

How Efficient Are Your Windows?

A Thermal Review of Typical Window Problems Using Thermal Imaging

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Have you ever wondered what one of the most difficult parts of a building to install correctly and maintain? It's not the roof, the siding, or the doors. It's the windows. The doors are important too, but the sheer quantity of windows usually far outnumbers the quantity of doors. Together as a system, the windows raise more questions regarding heat loss and efficiency. Windows provide delightful qualities to buildings in the form of

natural light, ventilation, and architectural splendor. Window glass was made energy efficient with the advent of insulated glass (IG) and low-e glazes. IG windows are filled with atmospheric air and sometimes with a heavy gas such as Argon. Why Argon? Argon gas has a lower thermal conductivity than air, which makes it a primary source for a separation between warm and cold, is inert, and reduces energy transfer from conduction (**Figure No. 1**). Low-e glazes provide a slight tint to the glass and reduce energy transfer from radiation. In an interest of time (and the author's attention span) we will concentrate on conductive heat transfer. More importantly, this seems to be the most common failure mode in IG windows and is readily identifiable with thermal imaging. *(While the author recognizes the myriad of window, glass, and glazing choices that exist today, we will concentrate on the more popular double pane, insulated and uninsulated types).*

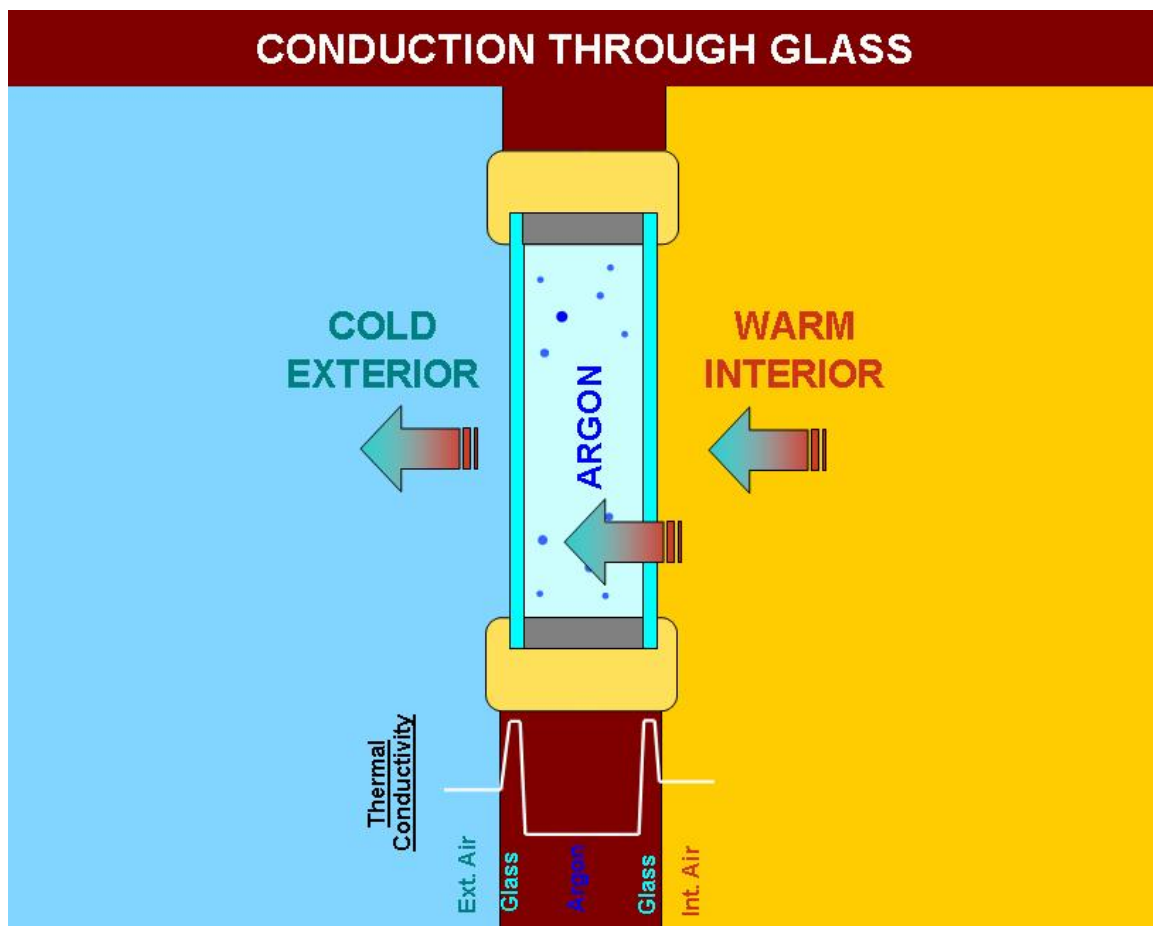


Figure No. 1: Conductive Heat Transfer – Figure showing typical conductive heat transfer through a double pane window. Heat flows from warm to cold. The chart below the window graphic illustrates the change in thermal conductivity across the profile.

Before low-e we had simple double paned windows. Double paned glass has an air space that reduces the heat transfer rate and results in a more efficient window.

While low-e may seem to be the responsible and “green” thing to include in your building, they are only as effective as their seal allows them to be. Air leaking from the between the panes will very quickly reduce a windows’ efficiency and you may never know it; unless you can see the unseen.

Thermal Imaging

Thermal imaging can provide a quick and accurate analysis of the installed windows and their operation. To provide honest results we compare neighboring sets with each other (**Image No. 1**). While temperatures are important, a simple scan will not reveal the true surface temperature. To read a true glass temperature we would need to place a piece of black tape on the glass, wait a bit, and then take a reading. The tape almost entirely removes the reflected type of infrared energy from the background. You see, in the infrared world glass acts as a mirror (**Image No. 3**) or is said to be opaque and visually it is translucent (unless it hasn’t been cleaned in a while) (**Image No. 4**). To further reduce the background effects we need to be as perpendicular to the window as possible. When the window is manufactured the air (whether argon or atmospheric air) is trapped between the panes and sealed. The key term is “sealed”. No seal, no air. Question, what happens when the air is heated and cooled? It expands and contracts, respectively. This process is repeated 24/7 as typically the exterior and interior are at two different temperatures. The sun heats the glass and the air expands. The interior is warmed including the glass and expands the air. When expanded, the pressure inside increases and the panes are “pushed” farther apart; decreasing conductivity (decreased density – increased insulated value). When contracted, the pressure inside decreases and the panes are “sucked” closer together; increasing conductivity (increased density – decreased insulated value). **Image No. 1** shows the panes are being “sucked” in by a small amount (good seals). However, **Image No. 2** shows a patio door with the panes “sucked” very close together (darker middle color). This is typical of a seal failure, which allows an unencumbered amount of

air to be let in and out from between the panes. The only clear way to fix this is replace the glass unit with new.

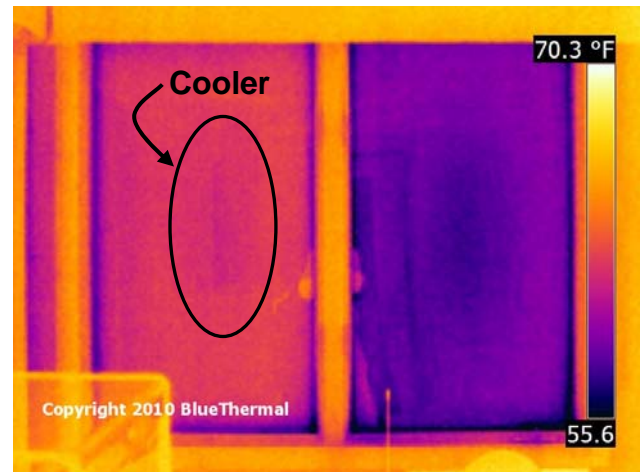


Image No. 1: Double window set thermal image

– A thermal image of a double casement window set approximately twelve (12) years old. The glass in the window on the right is much cooler than the glass in the left window. The image was taken when the exterior temperature was 49°F and the interior was 68°F. The insulating gas between the glass panes on the right is gone and replaced with atmospheric air. This window was also cooler to the touch than the left.

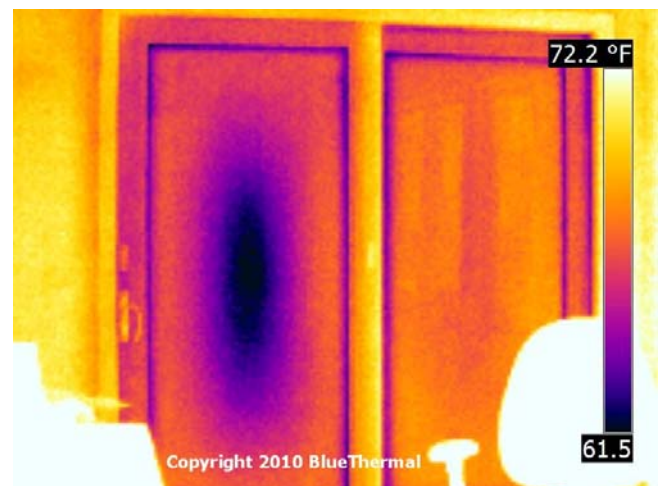


Image No. 2: Seal failure in a patio door – This image shows what a failed air seal can look like with a thermal camera. Notice the left side of the door. The middle portion of the glass is much cooler than the surrounding edges. Since the glass is reasonably flexible, the contraction (expulsion) of the air forces the panes to be “sucked” closer together and is also a function of the glass’ length. The area is longer up and down than side to side, because of the length versus width aspect of the door.

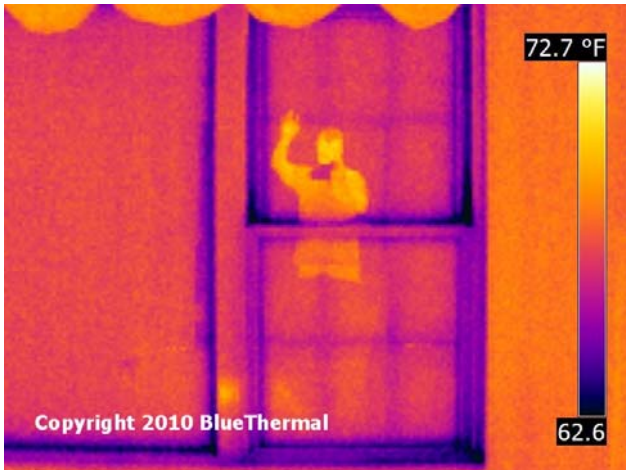


Image No. 3: Reflection on window – A thermal image of a window showing the author’s image reflected on the glass. This is an example how background infrared energy (or heat) affects our results.



Image No. 4: Visual of same window – A typical visual picture of the same window. Notice, no reflection.

When condensation exists between the panes of glass, the insulating quality is no longer effective. Having moist air between the panes is a lot like having water in your gas tank. Your car may run, but not very well.

If the windows are old, made of wood sashes, and are rotten, they are probably not energy efficient. Energy efficiency goes out the window (no pun intended). As the sashes rot and age, they fall out-of-square, loosen, warp, sag, don’t open, and so on. Gaps can form becoming simple conduits to the

outside. **Image No. 5** shows a seal failure around the windows from worn old sashes. Look at the hot areas around the perimeter. The window may as well be opened if this is what occurs. If warm air can leave, cold air can come in; bringing moisture with it. Condensation then forms on the first surface and is typically the sash or the glass (depending on location).

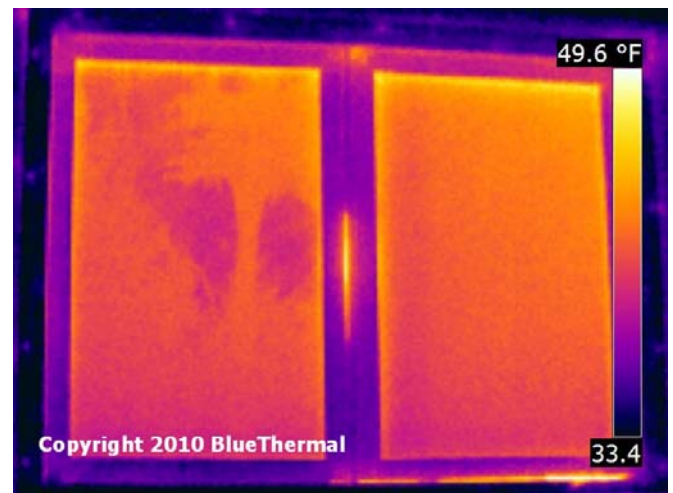


Image No. 5: Sash seal failure – Notice the warm areas around the perimeter of the right sash of this casement window set. The window is in a locked position. The image was taken from the exterior with an air temperature of 40°F and an interior temperature of 72°F.

What do leaky glass and window seals, bad sashes, and condensation have in common? Dollars. Simple answer, but not simply repaired. Not being able to see the unseen energy losses costs money.

Prior to thermal imaging the only way to detect seal failures was to observe the window. But observe what? You will see condensation between the panes, on the sashes, or feel a cold breeze. Instead of turning up the heat to compensate for the energy losses – why not find the source? Image numbers 1 and 2 were never discovered by the owners until they were made aware by the imaging. It was obvious to them after being shown the results. Building owners can save a lot of money over time, by finding problems now, and solving them quickly.