Material compatibility around insulating glass

Insulating glass sealant, Glazing sealant, Blocks

Contents

1. Introduction

Insulating glass is being used increasingly these days in more and more complex applications. Thus, the edge sealing materials come in contact with numerous other materials, so that under certain circumstances, harmful interactions cannot be ruled out. These harmful interactions affect the function of the total system consisting of insulating glass and construction. The following technical information explains the basics, causes, remedies and testing possibilities of such incompatibilities.

It also explains the responsibilities for the designs / constructions as well as the obligation of providing information, and the legal and technical consequences arising there from.

2. Basics

The compatibility of materials is defined in the German Standard DIN 52 480 “Joint and Glass Sealings – Concepts”

“Materials are compatible with each other if no harmful interactions occur between them”

This definition does not basically exclude interactions, as long as they are not harmful. Thus, the definition of “compatibility” contains a requirement according to which “harmful interactions” must be excluded.

2.1 What are interactions?

Interactions are all physical, physical-chemical or chemical processes that, for example, can occur when two different materials or material quantities are in physical contact. The interactions may cause changes in structure, colour, consistency etc.. In the context of our topic, the most important interactions are the physical-chemical ones, e.g., change of components, also referred to as migration.

2.2 What are harmful interactions?

In this context, harmful interactions are all interactions between materials or material quantities that affect the functions or lifetime of the concerned system negatively, e.g., of the insulating glass installed in a frame.

2.3 Basics of migration

To trigger the migration processes, at least two different materials are required, e.g., material A and material B. At least one of these two materials should consist of several components, e.g., material A. In material A, at least one of the components must be capable of migration. This component must be moveable in the texture or / mixture because of its molecular structure. Thus, it fulfils a necessary pre-condition for the occurrence of a migration process. Finally, material B must fulfil the structural pre-conditions of migration processes, i.e., it must be able to accept the migrating component and / or transport it further.

The typical and most important case of this physical-chemical interaction is the so called “plasticizer migration”. The material A contains a plasticizer (see 2.4), which moves from A to B after coming in contact with material B.

The driving force of this physical-chemical process is a difference in the content of the plasticizer in material A and material B. Thus there is a concentration slope, also called concentration gradient, between the two materials or, according to specialized terminology, the two phases. Without any concentration gradient, no migration will take place.

The gradient is one of the essential factors to determine the speed of the actual migration process. If the gradient is large, the process runs fast. If the gradient is small, it runs correspondingly slow.

Another item that influences migration speed is the temperature. High temperature accelerates the process while a low temperature decelerates it.

2.4 Plasticizer and plasticizer migration

A short explanation of the “plasticizer” denotation should be given for the sake of comprehensiveness. Substances, added to plastics to shape their mechanical properties, are denoted as “plasticizer”. As the name suggests, a plasticizer can work as a real solvent which converts plastics into a gel type substance.

Plasticizer migration represents a harmful interaction, if essential properties are changed to such an extent that the function of the system is affected negatively.

- The material loosing the plasticizer becomes harder, brittle and it shrinks in size.

- The material accepting the plasticizer becomes softer, more elastic and swells up.

Such interactions are dramatic in their effects, e.g., if the plasticizer accepting material looses its structure fully and dissolves completely.

3. Harmful interactions in practice

Hereafter some harmful interactions are discussed, which have been observed increasingly:

3.1 Butt joint seal or block fixing

In case of damage, the typical harmful plasticizer migration can be observed here.

Plasticizer migration, leading to a total dissolution of one of the affected components, takes place during direct contact of the insulating glass edge seal with another unsuitable sealing material, for instance, when a weather sealing in a butt (figure 1), or also when fixing a block in the glazing rebate with the help of an unsuitable sealant.

From the sealant, not suitable for this purpose, components (plasticizer, but also oils and/or extenders) penetrate through the secondary seal of the insulating glass. They enter the primary seal of the insulating glass (butyle) and dissolve it in the final phase of the process regularly. This leads first to dilution of the butyle seal and the draining of a mixture of butyle components and the migrated material or the migrated material mixture (Figure 2).

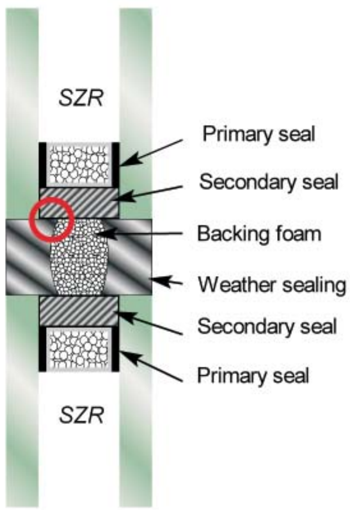


Figure 1: Weather sealing in a butt

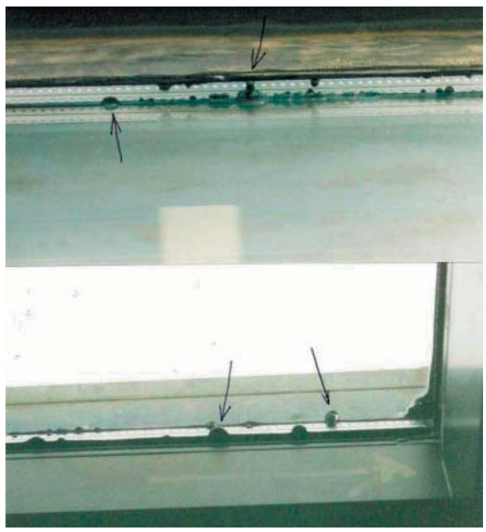


Figure 2: Dissolution of the butyle seal due to migration

This causes total damage to the insulating glass, because the blocking effect of the butyle seal against water vapour diffusion and gas diffusion is destroyed on account of the dissolution of the butyle seal. Moreover, the distribution of the mixture from components of the butyle seal and the migrated material on the inner surfaces (pos. 2 and 3) of the insulating glass causes an optical damage. Under these conditions, an adequate work of the insulating glass is not possible and a replacement becomes unavoidable.

3.2 Profile displacement in case of organic spacer

Another typical case of a harmful interaction is the migration process from an unsuitable glazing sealant in contact with insulating glass edge seal. An example for this case is an insulating glass system with organic spacer in an eave sealing (figure 3).

Contact with the insulating glass sealant enables migration-capable material from the eave seal to come out. The migrating material is transported through the secondary sealant of the insulating glass up to the organic spacer profile. Later on it penetrates into the interface between glass surface and organic spacer profile and destroys the adhesion of the profile to the glass. As a consequence of temperature and air pressure fluctuations ("pumping movements") the profile glides on a "lubrication film" made of oil, plasticizers and / or extenders into the cavity. This damage scenario is also called the "Garland effect" because of its appearance (figure 4).

When sealing eaves, besides the unsuitable selection of the glazing sealant, there is another fault often to be seen. The joint depth is dimensioned wrongly, i.e., it is set far too deep (see 4.2).

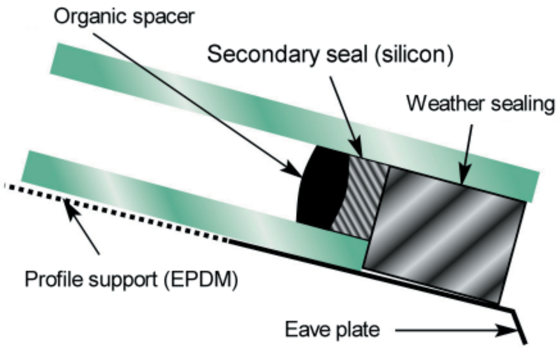


Figure 3: Faulty eave sealing

Figure 4: The Garland effect

3.3 Selection of glazing blocks

The contact between the sealant in the insulating glass edge seal and the glazing blocks may produce harmful interactions if the block material is not suitable (figure 5).

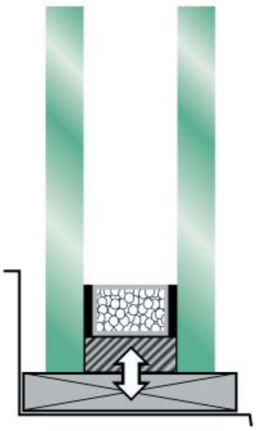


Figure 5: Interactions between edge seal and block.

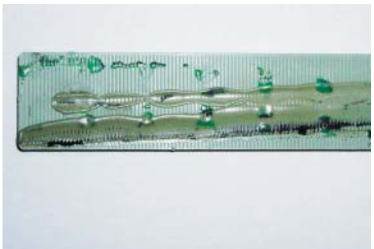


Figure 6: Block after harmful interactions

The unsuitable block material takes components from the secondary sealant, it becomes glutinous and plastically (Figure 6). The block looses its mechanical stability, so that its work of dissipation of loads can no longer be performed. As a consequence window casements may be twisted so dramatically that window opening or closing becomes very difficult or even totally impossible. In the final stadium of the migration process, when large sections of the block have dissolved, the insulating glass may get displaced in the window frame by several millimetres, so that the edge seal moves from the glazing rebate to the visible area.

Another possible consequence could be that the insulating glass units are no longer fixed properly. The glass products suffer non-planed stresses leading to various glass damages. Under certain circumstances, the loss of important components of the secondary sealant also impairs the function of the edge seal. Therefore it is absolutely essential to check the suitability of the block material in order to avoid faults of this kind. Special attention must be paid for example to block materials containing styrol bonds.

4 Avoiding errors in practice

4.1 General

The basic requirement for combining several materials to a “system” is the so called “system check”, which checks the mutual compatibility of all the combined components in respect to the function and usage. Test procedures as described below have to be carried out for all constructions. The “system manufacturer” is finally responsible for checking this compatibility. “System manufacturer” is the one who combines the components to the “system”, e.g., who installs an insulating glass in a framework.

While designing a system, the construction should be as simple as possible, because the risk of possible incompatibilities increases with the number of components.

The risk of harmful interactions can be ruled out where the materials are protected against mutual contact. Thus, for instance, an appropriate air gap can prevent material transport. If an air gap is not possible from the design perspective, appropriate “migration blockers” can be used – e.g., suitable metal foils or filling material – to interrupt the material transport paths and thus, to ensure compatibility. Obviously these changes should not affect other aspects of the construction.

Glazing blocks often are additionally fixed with a little amount of a sealant. This technique is a dangerous one, if the sealant for block fixing was not chosen with the criteria of compatibility. It is recommended to check if it is possible to fix the block without any sealant and thus to avoid a critical component in the system.

4.2 Joint dimensioning

For the design of joints between insulating glasses as well as for brickwork and corner joints corner the technical requirements in respect to the general design of joints and the sealant properties have to be considered.

The joint width depends on the dimensions of the mutually joined construction elements, e.g., insulating glass and frame. For the appropriate technical rules, please refer to standards and guidelines for glass processing and glazing. These rules must also be applied to joints between insulating glasses as well as brickwork joints.

The joint depth depends also on the dimensions of the construction elements to be mutually sealed. The joint depth shall not exceed a definite maximum value in case of single-component sealing materials.

One must remember that single-component sealant requires an adequate quantity of water in the form of moisture for crosslinking. Moreover, the curing of these sealants proceeds from "outside to inside". Therefore, on the way to the reactive part of the sealant, the moisture has to pass an increasing barrier. If the joint is too deep, the crosslinking process takes too much time. The result may be, even in case of normally compatible sealants, the possibility of harmful interactions, if parts or components remain unpolymerized for a very long time.

A typical construction, where the joint depth exceeds decisively the maximum permissible for a single-component sealant, is shown in figure 7. Due to the long diffusion path of the moisture, necessary for crosslinking, unpolymerized sealant is present at point A – the middle of the joint – for a very long time, at the same time very close to the edge seal of the horizontal marked insulating glass. Thus harmful interactions are an obligatory result of the impermissibly long crosslinking time, even if the sealants are compatible in suitable constructions. Besides, loss of adhesion may occur in this case due to the shrinking of the joint, conditioned by crosslinking.

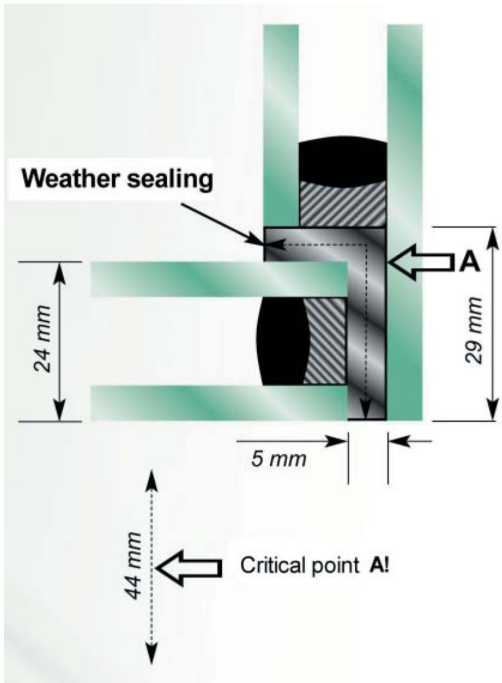
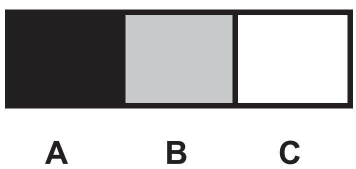


Figure 7: Faulty joint depth in case of single-component silicone.

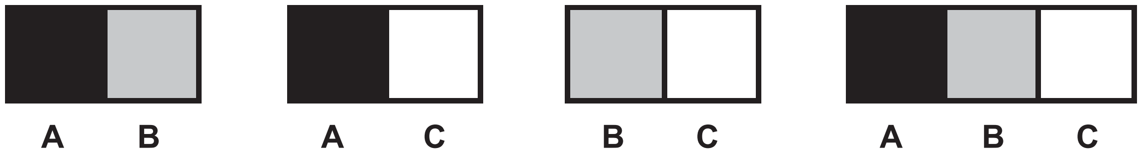
Remark: It is not the purpose of this technical information to show solutions for the design to be always suitable. On one hand, these solutions do not exist. On the other hand, creating an optimal design for the individual case should be left to the competence of the concerned expert.

5. Check of compatibility

At present, there is no standardized test procedure to verify the compatibility for all applications. Maybe an adequate test procedure has to be developed for each material combination and each design. By the way, in case of complex systems, it is necessary to check the mutual compatibility of the individual components as well as the compatibility of the total system. This is represented in the following graphics:



Sometimes it is impossible to avoid a three-component system, for instance consisting of a primary sealant A (butyle), a secondary sealant B and of a weather sealing C. In this case all possible combinations must be checked with respect to their mutual compatibility. Thus the following individual tests must be performed:



The test **A ⇔ B** may be dropped, for instance if both sealants come from the same supplier, or their mutual compatibility is guaranteed. This testing system illustrates why the most simple constructions are advantageous.

Further on , for the checks of compatibility there is no general evaluation of the test results and there is also no evidence if the test results are relevant for practical application. If necessary, several test procedures have to be carried out. As well, checking compatibility to minimize the risk of harmful interactions requires an enormous amount of knowledge and extensive experience.

5.1 Check of compatibility in practice

In practice, the different components of a system rarely come from the same supplier. However, only in this case the supplier if all components of a system is capable to guarantee the compatibility of these components. In this case, the supplier has the possibility to recheck the compatibility , whenever the composition of one of the products is changed. He can thus guarantee that clients need not fear any change in compatibility.

If the components come from different suppliers, the test results will be applicable only to the tested product batch numbers and do not show any general evidence. The test results cannot necessarily be applied to other product batches, because a possible change in product composition is supposed not to be known in time and taken into account. Thus it is impossible to provide a list containing combinations of compatible materials, without contractual regulations between the concerned suppliers.

A general statement on the compatibility of products from different suppliers requires a corresponding bilateral contractual regulation between the concerned suppliers and the purchaser of the material. As long as there are no standardized requirements for components, this is the only way out.

The responsibility for compatibility in the case of combinations containing different sealants is to be shouldered basically by the person who combines these materials into a “system”. The suppliers of the “pre-products” are not responsible for the compatibility ot materials they don’t know. This factor however, does not prevent them from advising their clients or helping them with technical tests. The practical conversion of the advice into a design, and the evaluation of test results however, is the prerogative of the system manufacturer.

It is remembered on the influence of the design of joints on the crosslinking of sealants, and therefore on the possibility of harmful interactions. Hence, the compatibility of the participating components is to be ensured in the sense of the absence of harmful interactions in the individual application.

6. Conclusion

Complicated material combinations require careful planning and execution. All participants of this process (suppliers, system designers, and system manufacturers) have to work hand in hand. If the components do not come from only one supplier, the procedures as described in this leaflet shall be carried out. With respect to complexity of these systems, it seems to be useful to proceed like it is obligatory for other areas of glass construction, for instance for fire protection glass constructions. For those constructions the “system description” describes precisely all components and their application. Further on the entire system has passed a so called “type test”. Every supplier has to ensure to deliver only with respect to the “system description” and it’s specifications for all components. Changes in the components are allowed only if it has been established, these changes do not affect the system and the result of the “type test”.

This technical information has been prepared by the working group “compatibility” of the technical committee of the German Bundesverband Flachglas.

The original text is based on a draft by Dipl.-Ing. Helmut Brook, Henkel Teroson GmbH. Revision and completion is provided.

Issue: June 2004

The original text has been published with kind permission of the Bundesverband Flachglas, Isolierglasherstellung Veredlung e.V., D- 53840 Troisdorf. The English translation was prepared by MC-Bauchemie Müller GmbH & KG and ISOLAR-Glas-Beratung GmbH.