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Kaboom!

There Goes Another Argon-Filled IG Unit

The Scope of the Problem:

Imploding Glass, a rare occurrence in the past, is becoming more common. Pat Burton is the general sales manager of Northern Michigan Glass, a wood window and door retailer based in Traverse City, MI. Over the past few years he has noticed a disturbing phenomenon: random, apparently spontaneous implosion of argon gas filled low-E insulating glass. Units have been reported to shatter with a bang, sometimes described as loud as a gun shot. While the broken glass usually stays within the unit, on at least one occasion glass has shattered with enough force to send glass shards flying outward.

Imploding glass used to be a rare phenomenon. But Burton finds it is becoming more common. He says he has not only seen this kind of breakage with his own products—but in performing glass replacement work for other window retailers. In fact, he believes the problem is widespread.

The imploding units are always small in size, and made of single strength or double strength annealed glass. These are the kind of units you would find in a door transom, or a true divided lite window. The glass breaks at different times of the year, but seems to break more often during colder weather. Although he has just started to track the incidents to get better data, Burton feels the problem is showing up in argon filled low-E units produced four or five years ago.

"We’re not just talking about one glass supplier. The problem seems to affect everybody’s product," he said. "You can notice there’s something going on by looking at almost any argon filled unit that’s been around for a few years. You can see the glass bowing inwards from the distortion in the glass surface."

Burton has two theories about this. "I remember years ago, there were problems with too much desiccant in units, drawing out the nitrogen. That caused units to distort the same way. And we know that argon can escape from units. Can it get out without air getting back in, to equalize the pressure?" said Burton. He’d like to know what the experts think.

Argon Adsorption

Desiccants can contribute to some argon depletion in a unit, but the effect is not progressive. In his article "Desiccant Selection" *(See February 1999 USGlass)*, David Darwin, technical service manager–adsorbents, of Grace Davison Co. of Baltimore, MD, explained how some molecular sieve desiccants adsorb nitrogen in air-filled units, and argon in argon-filled units. Can this contribute to glass breakage?

Darwin puts it this way: "The greatest effect on gas pressure inside the unit is caused by temperature, according to the "Ideal Gas Law." As the unit heats up, the pressure rises. When it cools, the pressure drops. Compared to this, the pressure changes due to desiccant adsorption are not usually great. Low-deflection desiccants like 3A molecular sieve and silica gel can add as little as five percent to the pressure change caused by temperature alone. Molecular sieves with larger pores like 4A or 13X adsorb gas more readily, and can add as much as 30 percent to the pressure change caused by temperature alone. Clearly, desiccant selection can be a contributing factor, especially when gas adsorbing desiccants are used."

Most unit manufacturers have adopted low-deflection desiccants, containing only 3A molecular sieve or blends of 3A and silica gel, to minimize both the initial argon dilution and the temperature-related gas adsorption/desorption effects.

Argon Escape

February's meeting of the Sealed Insulating Glass Manufacturers Association (SIGMA) focused industry attention on the issue of long-term argon retention. It is now recognized that all insulating glass sealant systems are somewhat permeable to gases. Bob Spindler, Cardinal IG's director, product development group, explains, "it's about partial vapor pressures. Air is approximately 78 percent nitrogen, 21 percent oxygen, and 1 percent argon. When you fill an IG unit with 90 percent or more argon, two things happen. The argon in the unit is under a partial pressure to escape, while nitrogen and oxygen are trying to get in. The individual gas pressures are trying to equalize."

Preliminary research indicates that argon travels through some sealants faster than nitrogen or oxygen. Ideally, a sealant would allow air (which is mostly nitrogen and oxygen) to enter the unit at the same rate the argon is escaping, and would have an air to argon exchange rate of 1:1. Some insulating glass sealants have air to argon exchange rates as high as 1:2, 1:3, or more. This means argon may be escaping up to three times faster than nitrogen and oxygen can replace it from outside the unit. The result? Progressive negative deflection of insulating glass units over time.

"It is clear there needs to be more research on gas migration through different sealants and different edge seal systems," said Spindler, who was one of the presenters at the SIGMA meeting. "At Cardinal we'd like to see an industry standard that specifies minimum argon fill levels, and that limits air-argon exchange to less than 1 percent per year. IG certification programs also need to address the issue of argon fill levels and air-argon exchange rates." At present there are no U.S. standards for initial argon fill level, or for the rate of air-argon exchange.

Negative Pressure Breakage

Can excessive negative pressure cause insulating glass units to break? "Yes," said Spindler, "but it is usually only one of the two lites that breaks. And since the glass panes are deflected toward the air space during breakage, the glass particles almost always remain in the opening." Spindler added, "it is not unusual for the glass fracture to sound like a loud bang. This loud noise is associated with the glass stress being relieved when fracture occurs and should not be construed as a dangerous situation."

There are several factors that can cause negative pressure in an IG unit. It is well known that installing units at elevations much lower than the elevation of an insulating glass plant can cause an initial negative pressure condition.

Weather related factors play a greater role. Cold outside air temperature will not only reduce the gas pressure in a unit, but will also increase the adsorptive effect of the desiccants. Daily changes in the barometric air pressure also affect the unit, sometimes increasing the external pressure on the unit, sometimes decreasing it. However, weather related factors are cyclical. They do not lead to a progressive loss of gas pressure within the unit.

We now know that long-term argon escape, when it occurs, can progressively reduce the pressure within a gas filled unit over time, adding to the effect of the weather related factors.

All of these factors can act together to impose significant structural loads on the glass. "While one load may sometimes cancel another, they can also act together on occasion and raise the total glass stress to the breaking point," said Chris Barry, manager of architectural technical services at Pilkington-LOF. "Of all these unavoidable loads, the effect of temperature is the greatest."

Size can affect the likelihood of breakage. In a larger unit, the low air space pressure is relieved by the spring-like action of the glass panes dishing in. In a narrow unit, the glass cannot deflect as readily in the short direction, and is more likely to break.

"For 1/8-inch glass, the worst sizes are those with a short dimension of 10-20 inches," said Barry. "The glass along the short dimension may not be flexible enough to move and relieve the air space pressure change, and it may not be stiff and strong enough to contain the pressure differences."

Replacement Units

As Burton has noticed, larger window units don’t break from negative pressure, because the larger glass panes are more flexible. And door lights don’t seem to break, because they’re tempered, and therefore stronger. Would it be a good idea to temper or heat strengthen replacement units?

"Heat treating the glass will definitely strengthen it, reducing breakage from all causes," said Spindler, "but it would be up to the customer to ask for that when ordering replacement units that have failed in this way." Barry thinks heat treatment may not be necessary, since many manufacturers have learned to make units that are better at retaining argon. Spindler agrees. "We certainly believe that for the most part, the industry today is making units that are far less likely to have a collapsed air space." He also offers this advice: "Work together with your window or glass supplier to find the best way to resolve issues dealing with glass breakage and replacement."

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SIDEBAR:

Canadian Argon Standards

While there is no U.S. standard for initial argon fill level, Canada has had one since 1997. CAN/CGSB-12.8-M97 specifies a minimum initial fill concentration of 90 percent. The Insulating Glass Manufacturers Association of Canada, has included testing for argon gas concentration as part of its certification program since the fall of 1997, according to Robert H. Rivard, executive director.

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