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## Condensation in Double-Paned Windows

Double-pane windows are susceptible to a form of deterioration in which the window develops an area of condensation between the glass sections. This is sometimes referred to as a “Fogged” window. As Industry Professionals, it is helpful to understand the causes and nature of this type of window damage.

Condensation is defined as “*The accumulation of liquid water on a cold surface*”. Most air contains at least some degree of water vapor, with higher concentrations of vapor present in areas of high humidity. Water vapor is the gaseous phase of water and is composed of tiny water droplets.



Double-pane or “thermal” windows are constructed with a quantity of gas (usually argon) that is trapped between the two panes of glass. This trapped air acts as insulation to reduce heat loss through the window. Some windows may also have a thin film installed between the panes, further reducing heat loss / gain through the window. If multiple-pane windows appear misty or foggy, it usually means that the seal protecting the window assembly has failed.

### Silica Desiccant

Silica desiccant is an absorbent material that is designed to prevent moisture accumulation. In a double-paned window, silica pellets inside an aluminum strip at the perimeter of the window frame absorb moisture of any incoming air that enters the space between the panes



## **Quick Fact**

Silica gel has an absorbency factor of approximately *7,200 square feet per gram*. This property allows it to absorb large amounts of water vapor.

## **Desiccant Strip Failure**

As the seal or sealant (sometimes referred to as the “Thermal Seal”) of a window frame begins to fail, moist air enters the space between the panes, and the silica pellets (or “Desiccant Strips”) become saturated. Eventually, the pellets or strips are unable to prevent the accumulation of condensation. This results in condensation buildup between the glass panes.

## **Solar (Thermal) Pumping**

Although window frames are rigid, double-pane windows actually experience a daily cycle of expansion and contraction. This results in what is known as “Thermal Pumping”.

Sunlight on the window during the day heats the airspace between the panes and causes any gas between the panes to expand, increasing the pressure in the space between the panes. When the window cools at night, the opposite occurs and the pressure decrease causes contraction. This phenomenon is known as *Thermal Pumping*.

Over time, the constant pressure fluctuations caused by thermal pumping will stress the window seal, eventually causing small fractures in the seal that slowly increase in size, allowing increasing amounts of moisture to accumulate in the space between the panes.

## **Failure Factors**

Windows on the sunny side of a dwelling or building can experience larger temperature swings than those on an area with lots of shade, resulting in greater amounts of thermal pumping, seal stress, and subsequent failure.

Vinyl window frames have what is known as a *high coefficient of expansion* which causes greater long-term stress on the double-pane assembly. This subsequently causes this type of window to failure earlier than other types.

“Batch Failure” describes a defective production lot of windows in which the pane assemblies have been manufactured with defective seals that result in premature failure of the window.

## **Damage Caused by Condensation Buildup**

If allowed to continue, window condensation can ultimately lead to irreversible physical window damage. This damage can manifest itself in the following ways:

- *Riverbedding*: This is caused by condensed water vapor between glass panes forming water droplets that run down the length of the window that carve small grooves into the glass surface. This is essentially an “erosion” of the glass material over time.

- ***Silica Haze***: Once the silica material in a window frame is completely saturated, it slowly erodes and results in an accumulation similar to white-colored “snowflakes” on the window surface.

## **Failure Detection Methods**

Although visual detection methods are the most reliable, condensation is not always visible.

***If the failure is recent, a failed window may not be obvious, since condensation doesn't usually form until the window is heated by direct sunlight numerous times.***

Under the right conditions, it is possible to use infrared / thermal imaging equipment to detect failed windows. This type of equipment is designed to record differences in temperature, which can be helpful in failure detection.



## **Recommendations for Failed Windows**

***In most applications, the window insert (dual glass pane assembly) can usually be replaced without complete removal of the entire window.***

Although there is still some debate as to the suitability of the following type of repair, some window repair companies make the claim that windows that have developed condensation between the glass panes can be repaired through a process called “De-Fogging”.

This type of repair method can be described as follows:

1. A hole is drilled into the window, usually from the outside, and a cleaning solution is sprayed into the dead-air chamber between the glass panes.
2. The remaining solution (and all other moisture and foreign matter) is sucked out using specialized vacuum equipment.
3. A small “De-fogger Device” is then permanently inserted into the drilled hole that will allow the release of moisture during thermal pumping.

There is currently a debate as to whether this process is a suitable repair for windows that have failed, or if it merely removes the symptom of this failure. Condensation appears when a window seal is compromised. Condensation removal does not repair the failed seal. Although absent of condensation, this type of repair fixes the symptoms not the cause of failure. Opinions regarding the effectiveness of this type of repair vary widely.

**As always, consultation with a licensed, certified window specialist is always recommended in order to determine the best course of action for repair or replacement of condensation-damaged windows.**