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Continuing Education Section:

Understanding Light and Solar Heat Gain

Temperature Gains and Losses

There are multiple factors that affect the ability of a window to control heat gains and losses. In the winter you want a window that gains heat and keeps it indoors; in the summer you want a window that loses heat and prevents it from entering your home. So how can a window achieve both?

A proper window will effectively "control" the four main processes in heat or cold transfer found in most windows: radiation, conduction, convection, and air leakage.

How Windows Lose Energy

Radiation – How much cold passes through the glazing (glass). About two thirds of heat lost through a window is due to radiation. Ordinary glass easily transfers heat to colder areas and is considered to have a high emissivity. In other words, glass in the summer months passes the outdoor heat to the cool interior of your home, and in the winter the glass passes the warmth of your home to the cold outdoors.

Every Alpen Window's product is engineered with low emissivity (low-E) coatings that effectively control how heat passes through our glazing systems. These coatings help keep heat inside in the winter and block it in the summer.

Conduction – How much cold passes through the edges and framing system of a window. The material of a window's framing system is what determines how well a window controls conduction. Some materials are better conductors than others; for example, copper and aluminum pots and pans are the most coveted in a kitchen because they are extremely good conductors; however, you would never want that for your windows.

Alpen Windows are constructed using fiberglass, the least conductive materials available for windows. This material prevents the transfer of unwanted heat or cold into your home.

Convection – The warm air movement between the spaces in a multi-glazed window and the air that circulates within your home and touches the glass. The "drafty" feeling, often felt by low performing windows in the winter, results from warm interior air traveling along a window, cooling down, dropping toward the ground and then circulating out toward the interior of the home. This cycling of air is what causes that cold draft feeling in the winter.

When warm air touches cold glass, heat is passed to the coldest side of the glass. In the summer that means the warmth is passed to the inside of your home, and in the winter the warmth is passed to the outside of your home. Too large of an air space increases convection and too small of an air space increases conduction and colder interior glass temperatures increase convection.

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Every Alpen Window's product has been engineered to have optimal spacing between panes of glass and suspended film, nearly eliminating temperature fluctuations due to convection or conduction. Also, the full frame R-Value of our windows create warm interior glass temperatures and nearly eliminate that cold drafty feeling.

Air leakage – The air movement between all of the moveable parts of the window's frame. Most air leakage occurs between the sash and frame, or the meeting rails of a sliding sash in operable windows. Air leakage performance is shown on a window's NFRC label and is labeled as "air infiltration rate" – the lower the number, the better the performance.

Posting air infiltration rates is considered voluntary for a window manufacturer and is not required on an NFRC label. We post all of our product's air infiltration rates because we believe in being as open and honest as possible about our windows. Unlike some competitors, you will always and easily be able find performance data for all of our products.

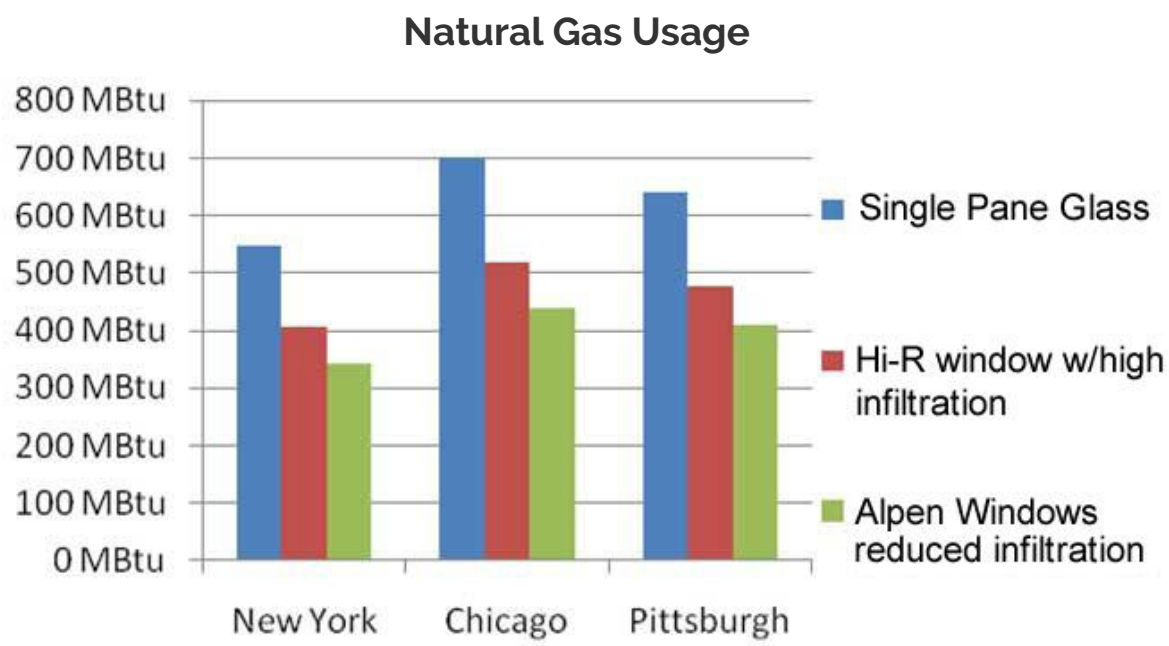
Why Air Infiltration Matters for Energy Efficient Windows

According to ENERGY STAR, air leakage accounts for 25% to 40% of the energy used for heating and cooling in a typical American home.*

What is Air Infiltration?
Air infiltration refers to air leakage through unsealed joints in a structure and around the windows. A leaky home allows unwanted cold air to seep indoors during the winter and warm air in during the summer. The ability of a window to retain heat by reducing air leakage through gaps in or around the window is tested to a national standard and described by its Air Infiltration value and is typically given in cfm/ft² (cubic feet of air per minute/square footage of the window). The lower the Air Infiltration, the less air there is leaking in or out. A common replacement window has an Air Infiltration value of approximately 0.3 cfm/ft2.

What are the Air Infiltration Benefits?
To understand how air infiltration performance affects energy consumption and energy costs, consider the results of the following computer simulation designed to illustrate the impact of air infiltration and R-value on energy consumption in a multi-family home.

A typical multi-family home was modeled with three types of windows. The first model represented the existing energy use of the building with single pane, low R-value, high air infiltration windows. Such windows are common to this building type. The second scenario modeled the same multi-family home with high R-value windows (comparable to Alpen Windows R-value) but without the benefit of improved air infiltration. The third model represented the home with Alpen Windows that feature the combination of both high R-value and low air infiltration. Each home simulation was placed in three cities and focused specifically on heating energy. The graph below depicts the natural gas consumption of each simulation.



As the graph above highlights, R-value and air infiltration both contribute incremental improvements to the overall energy usage. While absolute energy consumption varies somewhat among the cities, the upgrade from single pane, low R-value, high air infiltration windows to high R-value low air infiltration windows created savings in energy consumption across the board.

Note that achieving good air infiltration results depends on window installation in accordance with AAMA guidelines by a certified installer.

What to Look For:

When shopping for windows, check the NFRC label to learn about its air infiltration performance. It is important to keep in mind that a window's air infiltration depends heavily on the window style. The table below summarizes some reference Air Infiltration values for different types of windows.

Air Infiltration Reference Values:

Window Type	Air Infiltration
Common replacement window (based on IECC2006 code requirements)	**0.30**
Alpen Windows 525 series Double Hung	**0.16**
Alpen Windows 525 series Casement	**0.01**

When shopping for new or replacement windows, be sure to verify that your new windows have low air infiltration values in order to maximize your energy savings.

**Depending on location and other factors.*
***Depending on building type, location, and other factors. Computer simulation used eQuest modeling software. Building model details based on low-rise multi-family residential building and other assumptions.*

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Glazing Comparison

of Alpen Windows vs. Triple Pane and Dual Pane Windows

Window	R-Value	Avg. winter glass temp (F)	SHGC	Weight per ft.	STC rating	UV blockage
Alpen Windows	**Up to R-9.1**	**65**	**.20-.60**	**3.4**	**35-42**	**99%**

R-Value: a measure of the resistance of a glazing material or fenestration assembly to heat flow. It is the inverse of the U-factor (R = 1/U) and is expressed in units of hr-sq ft-°F/Btu. A high-R-value window has a greater resistance to heat flow and a higher insulating value than one with a low R-value.

SHGC: the lower the number the more comfortable the window in the summer heat, while a high number can be used on certain elevations for passive winter-time heating. The fraction of solar radiation admitted through a window or skylight, both directly transmitted, and absorbed and subsequently released inward. The solar heat gain coefficient is a standard indicator of a window's shading ability. It is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits, and the greater its shading ability. For instance, to mitigate summer heat, a windows with a lower SHGC would be used, while a high SHGC window can be used on certain elevations for passive winter-time heating. It is important to understand the concept of directionally tuning windows and glass package to optimize solar control, and this very much depends on climate, location, orientation and placement of a building in relation to the sun.

STC Rating: the higher the number the better the window reduces external noise transmission.

Weight per ft: important to keep weight low to minimize wear on operating hardware. Generally, heavier windows can also result in higher installation costs.

Types of Glazing

There are four basic glass options available to choose for your window: single pane, double pane, triple pane and suspended film. Dual pane windows are commonly used but lack the insulating performance found in triple pane windows and suspended film windows. Though triple pane windows exceed the performance levels of dual pane windows, they still can't offer the thermal performance of

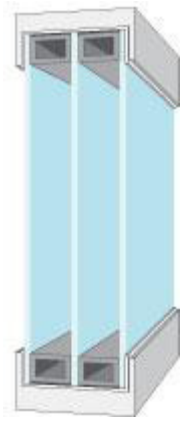
suspended film glazing and can be more than three times heavier. This excess weight causes multiple limitations and issues when it comes to operable windows.

Single pane windows – These windows are very light and low cost. They are composed of a single pane of glass surrounded by a frame. Initially they are the least expensive glass option, but can end up costing more in heating and cooling bills because they do not insulate well.

Double pane windows – Double pane windows consist of two layers of glass with one layer of gas in the middle. They are slightly more expensive than single pane glass but offer a significant improvement over single pane glass in insulating a home and can reduce a home's cooling and heating bill.

Suspended film (SF) – Suspended film technology is one of the best advancements in improving insulating performance of window and glass design. SF has a low-e coated polyester film suspended inside an insulating glass unit creating two to four air chambers that provide exceptional insulation performance that reduces conductive heat and radiated heat, but without the weight and size restrictions imposed by triple-pane insulating glass.

Triple pane windows – Triple pane windows consist of three layers of glass – the exterior glass, a middle layer of gas, and the interior layer glass. Each cavity can be filled with different types of inert gas. Because of dual air chambers this provides, triple pane windows also reduce conductive heat flow better than dual pane windows; however, they do not insulate against radiated heat flow. In addition, because of the extra pane of glass, triple pane windows are much heavier than Alpen Windows. Additional weight puts added stress on the window frame and will compromise the operability and functionality of window fixtures over time.



Low -E Coatings

Alpen Windows' unique framing and super-insulating glass system incorporates a combination of key technologies and best manufacturing practices to deliver high performance. Our super-insulating windows are built with highly insulating fiberglass frames, and spectrally selective Low-E coatings, inert insulating gases and warm edge technology that control temperature gains or losses.

Glass is naturally considered to have a high-emissivity characteristic. To better understand this, think of your morning coffee cup, when you pour hot coffee into a glass cup you can easily feel the heat transfer from the coffee to the coffee mug. This example applies to the glazing in your home's windows as well; in the winter your home's interior heat is transferred outdoors due to the high-emissivity of your window's glass. A similar effect happens in the summer but in reverse, the glass transfers heat from the warm outdoors into your cool home.

What are Low-E Coatings?

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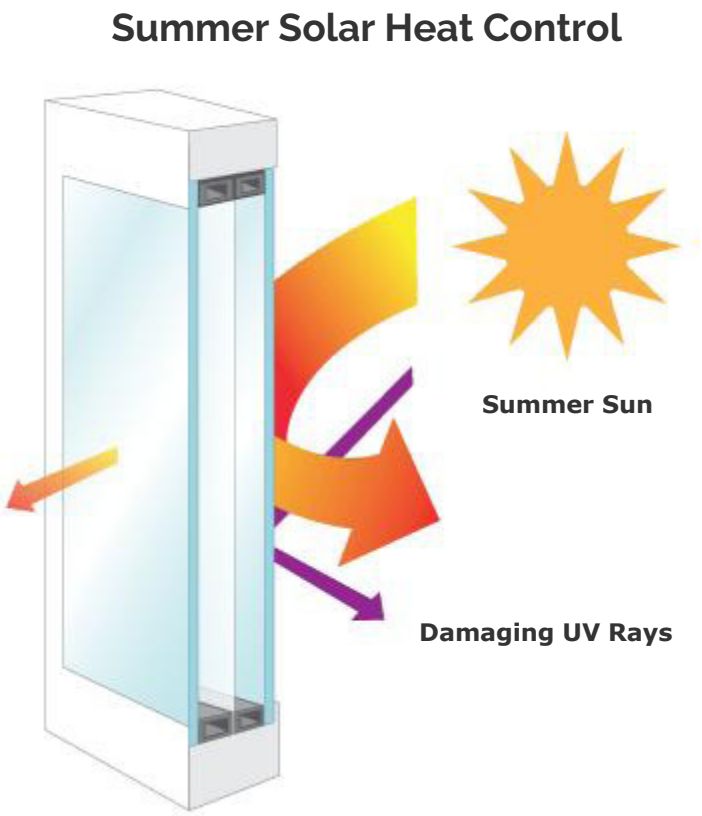
Low-emissivity (Low-E) coatings were created to counteract the natural high-emissivity of the characteristics of glass. In essence, Low-E coatings act as a thermos would for your coffee cup; it helps control where to keep the heat, either indoors in the winter or outdoors in the summer.

Low-E coatings are thin invisible layers that are applied to the glass or suspended film of an energy efficient window. The coating works by reflecting back heat to its source; in the winter the heat is reflected back into the house and in the summer the sun's excess heat is reflected back outside. Low-E coatings are unique in the fact that they can block long-wave infrared heat and UV rays without preventing visible light from passing.



Alpen Windows low-E coatings reflect excess solar heat back outside in the summer and block harmful UV rays

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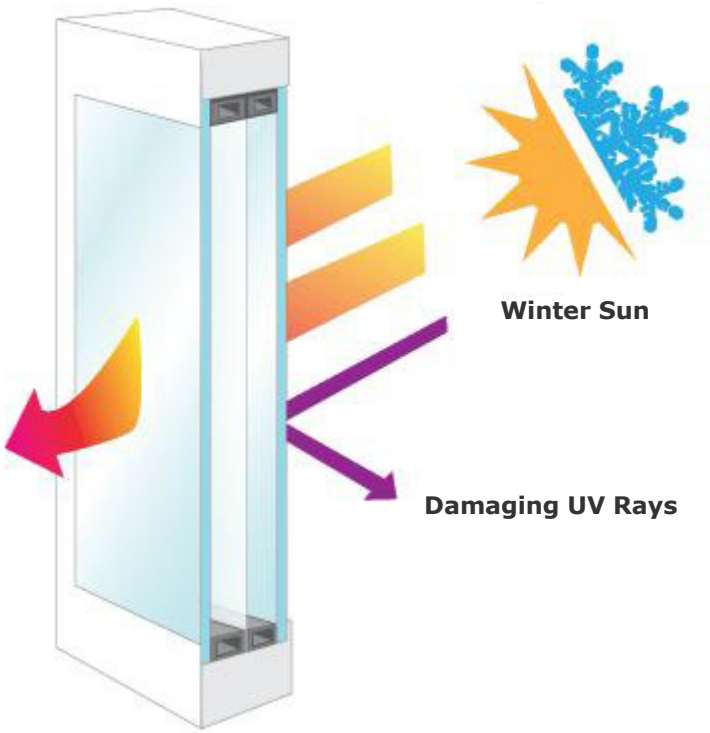
Winter Passive Heating



Alpen Windows low-E coatings allow passive solar heat into your home in the winter while blocking harmful UV rays

There are several types of Low-E coatings that benefit each climate differently. In cold climates like Boston, a home can save more energy if it uses super-insulating windows that maximize solar heat gain in the day and minimize heat loss at night. In hot climates, like Phoenix, the reverse would be true.

Alpen HPP understands that one of the best ways to save energy in your home is by utilizing the appropriate low-E coating and thermal performance for your individual climate and your home's unique orientation towards the sun. Our super-insulating glass packages are carefully engineered to provide optimal performance for a variety of climate zones, so that both energy savings and comfort can be achieved.

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