TECHNICAL BULLETIN

TRUSEAL
FLEXIBLE SPACER TECHNOLOGIES

TOPIC: Glass Washing Issues and IG Failure Analysis

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From IG failure investigations and customer quality audits, we have found an association between detergent residues on improperly cleaned glass and insulating glass failure. This may be a recurrent problem against which **immediate** steps must be taken toward its elimination. This bulletin will help to identify key problem areas in the glass washing operation and provide simple analysis techniques to detect whether detergent contamination is a factor to insulating glass failure.

No sealants, including both insulating glass and glazing sealants, will stick reliably to detergent - contaminated surfaces, especially when the bondline is in contact with water. Detergent contamination alone is not likely to cause a loss of adhesion in the short term. However it can cause extreme water sensitivity, highlighting again the need for glazing designs that keep water out of the glazing pocket.

A simple way to reduce the risk of detergent contamination is use as little as possible or to cease using it completely. Cleaning action on typical washers is primarily mechanical (brush action) and the contribution of detergent to cleansing effectiveness is minimal. New glass is generally perfectly clean except for interleaving powder that is easily removed with clean water alone. This advice is not intended to preempt recommendation for judicious detergent use by other stakeholders such as glass suppliers.

1.0 GLASS WASHING

1.1 THE PROBLEM

Detergent contamination occurs when detergent laden water is blown off glass surfaces by the air knives of a glass washing machine. To understand this better, imagine a small droplet of contaminated water blown along the glass surface. As it moves across the glass surface, it slowly evaporates until no water is left. A trail of contaminants is all that remains. The same happens as dirty rinse water is blown off the glass surface. A thin film of contaminants (most likely made up of mainly detergents) will be left across both glass surfaces. Such thin detergent films are often invisible to the naked eye, even under bright lights as are usually installed at the washer exit for inspection purposes.

The only way to prevent contamination when detergent is used in the wash water, is to provide a reliable and ample supply of **clean** rinse water.

1.2 RINSE SYSTEMS

Most machines have a two-stage rinse operation where glass washing is followed by rinsing with clean recirculated water that, in turn is followed by a final rinse of fresh (not recirculated) water. The recirculated rinse section is on all the time and, as a water conservation measure, the final fresh water rinse is switched on only when glass passes through the machine. Water from the final rinse is fed back into a recirculating rinse tank that is constantly overflowing into a drain when the machine is operating. This backflow is critical to keeping the recirculating rinse water clean, especially when detergent is used in the wash water.

Other systems have one or two "direct supply" rinse sections without water recirculation. Water flow to the rinse section on these machines generally only switches on when glass passes through the machine, and is off the rest of the time.

When both types of rinse systems are functioning properly, glass contamination, in practical terms, will not occur. **Glass contamination happens only when equipment malfunctions or is improperly used.**

Sufficient flow of fresh final rinse water should always be available back to the recirculating tank such that froth does not accumulate or persist on the water surface. When inspecting a machine for proper operation, a quick glance at the surface of the recirculating rinse water provides immediate indication on the condition of the rinse system. Any froth on the water surface suggests inadequate water supply from the final rinse. An advantage of recirculating systems is that should the final rinse fail to switch on, it will take some time to contaminate the water in the reservoir to an extent that sealant adhesion is affected.

2.0 A TEST FOR WATER CLEANLINESS & ABSENCE OF DETERGENT

Water cleanliness can be tested by agitating the water with your hand or taking a sample in a clean jar and shaking it. In both cases, bubbles or froth produced by the agitation should disappear within a few seconds. When using a jar, put some clean tap water in a second jar, shake, and compare to the rinse water. Bubbles and froth should disappear in the same interval in both jars.

Water in the recirculating rinse tank must always be clear. Any haze, milkiness or froth suggests that contaminant levels are too high.

2.1 REQUIRED ACTION IF WATER IS CONTAMINATED

If the water in the recirculating rinse tank is not clear or if froth is seen when tested as described above, the tank should immediately be drained, cleaned and refilled with fresh water. The cause of contaminant build up must be established and eliminated.

Recirculated rinse water gets excessively contaminated when the flow of fresh water from the final rinse is too small, somehow interrupted or nonexistent. Also, excessive transfer of soapy wash water to the rinse section or the use of too much detergent will raise contamination levels.

3.0 TESTING GLASS CLEANLINESS

Four very simple tests can be used to assess glass cleanliness. Three of them, if used regularly and acted upon, would probably eliminate adhesion problems due to glass contamination.

3.1 GLASS TEST NO.1----------THE VISUAL CHECK

We sometimes need to be reminded of the obvious, so here it is! If any contamination is seen on the glass, measures must be taken to eliminate it. Contaminants that show up in a visual inspection will most likely prevent durable adhesion. A customer would probably complain or reject the window on spotting such contamination. Generally, insulating glass manufacturers effectively screen their production at this level of quality, i.e., if it can't be seen, it is not a problem.

3.2 GLASS TEST NO.2----------THE FOG TEST

Detergent films can be invisible to the naked eye, so we need simple, on-line methods to make them show up. One of the simplest has been around for a long time and promoted by glass manufacturers such as PPG. When fog or mist forms on glass, it will show up non-uniformity of residues on the surface. This is often noticed on your bathroom mirror where streaks (and sometimes messages) reappear every time the mirror fogs.

To get glass to fog, the simplest way is to hold it over steam rising off the glass washing machine, for example, around the hot washing section. The colder the glass, the more likely that condensation will occur and the longer it will last, permitting examination.

Also, a refrigerator can be used to chill the glass below the ambient dewpoint temperature. On removing the glass from the fridge, water vapor in the air will condense on the glass producing a fog.

Look for any signs of nonuniformity in the fog. Streaks, droplet outlines and trails, and fingerprints are just a few of the features that may be observed. If the glass is clean, the fog will be absolutely uniform.

3.3 GLASS TEST NO.3----------THE "RINSE and FROTH" TEST

Detergents dissolved in water, will froth and produce suds when the liquid is agitated. This property can be used to our advantage to test for glass cleanliness.

Pry open the final corner or even simpler, punch a hole through the IG seal with an awl or small screwdriver. With the IG unit stood on end, pour clean tap water into the hole until it is about 6mm deep. By manipulating the IG unit, run the water all over (i.e. rinse) both interior surfaces of the glass. The purpose is to pick up any water-soluble contaminant and detergent residues that may have been deposited on the glass surfaces.

When checking a small unit, slosh the water back and forth within the IG unit in an attempt to produce froth. On larger IG units, transfer the rinse water to a clean jar that is easier to shake. Another advantage of using a jar is that a second one can be filled with an equal amount of clean tap water and used as a control. Bubbles in the clean water will disappear when shaking stops providing an effective comparison. Detergent residues on the glass, will show the difference due to the suds' action.

3.4 GLASS TEST NO.4----------THE CONTACT ANGLE TEST

An excellent "Technical Brief" on glass cleanliness is published by the Insulating Glass Manufacturers of Canada (IGMAC) and includes an explanation of what a contact angle is. Water should lie very flat on clean glass but will and bead up on contaminated glass. However, detergents reduce surface tension and therefore, contact angles as well. As judged by contact angle, the presence of a detergent film will give the same appearance as very clean glass. Thus, contact angle is not a good test for detergent contamination, but is very useful for other types of contamination and customers should be encouraged to use it.

4.0 ADDITIONAL COMMENTS

4.1 Not all detergents produce the same amount of froth. In fact, low suds action is a much-touted feature of some products. It follows that even if almost no froth is observed after shaking a sample, detergent may still be present. Froth and suds prove something other than clean water is present. When we see no froth or suds, it does not prove the absence of contaminants.

4.2 When doing the rinse test, if the IG unit was sealed for some time, detergent residues may be very difficult to dissolve. When your result is “no froth,” wait 15 minutes to allow the water to dissolve the detergent. Rinse the glass again (preferably with the same water) and shake.

4.3 Even if detergents are not used in the glass washing operation, the wash tank will accumulate any dirt or glass interleaving materials removed from the glass. Detergent contaminants can be found in these materials. Therefore, the rinse test may sometimes produce a “froth” result even if detergent is not used in the glass washing machine.

5.0 INSULATING GLASS FAILURE ANALYSIS

Usually, one has deglazed units because the IG unit has failed but, on occasion, good units are available. In nearly all cases where we witnessed deglazing of failed units and examined the glazing pocket, water contact (or evidence of it) with the IG seal was obvious. Invariably, adhesion loss occurs at the point of water contact. Remember that when an IG unit fails by adhesion loss due to contact with water, the expansion and contraction of the airspace will end up sucking the water (and all the contaminants it contains) into the airspace. Water gets sucked in as the IG units cools and air gets blown out as the unit warms up causing an accumulation of water between the panes, and such an IG unit is sometimes referred to as a “fish tank”.

Let’s say a rinse test was done on a IG failed unit and froth was present. The question arises whether the froth producing contaminants were present on the glass before the failure occurred, or whether the water entering the IG airspace via the breached seal introduced the contaminants. It follows that when taken from a failed unit, we should treat a froth result with caution.

When assessing glass cleanliness on a failed IG unit, the cleaner the glazing pocket, the less likely it is that contaminants were introduced into the airspace after failure. A froth result from a good IG unit that has not failed is an unequivocal statement that the glass was contaminated with some sort of detergent, probably the one used to wash the glass at the time the IG units was manufactured.

5.1 FAILED IG--GLASS CLEANLINESS TEST NO.3 (from above)— "RINSE and FROTH" TEST

5.1.1 Turn the unit upside down so that the sill area is at the top. Prolonged water contact with the bondline usually causes adhesion loss that mostly happens at the sill. We do not want the rinse water to run out of the IG unit as we do the test. We keep the water in the head area of the IG unit where the sealant not been subjected to prolonged water contact.

5.1.2 Punch a hole in a corner with a sharp object such as a screwdriver or awl.

5.1.3 Using a squeeze bottle with a fine tip or other appropriate means, inject the airspace with water to a depth of about 6mm.

5.1.4 Run the water over both glass surfaces.

5.1.5 Stand the unit on end and let the water gather. Slosh the water in the IG unit or drain into a clean jar and look for froth. If the airspace was dry before introducing the water, the increased relative humidity is likely to cause a fog to form on the interior glass surfaces. Look for patterns caused by poor glass washing as described in the Fog Test (Glass Test No. 2) above.

Sometimes, the airspace of a failed IG unit is dry after deglazing, despite showing fog during the cold season. This happens when the glazing pocket dries out before the adsorption capacity of the desiccants are exceeded. The residual desiccant capacity scavenges sufficient moisture such that condensation no longer occurs at the warmer temperature.

We have noted that when doing the rinse test on “dry” units (failed or good). It may take a while for the water to dissolve any detergent residues on the glass. So, when “dry” units are tested, run the water over the glass, slosh it and check for froth. If you see little or no froth, wait 15 minutes and repeat this step.

5.2 IG--GLASS CLEANLINESS TEST NO.2--DEWPOINT ANALYSIS

As discussed earlier, the simplest method for revealing glass cleanliness is by producing a fog on the surface and examining it for non-uniformity. On a good (not failed) IG unit this is difficult because one can expect the dewpoint (frost point) to be below -40° C (-40° F). Special equipment is required to reduce the interior glass surface (surface nos. 2 & 3) to such low dewpoint temperatures.

Such equipment is generally only available in the laboratory. When we do the dewpoint test, the only information we seek is the temperature at which the onset of fog occurs on the glass surface, airspace side. Having produced a fog, it follows that one can examine the texture of the fog spot for signs of non-uniformity that suggests faulty glass washing. This is based on observations made in the lab while checking the dewpoint of a good IG unit (not failed but badly contaminated with detergent as determined by a subsequent rinse test) taken from a site where abnormally high numbers of IG failures occurred.

Remember that careful examination under good lighting and a dark background is required.

This is a nondestructive test but can be followed by the rinse test to provide confirmation of the visual result. Extending the standard dew point test to include a record of the visual observation of fog spot texture may be useful.

6.0 BEWARE OF THE “DOUBLE WHAMMY”

Note that when detergent contamination occurs, both surfaces of the glass will be contaminated. It follows that if interior and/or exterior waterproofing of the glazing cavity is done using sealants that are meant to adhere to the glass surface, that bondline will be also be weakened by the detergent contamination, especially in the presence of water. The double whammy occurs when waterproofing fails, allowing water into the glazing cavity. Now, water that should have been kept out contacts the IG bondline(s) causing premature seal failure.