IGMA/NGA Compatibility Testing of Glazing Materials Related to the Performance of Polyisobutylene in Insulating Glass Units
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The scope of this GIB is to provide information on compatibility testing of glazing components. Glazing system components include, but are not limited to, setting blocks, glazing sealants, spacer materials, shims, and backer rods (see Figures 1 and 2).

Potentially incompatible materials coming from the glazing components include, but are not limited to, plasticizers, off-gas vapors, oils, solvents and other organic components commonly used in proximity to, or in contact with, insulating glass units (IGUs) containing Polyisobutylene (PIB) primary sealant.
PIB performance during use may be affected by factors such as UV light, heat, and/or diffusion of incompatible materials throughout the entire glazing system. Several factors can lead to migration of PIB or an incompatible material beyond the sealant sightline that may have negative effects on the IG perimeter seal performance including loss of adhesion and/or compromised moisture barrier or gas retention properties as well as negative aesthetic effects. One of these factors is the incompatibility of the PIB primary sealant and other glazing materials used in the glazing system cavity.

Three documents that address glazing system compatibility are the ift Rosenheim GmbH Guidelines DI-01 and DI-02 *The Usability of Sealants* and ASTM C1087 *Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems*.

This document provides validation for and suggestions on quantifying the ift Rosenheim GmbH “Three-Compound Test” as well as reviews the ift Rosenheim GmbH “IGU Test”. Both tests directly assess the effects of incompatible glazing materials on polyisobutylene (PIB) primary sealants.

**Ift Guidelines DI-01 and DI-02**

Available from ift Rosenheim GmbH (www.ift-rosenheim.de), these two documents specify methods for testing glazing system components that come into direct or indirect contact with each other. Guideline DI-01 discusses testing of materials in contact with the edge seals of insulating glass units and Guideline DI-02 involves those that contact the edge of laminated glass. With respect to PIB compatibility, the ift test procedures in DI-01, sections 4.1 and 4.3 determine if certain materials can be combined “without negative interactions having a detrimental effect on the function of the component”. There is also a Peel Test (P2), which is not considered since it does not involve the primary sealant.

**Three-Compound Test P1 (Section 4.1)**

Intended to serve as a test for incompatibility damage that would appear relatively quickly (i.e. short-term incompatibility), the “Three-Compound Test P1” (section 4.1) provides useful information on effects of migrating components from secondary and glazing sealants into the PIB through direct and/or indirect contact. Component migration in a glazing system is not limited to components that touch each other – materials seek equilibrium and will diffuse throughout the edge seal (Figure 3).

![Figure 3 – Depiction of materials migrating to other components in indirect contact.](image-url)

Round Robin Testing
The ift Rosenheim GmbH guideline describes a test sample setup wherein the volumetric ratio between sealants is not representative of the conditions present in a glazing system. Additionally, the test is run for 28 days at 50°C (122°F). A design of experiment was run to determine if volumetric ratio and/or test temperature would affect the results of the test. The test was carried out using the ift protocol as a control, with additional variants modifying the volumetric ratio of PIB to secondary sealant to glazing sealant as well as increasing the test temperature from 50°C to 70°C (122 to 158°F). These experiments were performed with a known compatible and incompatible glazing sealant. It was hypothesized that the increased volumetric ratios and temperature should allow for faster determination of incompatible materials. An example of the sample construction and a test sample matrix can be found in Figures 4 and 5, respectively.
The samples were prepared and aged per the ift guidelines with the secondary and glazing sealants indicated. Samples were visually evaluated as instructed in the guideline, with additional evaluation performed via a modified cone penetration test (modifications were: 150g cone with penetration time reduced from 5 seconds to 2.5 seconds) and dynamic mechanical analysis (DMA) to quantitate differences in rheology. It was found that visual observations aligned well with penetration data except in samples 2.4 and 2.6, which were aged at 70°C and showed no visual disturbances but increased cone penetration (see Figure 6). The DMA data (not shown) corroborated this observation, showing a diminished effect on viscosity reduction with increased aging temperature, contrary to the hypothesis proposed. Although further chemical characterization would be helpful, it is believed that higher conditioning temperature favors volatilization, rather than migration, of the low molecular weight components that tend to cause softening of the PIB.

With respect to the changes in volumetric ratios, it was observed that the ift control sample (sample 2.2) showed the most pronounced effects from the incompatible silicone. Sample 2.5, with a larger glazing silicone bead, shows a similar effect. The rest of the samples utilizing a thinner PIB film and thicker secondary sealant film (to better represent the smaller PIB bead against the larger mass of secondary sealant as present in an IGU) did not show softening from indirect contact with the incompatible glazing sealant. This is likely a physical issue such that the migrating compounds from the incompatible silicone take longer to diffuse through a thicker secondary silicone film.

<table>
<thead>
<tr>
<th>Sample #</th>
<th>PIB appearance after 4 weeks</th>
<th>150g Cone Pen @ 23°C, 2.5 sec (dmm)</th>
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Figure 6 – Visual observation and cone penetration hardness of tested samples. Column A- control, Column B- direct contact, Column C- indirect contact.
Based on these data, the hypothesis that an increased temperature and more “realistic” volumetric ratio between PIB, secondary sealant, and glazing silicone will lead to more severe incompatibility results is not supported. It was found that cone penetration, which can be easily run on the ift-recommended PIB film thickness, is a simple and effective way to quantitate effects on the PIB film. Note that cone penetration time was halved from 5 seconds to 2.5 seconds in order to be able to test 1/8” thickness PIB samples. However, shortening the penetration time makes the test less accurate. Therefore, it is recommended that future testing use ½-inch PIB thickness so that a standard 5 second cone penetration can be performed.

Conclusion

The results of this study support the use of the ift guideline as written to study short-term incompatibility – with cone penetration as an optional additional evaluation tool. This recommendation comes with the caveat that this “Three-Compound Test” represents a severe scenario, with a large amount of incompatible compound and small amount of silicone that could potentially “defend” the PIB, and is intended to be used in conjunction with the longer-term tests also present in the ift guideline.

Test on IGU with Test Material in Contact (‘IGU-Test’) P3 (Section 4.3)

The “IGU Test” found in section 4.3 of the ift guideline is intended to serve as a companion PIB compatibility test to the “Three-Compound Test” described above. It is a longer-term test (24 weeks of climate cycling) that tests the entire IGU, using units with no glazing material applied as a control and units with a 10mm thick bead of glazing sealant applied on the edge for test units. If the intended end use of the IGU includes an exposed edge condition (e.g. structurally glazed), the test units are also exposed to UV.

After testing, the PIB primary sealant is visually assessed for softening, adhesion, or other irregularities (refer to the ift standard for details). Butterfly testing and/or additional analytical work may be helpful to the evaluation.

Third Party Test Labs

This list, though not exhaustive, includes laboratories that may be able to provide the ift Guideline DI-01/1 testing services and a report:

- Intertek (www.intertek.com)
- Chemir/EAG (www.eag.com)
- ANALYZE Inc. (www.analyzeinc.com)
- Akron Rubber Development Laboratory (www.ardl.com)

Disclaimer
Specific installation practices and varying but unknown and unknowable environmental conditions to which the IG units will or may be exposed after installation may affect compatibility beyond those observed in the testing results.

References

1ift-Guideline DI-01/engl/1 “The usability of sealants Part 1, Testing of materials in contact with the edge-sealing of insulating glass units,” ift Rosenheim, Rosenheim, Germany, www.ift-rosenheim.de

2ift-Guideline DI-02/engl/1 “The usability of sealants Part 2, Test of Materials in contact with the edge of laminated glass and laminated safety glass”, ift Rosenheim, Rosenheim, Germany, www.ift-rosenheim.de


IGMA TM-3100-09 Voluntary Guidelines for the Identification of Visual Obstructions in the Air Space of Insulating Glass Units

TR-1000 Voluntary test method for chemical effects of glazing compounds on elastomeric edge seals

NGA FB27-11 Guidelines for the Appearance of Insulating Glass Unit Edges in Commercial Applications at the Time of Installation