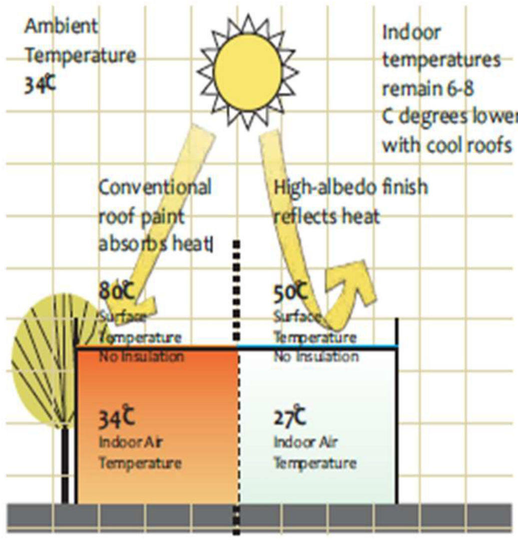
Making Roof Types Cool

Many roof systems are available, but the surface material exposed to the sun is what determines if a roof is cool. This means, with the appropriate surface or coating, almost any roof can be made to be cool.

Cool roof coatings are white or have special reflective pigments. Some are like very thick paints, protecting roofs from ultra-violet light and chemical damage, while also offering moisture protection. Products are available for most types and slopes of roofs.

Systems for Low Sloped Roofs

1. Single-ply membranes are pre-fabricated sheets, held down to a substrate with mechanical fasteners, chemical adhesives or the weight of ballast like stones or pavers. If not already light in color, they can be made cool by resurfacing them with a reflective coating.



2. Built-up roofs consist of a base sheet, fabric reinforcement layers and a protective surface, usually bound together with asphaltic compounds. Sometimes they are also protected by a gravel ballast. The usually dark surface layer can be made cool in several ways.
    - Reflective marble chips can be substituted for dark colored ballast.
    - A coat of reflective mineral granules can be applied on site, or if new, in a factory.
    - A cool coating can also be applied directly on top of the last asphaltic coat.

3. Modified bitumen sheet membranes are layers of plastic or rubber with reinforcing fabrics, surfaced with mineral granules or a smooth finish. These are sometimes used to resurface built-up roofs. Many sheet membranes can be obtained from manufacturers with a cool coating.

4. Spray polyurethane foam coverings mix two liquid chemicals together to react and expand into one solid piece, adhered to and covering a roof. These are very prone to mechanical, moisture and UV damage, and must have a protective coating. Those protective coatings are usually already reflective and cool.

Systems for Steep Sloped Roofs

1. Shingle roofs are protected by overlapping pieces of fiberglass asphalt, wood, polymers or metal. The best option is to purchase cool asphalt shingles, surfaced with special coated granules that reflect sunlight. Coating existing asphalt shingles in place is neither recommended, nor approved by manufacturers. Other shingle types can also have cool coatings applied in the factory.

2. Tile roofs come in clay, slate or concrete pieces. They can be coated to provide custom colors and surface properties. Some are already reflective enough to be cool and others can be transformed with reflecting coatings into cool roof tiles.

Systems for Low and Steep Sloped Roofs

1. Metal roofs come with natural metal finishes, oven-baked paint finishes or granular coatings. Unpainted metals are good solar reflectors but perform poorly thermally, so they don’t qualify

as cool roofs. Paint can increase solar reflectance and thermal emittance, allowing metal roofing to meet cool roof requirements. Cool reflective coatings can also be applied to metal roofing.

Green Roofs
Green roofs are not actually reflective, though they are still considered to be cool roofs. Green roofs are used on flat or shallow-pit roofs and range from basic plant cover to a full garden.

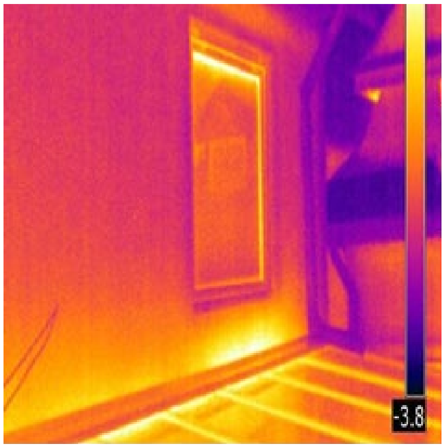
These are used to manage storm water and create enjoyable open spaces on rooftops. They also insulate, lower A/C loads and reduce the urban heat island effect. They are expensive to put in place and must be carefully planned to ensure durability and drainage.

<u>Making Roof Types Cool Review</u>

2. Green roofs are used on _____ or shallow-pit roofs.
   a) Steep sloped
   b) Flat
   c) Only residential homes
   d) All of the above

Avoiding Thermal Bridging

Thermal bridging is a major cause of heat loss in buildings. It occurs when heat moves through an object in an assembly that is more conductive than materials around it. The energy flows through the path of least resistance.



Thermal Bridges In Infrared

The R-value rating of a wall or roof assembly does not mean the entire assembly performs at that resistance level. Thermal bridges from framing materials and discontinuities in the system result in holes in the thermal envelope that insulate at much lower levels. The overall performance of the whole assembly lowers when these areas are averaged into the whole.

It is not hard to find thermal bridges. Run a hand along a wall on a cold day and they will find you. These points of leakage not only impact energy use, but also quality of life. We tend to avoid really cold or hot walls and spaces, so bridges can make parts of a home unusable in certain times of the year.

Wood, metal, and concrete spanning from face to face of an assembly conduct far more heat than insulation around them. But we usually have little choice other than to use some heat conducting material for framing. Studs made of rigid foam won't carry snow loads. That said, there are existing methods to move toward bridge-free construction, and new and promising framing materials are being developed and tested. Some wood used in exterior framing, all of which acts as bridges, can safely be eliminated. Examples include headers in non-load bearing walls, unnecessary cripples and redundant corner studs.

More methods

1. The use of metal fasteners of any kind that span from face-to-face should be avoided.
2. If basement walls can be built of wood, that concrete thermal bridge can be eliminated.
3. Leave batt insulation out of metal stud cavities. Instead, give up a couple inches of inside space and install a thick, seamless layer of board insulation over the face of the studs.

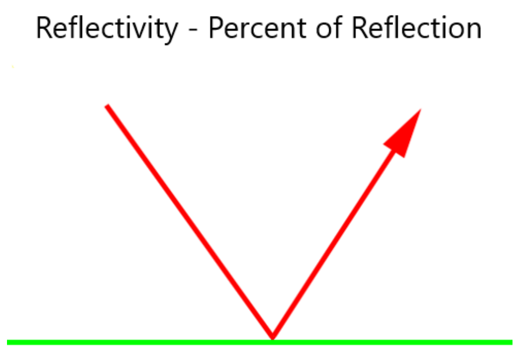
General Energy Concerns: Part 2 - Roof Considerations Continued

- Using Reflective Surfaces
- Use of Vapor Barriers
- Venting Roofs to Control Energy Loss

Using Reflective Surfaces

Radiation plays a large part in heat transfer in both heating and cooling scenarios, even with typical temperatures involved and no sunlight in play. It is a critical consideration for surfaces in sunlight or where large temperature differences exist between surface and surroundings, like with radiant heating, refrigeration, hot industrial surfaces and ice rinks.

Reflective (low- emissivity) products are useful in most of these, but in certain applications, a high-emissivity (non-reflective) surface performs better. A basic understanding of reflectivity and emissivity helps in evaluating the use of reflective products.
Reflectivity and emissivity are surface properties affecting radiation heat transfer, or how a reflective product performs. Radiation arrives at a surface and the percentage of radiation reflected from it is called its reflectivity.



Emissivity is a surface's tendency to emit radiation to other bodies.

- High emissivity means a surface will readily absorb radiation striking it, depending on the wavelength of radiation striking it, and emit it later.
- For example, a surface may reflect most of the wavelength of light hitting it, but not much ultraviolet or infrared radiation coming at it.

Knowing reflectivity and emissivity are interrelated can be helpful in understanding them. Low emissivity (Low-E) materials will save energy, should you want to reduce heat transfer.

Places where it's a good idea to reduce heat transfer

1. Between interior objects (including people) and between interior and exterior surfaces of exterior wall assemblies, when interior air is being conditioned different than the outdoors
2. Between exterior surfaces of a building and outside air, on both hot and cold days. Low-E glazing saves energy by reducing heat transfer with its surroundings.
3. A low-emissivity ceiling in an ice rink, like one painted with a reflective aluminum paint. This may result in very good energy savings, by reducing radiation heat transfer between the warmer ceiling and the surface of the ice.
4. Low-E surfaces on windows or walls are bad in rooms with high internal gains, like computer server areas or telephone rooms.
    - In these, you usually want to get rid of heat at all times.
    - The only time low-E surfaces help you in server rooms is when it gets so cold outside that you have to begin heating the space.
5. A surface used as a radiant heater, like a radiator or a radiant floor, is a place where high emissivity is beneficial to enhance heat transfer from the radiator.

Using Reflective Services Review

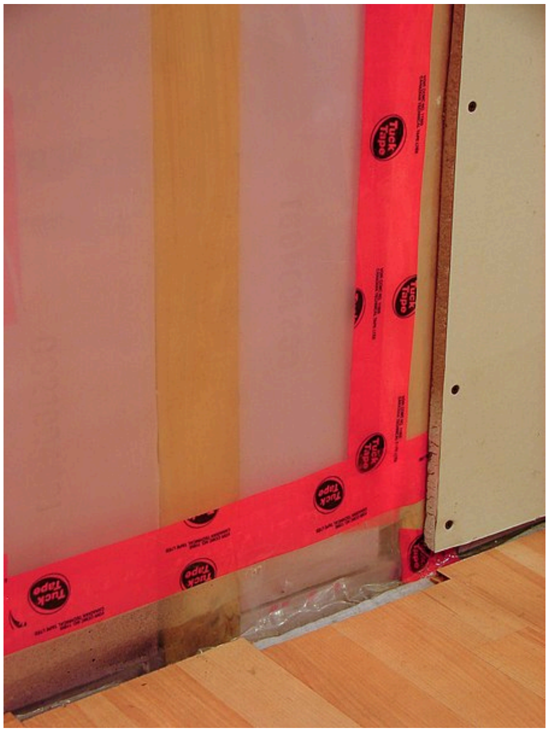
3. ________________ and _________________ are surface properties affecting radiation heat transfer, or how a reflective product performs.
    a) North and south
    b) Air and sound waves
    c) Reflectivity and emissivity
    d) None of the above

Use of Vapor Barriers & Their Location

A vapor barrier is a material used to retard water movement into and through walls. It is applied independently over the warm side of exterior walls or as an integral part of another facing material.

Vapor barriers are also referred to as vapor diffusion retarders. These interfere with the movement of airborne vapor inside a wall cavity. They should be installed on the side of the cavity consistently exposed to the highest vapor pressure. In very hot or very cold climates, that distinction is easily made as being the warm side. In more temperate climates, that decision on location becomes more difficult.

In any event, care must be taken that only one vapor barrier, or material that can act as one, be placed in a wall or roof system. Otherwise, moisture may become trapped between multiple barriers.



Plastic sheeting, Kraft paper, foam plastic sheeting/insulation, solid vinyl wall covering and asphalt-impregnated building paper are all building materials known to act as vapor barriers. Not as well-known are unfaced insulation, building paper without asphalt compounds, plywood sheathing and building wraps like Tyvek. These all retard vapor flow to some degree.

Vapor barriers must be correctly installed to be effective. Insulation in cavities should fill all voids prior to installation of a vapor barrier. The vapor diffusion retarder must then be properly sealed at its seams, per its manufacturer's recommendations. Care must be taken to properly seal window and door openings. When fastening them to the building, they must be secure, but with no fasteners allowed to tear through a barrier, leaving holes through which moisture can migrate.

<u>Use of Vapor Barriers and their Location Review</u>

4. Vapor Barriers also known as Vapor Diffusion retarders should be installed on the side of the cavity consistently exposed to the _____________________.
   a) Highest vapor pressure
   b) Cavity
   c) Insulation
   d) Outdoors

Venting Roofs to Control Energy Loss

Guaranteeing Airflow

Roof ventilation works since warm air rises. In the summer, solar gain heats air inside the attic and in the winter, heat escaping from your home does the same. In either case, venting needs to occur as cool air enters attics near eaves and ceilings and rises to exit near the peak.
Ideally, equal amounts of air should enter low and exit high. The goal is for temperature and humidity levels in the attic to be allowed to equalize with those same conditions outdoors.

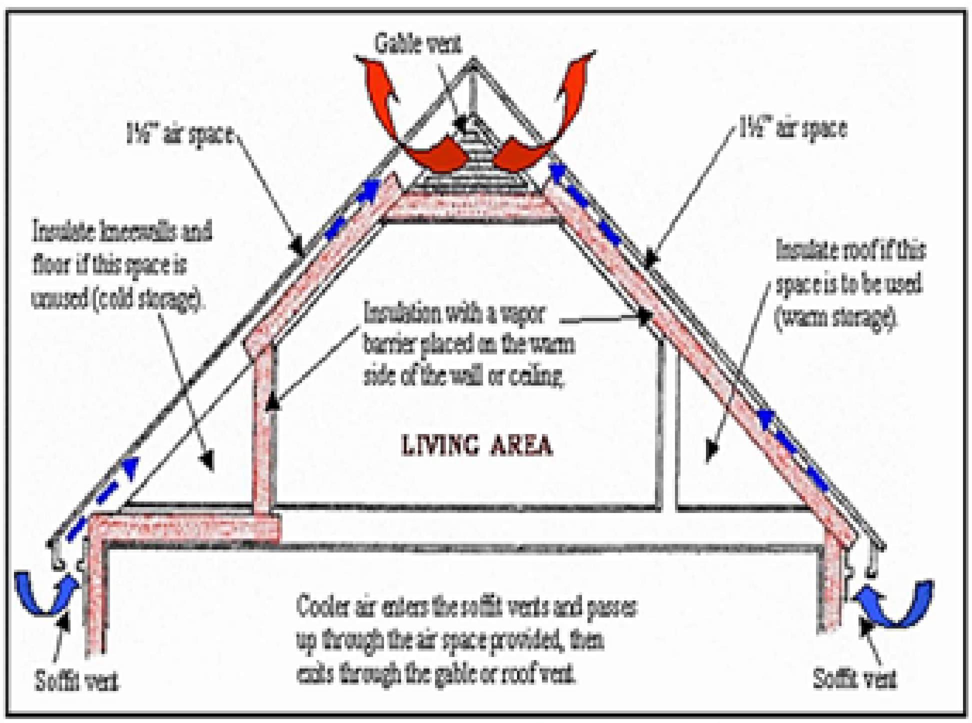


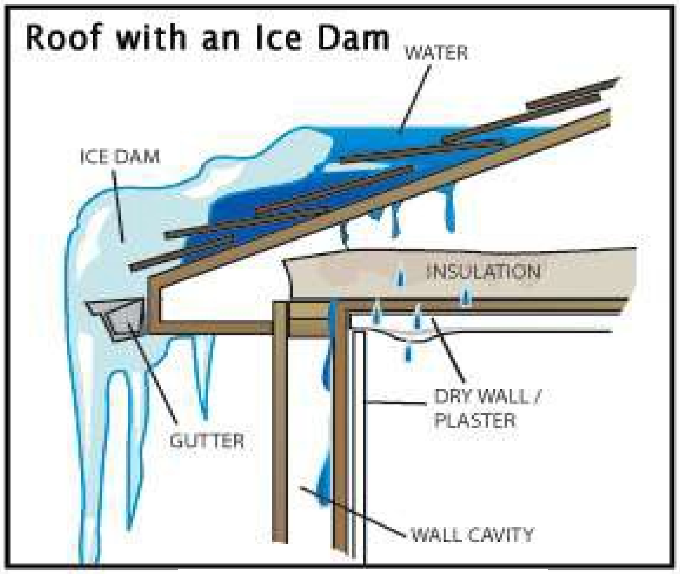
Figure 1 - Proper method of insulating and ventilating a typical 1½ story

Airflow

Soffit vents work very well for intake air, which can then exit passively through ridge vents or hood vents. Turbine vents use exterior wind energy to create vacuums that in turn, pull air out of the attic. Electric-powered vents are the ultimate air movers but are unnecessary in most situations. Gable vents allow air in and out, but don’t help air flow evenly throughout the attic.

Poor ventilation equals damage

Moisture damage is one result of poor ventilation. Warm, humid air tends to migrate upwards into an attic through ceilings. Condensation then forms on roof framing and sheathing, which can support rot and cause serious structural damage. The condensed water can also drip back down, on and through ceilings, causing mold and other issues.



Badly Vented Roof

Ice dams also result from bad ventilation. If an attic gets warm enough, escaping heat will melt snow on the roof, while the eaves still remain cold. When melting water from above flows down to the eaves, it freezes there again, forming a dam. Melting water still coming down the roof then encounters that dam and may back up under the shingles to cause damage.

Ventilation code requirements

Building codes usually require 1 SF of vent area for each 300 SF of attic. This proportion assumes half the supplied vent area is high on the roof for outgoing air, and half is low near the eaves for incoming air. Otherwise, the required vent area must be doubled to 1 SF of vent area for each 150 SF of attic. These suggested numbers are minimums. There cannot be too much ventilation.

Insulation systems

An obvious part of a well-insulated building shell will be the insulation placed therein. There are many products, available in many forms, to do just that.

<u>Venting Roofs to Control Energy Loss Review</u>

5. What are examples of types of Roof Vents that help Guarantee Airflow?
    a) Soffit vents
    b) Rubine vents
    c) Electric-powered vents
    d) All of the above

General Energy Concerns: Part 3 - Windows, Doors, and Skylights

Introduction

Larger gaps in building energy envelopes are sometimes known as windows, doors, and skylights. These fenestration elements are significant holes in energy conservation strategies. Striving to make them as energy efficient as possible will save energy, reduce heating, reduce cooling and lighting costs and improve comfort levels inside.

In Part3 we will explore the following topics:

- The Danger Inherent in Airtight
- Window Frame Types
- Window Glass Types and Coatings
- Window Operating Types
- Selecting Windows
- Storm Windows
- Energy Efficient Skylights
- Energy Efficient Doors

Danger Inherent in Airtight

Infiltration, into and through buildings and materials, occurs for multiple reasons. Wind can literally push itself in, can be drawn up by rising hot air, sucked in by ventilation fans and pulled up to higher spaces by a chimney effect. The force called infiltration does not transport liquid water, but it does bring in humidity in the air entering and surrounding structures.

In the past, buildings were far looser in construction and frequent air changes helped control moisture by moving it out as easily as it was drawn in. Our newer, tighter buildings have lower rates of infiltration, and therefore fewer natural air exchanges.

Moisture that does enter via infiltration has more time to saturate materials and then be drawn into and out of those materials, increasing humidity levels inside the building. Inadequately ventilated, damp air will cause rapid deterioration of many building materials.

To stop the penetration and entrapment of this humidity, joints and cracks must be sealed (making the building even more airtight) and controlled air exchanges must be introduced through operation of the HVAC system. It is a bit of a balancing act though: an airtight building that cannot breathe at all will quickly become an unhealthy building to occupy.

Solutions to air quality problems in buildings include eliminating or controlling sources of pollution, increasing ventilation or installing air cleaning devices. Often a resident will improve indoor air quality by removing a pollution source, altering an activity, unblocking an air supply vent or opening a window to temporarily increase ventilation. In other cases, requiring renovations or upgrading of building components, only the building owner or manager will be able to remedy the problem.

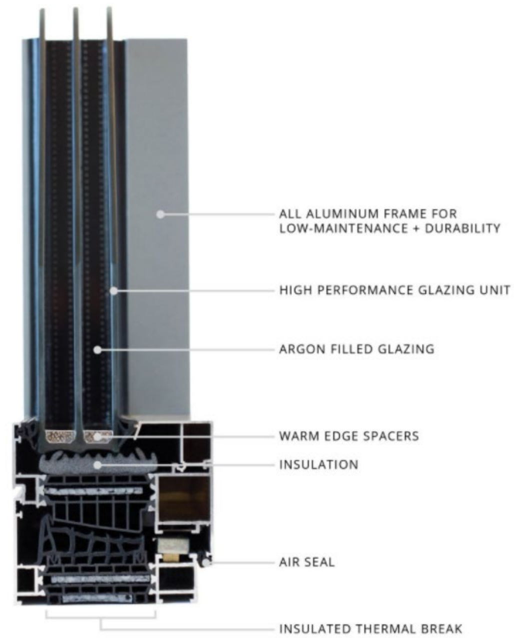
Window Frame Types

Windows are becoming more energy efficient while durability, aesthetics and functionality are being improved. When selecting new windows, consider frame materials, glazing or glass features, gas fills and spacers and the window's method of operation.

Improving a frame's thermal resistance can contribute to its energy efficiency, especially its U-factor, or rate of heat transfer. Each type of frame materials has pros and cons, but vinyl, wood, fiberglass and some composite materials provide much better thermal resistance than metal. Although strong, light and almost maintenance free, metal or aluminum frames conduct heat quickly, making metal a poor insulating material. To reduce heat flow, metal frames should have a thermal break between the inside and outside of a frame or sash.

Composite window frames are of composite wood products, like particleboard and laminated strand lumber. Some have polymer plastics mixed in. Composites are very stable, have equal or better structural and thermal properties than wood, and have better moisture resistance and more decay resistance. Fiberglass frames are dimensionally stable, containing air cavities filled with insulation. This results in better thermal performance than wood or uninsulated vinyl.

Windows are becoming more energy efficient while durability, aesthetics and functionality are being improved. When selecting new windows, consider frame materials, glazing or glass features, gas fills and spacers and the window's method of operation.



Improving a frame's thermal resistance can contribute to its energy efficiency, especially its U-factor, or rate of heat transfer. Each type of frame materials has pros and cons, but vinyl, wood, fiberglass and some composite materials provide much better thermal resistance than metal.

Vinyl frames are made of polyvinyl chloride with stabilizers to keep ultraviolet light from breaking down their material. These frames require no painting and resist moisture. Their hollow cavities can also be filled with insulation, making them thermally superior to standard vinyl and wood frames. Wood window frames insulate well but require regular maintenance. Cladding them with aluminum or vinyl reduces maintenance but using metal cladding will result in slightly lower thermal performance as heat transfers through it.

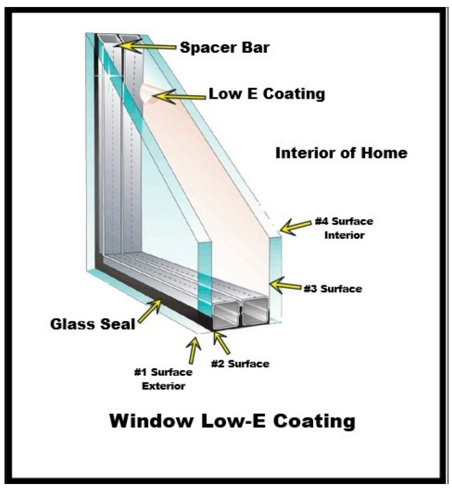
Window Glass Types and Coatings

Besides choosing frames, a type of glazing or glass should be selected which improves energy efficiency. Based on factors like orientation, climate and building design, different types of glass may even be more appropriate in different faces of the same home. For very good information on energy efficiency of different glass types, visit the website of the Efficient Windows Collaborative at https://www.efficientwindows.org/gtypes.php.

Here are some terms that may be encountered when shopping for windows:

- **Insulated window glazing** refers to windows with two or more panes of glass. These are held apart by spacers and hermetically sealed to create an insulating air space inside. Insulated window glazing primarily lowers the U-factor of a unit.

- **Low-emissivity** (low-E) **coatings** on glass control heat transfer through insulated glazing. Windows with these coatings typically cost 10-15% more than regular windows but reduce energy loss by 30-50%. Low-E coatings are microscopically thin metal or metallic oxide layers, deposited directly on one or more of the panes.



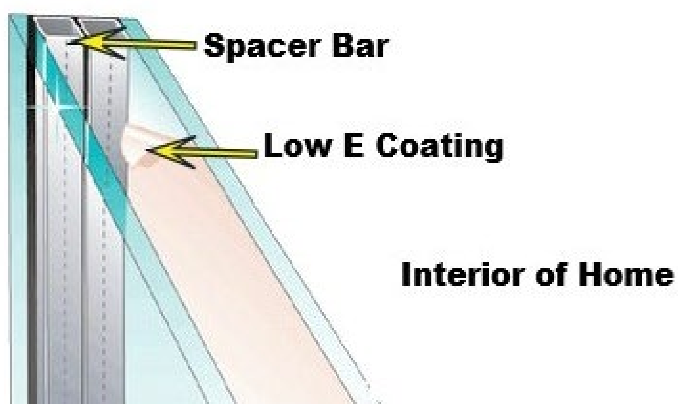
The low-E coating lowers the U-factor, and different coatings are available to allow for high solar gain, moderate solar gain or low solar gain. Most low-E coatings are applied in factories, but do-it-yourself products are available as films.

A special type of low-E coating is one that is spectrally selective.

- These filter out 40-70% of normal heat transmission, while allowing in full transmission of light.
- They do this by reflecting only particular wavelengths of light like the infrared portions, while remaining transparent to others in the visible part of the energy spectrum.

Advanced window glazing with spectrally selective coatings can reduce cooling requirements in hot climates by more than 40%.

- **Gas filled layers of glass** can also minimize heat transfer between the interior and exterior. Argon or krypton gasses are typically used, as both are inert, non-toxic, clear and odorless.
    - Krypton is used when the space between layers must be thin, about 1/4”. It performs better than argon at stopping energy transfer, but costs more.
    - Argon can be used when the spacing between panes is larger, closer to 1/2”. Sometimes argon is mixed with krypton to keep cost low but increase the thermal performance.
- **Spacers** are used to keep and maintain layers of glass the correct distance apart. They accommodate thermal expansion and pressure differences, while preventing moisture and gas leaks.



Window Operating Types

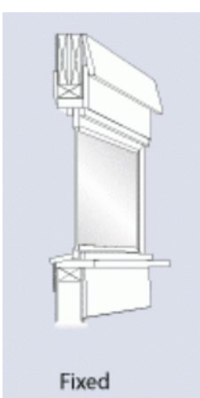
Another consideration of energy efficiency must be how windows operate, because some types have lower air infiltration rates than others.

- Awning
- Hopper
- Sliding
- Fixed
- Single and Double Hung
- Casement

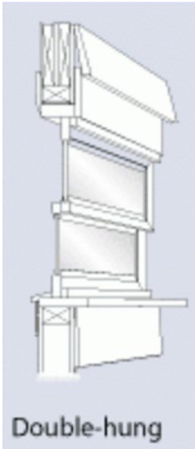
Awning windows are hinged at the top and open outward. Since the closed sash presses against the frame, they tend to have low air infiltration.

Hopper windows hinge at the bottom and open inward. They also have lower air leakage, with closed sashes pressed against the frame.

Single and double-sliding windows have two sashes that slide horizontally in a double-slider and one sash that slides in a single-slider. With no pressure against them when they are closed, they have higher air leakage rates.



Fixed windows don't open. When installed properly, they're airtight, but not very useful where egress or ventilation is needed.



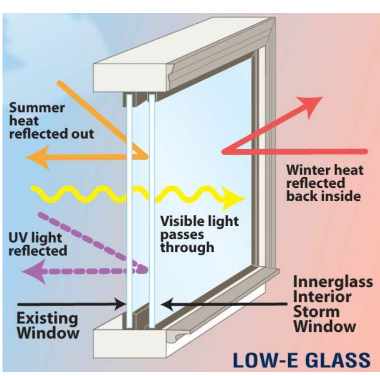
Single and double-hung windows have two sashes that slide vertically. Both sashes slide in a double-hung window. Only the bottom one slides up in a single-hung window. With no pressure holding them closed against a frame or each other, these sliding windows have a high air leakage rate.

Casement windows are hinged on one side and open outward. Since the closed sash presses against the frame, they also tend to have low air leakage.

Selecting Windows

Storm Windows -

Replacing single-pane windows with high-performance double-pane windows can be cost- effective. Another less expensive option might be installing exterior storm windows instead. They produce similar savings at a lower initial cost. Some storm windows can be installed by those living in apartments, to reduce air infiltration and reduce utility costs.



Older storm windows were clear glass, but new models offer low-E coatings to lower emissivity and reduce heat transmission. Storm windows with a low-E coating reflect heat back inside in the winter and reflect it back outside in the summer. Uncoated glass has an emissivity around 0.84, but low-E coated glass can be 0.16 or lower. Storm windows can be operable or fixed in place to reduce air leakage. In climates where heating is most in demand, low-E insulating storm windows and insulating shades are effective in reducing heat loss and energy costs. In warmer climates, solar control low-E storm windows will work better for energy savings.

Low-E storm windows offer multiple benefits. They cost about a fourth of complete window replacements. They are aesthetically pleasing, operable, reduce drafts, reduce noise and increase comfort.

Low-E storm windows offer similar energy savings to completely replacing windows and reflect radiant heat 35% more effectively than clear storm windows. They can help seal against air leakage and reduce it as much as 10%. Finally, low-E exterior or interior storm windows can save 12-33% on utility costs. These advantages yield a payback period of about 5-7 years.

Energy Efficient Skylights – Energy-efficient skylights can provide daylighting and ventilation and minimize lighting costs.

Skylights on roofs can result in unwanted summer solar gain and winter heat loss. Various technologies can reduce these negatives, including heat-absorbing tints, insulated glazing and low-E coatings. A translucent insulation material like aerogel can even be inserted between layers of glazing for a more thermally efficient unit.

Before selecting a skylight, determine what type will work best and where to place it, to optimize its contribution to daylighting and ventilation. Whether daylighting or heating potential is maximized or minimized will depend on a skylight's position.

The actual size of a skylight affects the amount of illumination and solar gain in the space below. A skylight's area should not be more than 5% of the floor area in rooms with lots of windows, or 15% of the room's floor area in spaces with few windows.

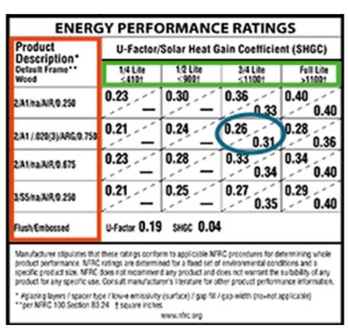
Unwanted heat gain can be mitigated by placing skylights in the shade of deciduous trees or adding a movable window shade inside the skylight. Some units have special glazing to help control solar gain.

Energy Efficient Doors - Doors can be problematic, especially when they are old, uninsulated, improperly installed or improperly sealed. Replacing weatherstripping or caulking exterior doors can save money and energy by reducing energy losses due to air leakage.

Selecting New Exterior Doors

- New exterior doors tend to fit and insulate better than older ones.
- Replacing existing doors with new ones might have a surprisingly short payback.
- If building new, consider buying the most energy-efficient doors possible.
- When seeking energy efficiency, first consider energy performance ratings relative to the local climate and your home's design.

The National Fenestration Rating Council (NFRC) label helps compare energy performance of different doors. An example is below.



ENERGY PERFORMANCE RATINGS

Product Description* Default Frame** Wood	U-Factor/Solar Heat Gain Coefficient (SHGC)			
	1/4 Lite <410†	1/2 Lite <900†	3/4 Lite <1100†	Full Lite >1100†
2/A1/na/AIR/0.250	0.23 / —	0.30 / —	0.36 / 0.33	0.40 / 0.40
2/A1/.020(3)/ARG/0.750	0.21 / —	0.24 / —	0.26 / 0.31	0.28 / 0.36
2/A1/na/AIR/0.675	0.23 / —	0.28 / —	0.33 / 0.34	0.34 / 0.40
3/SS/na/AIR/0.250	0.21 / —	0.25 / —	0.27 / 0.35	0.29 / 0.40
Flush/Embossed	U-Factor 0.19 SHGC 0.04			

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information.

* #glazing layers / spacer type / low-e emissivity (surface) / gap fill / gap width (na=not applicable)
**per NFRC 100 Section B3.24 † square inches

www.nfrc.org

The label shows the solar heat gain coefficient (SHGC) and U-factor for a door. A low SHGC is needed in warm climates and a high SHGC is best in a climate that is cool. SHGC measures how well a door keeps out solar gain, ranging from 0 to 1.

One popular door has a steel skin with a foam insulation core. It usually includes a magnetic strip seal as weatherstripping. If installed right and not bent, this door needs no further weatherstripping.

Most steel and fiberglass-clad entry doors offer R-values from R-5-R-6, excluding any windows in them. A 1-1/2" thick fiberglass door without a window offers over 5 times the insulating value of a solid wood door of the same size.

Sliding glass doors lose far more heat than other door types, because glass is a poor insulator. Moreover, all the air leakage around weatherstripping on a sliding glass door can't be stopped and still allow use of the door. After years of use, the weatherstripping wears down, so infiltration increases. Sometimes, worn weatherstripping on sliding glass doors can be replaced.

Most modern glass doors offer metal frames with a thermal break between inner and outer parts of the frame. Models with several layers of glass or low-E coatings or gas between panes are a good investment, especially in extreme climates.

When buying or replacing doors, swinging doors offer tighter seals than sliders. A door with one fixed panel will have less leakage than a similar door with two operating panels.

<u>Windows, Doors and Skylights Review</u>

6. An airtight building that cannot breathe at all will quickly become an unhealthy building to occupy.
   a) True
   b) False

References

Building Thermography. (n.d.). Thermographic Building Inspections. https://www.infratec-infrared.com/thermography/industries-applications/building-thermography/
Gambrick. (2019, April 8). *Thermal Bridge Free Construction*. Modern Design. https://gambrick.com/thermal-bridge-free-construction/
GAF. (2019, October 2). *Cool Roofing Solutions*. GAF.Com. https://www.gaf.com/en-us/for-professionals/resources/cool-roof-solutions
Jain, V. (2016, September 15). *Roof Waterproofing Using Bituminous Waterproofing Membrane Sheet*. The Constructor. https://theconstructor.org/practical-guide/bituminous-waterproofing-membrane-roof/13285/

ICECO Low E Ceiling | ICECO Advanced Arena Products. (n.d.). Iceco. https://icecoadvanced.com/product/iceco-low-e-ceiling/

Overbey, D. (2015, November 23). *The Difference Between Reflectance and Emittance*. 2015-11-18 | Building Enclosure. https://www.buildingenclosureonline.com/blogs/14-the-be-blog/post/85546-the-difference-between-reflectance-and-emittance

Design. (n.d.). Energy.gov. https://www.energy.gov/energysaver/design
Kevin, A. (2021, January 13). *Category: Custom Home Building*. Turnberry Construction Groups https://www.turnberryconstructiongroup.com/blog/category/custom-home-building/
GLO Windows. (n.d.). *What Is A Thermal Break In Windows?* Glo European Windows. https://glowindows.com/what-is-a-thermal-break-in-windows/
Low E Glass. (2014, February 1). The Glass Guru of TC. https://theglassguruoftc.wordpress.com/glass-information-and-resources/low-e-glass/
Maghriby2660. (n.d.). *Innerglass Low E* [Illustration]. Wikimedia. https://commons.wikimedia.org/wiki/File:Innerglass-low-e-illustrati.jpg

Review Question Answers

1. Cool roofs are best described as roofs made of ________materials, designed to absorb sunlight and absorb less of its heat.
   a) Wood; incorrect, wood alone is not a product typically used to make a cool roof
   b) **Reflective**; correct reflective materials tend to absorb less heat
   c) Dark; incorrect dark roofs tend to absorb more heat then other lighter colored roofs
   d) None of the above; incorrect, reflective roofs can be described as a cool roof

2. Green roofs are used on _____ or shallow-pit roofs.
   a) Steep sloped; incorrect, this roof type is never on a steep sloped roof.
   b) **Flat;** correct, green roofs are generally made on flat roofs
   c) Only residential homes; incorrect, many green roofs are on business buildings
   d) All of the above; incorrect, the flat roof and shallow pit roofs are what you need to make a green roof.

3. ________________ and _________________ are surface properties affecting radiation heat transfer, or how a reflective product performs.
   a) North and south; incorrect, north and south is not a surface property
   b) Air and sound waves; incorrect; air and sound waves are not a surface property
   c) **Reflectivity and emissivity**; correct these are surface properties that will affect radiation heat transfer
   d) None of the above; incorrect

4. Vapor Barriers also known as vapor diffusion retarders should be installed on the side of the cavity consistently exposed to the ____________________.
   a) **Highest vapor pressure;** correct
   b) Cavity; incorrect, should be exposed to the side with the highest vapor pressure
   c) Insulation; incorrect, should be exposed to the side with the highest vapor pressure
   d) Outdoors; incorrect, should be exposed to the side with the highest vapor pressure

5. What are examples of types of roof vents that help guarantee airflow?
   a) Soffit vents; correct
   b) Rubine vents; correct
   c) Electric-powered vents; correct
   d) **All of the above;** correct these are all types of roof vents that help airflow

6. An airtight building that cannot breathe at all will quickly become an unhealthy building to occupy.
   a) **True**; correct some buildings have become so airtight that they are unhealthy, this can be managed by vents and airflow.
   b) False; incorrect, these buildings can become unhealthy.