# The Influence of the Desiccant on the Result of the Climate Test of the Future European Standard for Insulating Glass



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4 = Climate test
5 = Moisture penetration index
6 = Desiccant

## Abstract

Insulating Glass Units filled with Molecular Sieve desiccants in beaded form have been exposed to the climate test procedures of the DIN Standard and the future European Standard (prEN 1279-2). On the basis of these test results, this paper discusses the influence of relevant desiccant parameters like Water Pre-loading, Water Capacity and Desiccant Filling Amount on the Moisture Penetration Index of the future European Standard.

## Introduction

The forthcoming implementation of the future European Standard for Insulating Glass Units EN 1279 (part 1–6) will bring significant changes to the national Insulating Glass Standards of most European countries. In Germany, for example, EN 1279-2 will supersede the corresponding German Standards DIN 1286 Teil 1, DIN 52 344, DIN 52 345 and DIN 52 294. The major differences between these DIN Standards and the future Standard EN 1279-2 are in the procedure of the climate test and also in the evaluation of the test results. The future European Standard – as opposed to the DIN Standard – measures the quality of the IGU by means of the Moisture Penetration Index (MPI). The MPI represents the increase in the moisture content of the desiccant during the climate test related to the “Useful Water Capacity” of the desiccant. This means that the European Standard evaluates the moisture content of the desiccant not as an independent parameter but always in relation to the useful water adsorption capacity of the desiccant.

## Experimental

In the first test series, 25 air–filled Standard IG Units (4/12/4 mm, size 500mmx350 mm) have been manufactured under the same manufacturing conditions. All units were double sealed. Primary seal: polyisobutylene, secondary seal: polysulfide. The corners were closed by aluminum corner keys with additional polyisobutylene sealing (butylene injection). 10 test units were submitted to the DIN type test (DIN 1286-1), and 15 test units were submitted to the EN climate test according to the draft prEN 1279-2 (1993). All units were filled with 50 g PHONOSORB® (molecular sieve type 3A) per unit.

In the second test series IGU’s with spacer bar corner keys were compared to IGU’s with bended spacer bars. In this case, 15 test units were manufactured by means of a profile bending machine. The bended spacer bars were filled with 39 grams PHONOSORB® per unit. The applied sealants were the same as those used in the first test series.

DIN climate test procedure

- Measurement of the initial dew point temperature $t_A$ of all test units (DIN 52 345)
- Determination of the initial moisture content of the desiccant $b_A$ of two test units (DIN 52 294)
- Climate test: two consecutive test runs according to DIN 52 344 on four test units without intermediate dew point determination
- Measurement of the final dew point temperature $t_E$ of the four tested units
- Determination of the final moisture content of the desiccant $b_E$ of the four tested units

Pass criteria:

– Initial dew point temperature of all test units: $t_A \leq -30°C$
– Initial moisture content of the desiccant (zeolite) in all test units: $b_A \leq 4{,}0$ %wt
– Increase in moisture content of the desiccant during climate test: ≤2,5 %wt. (average), ≤ 3,0 % wt. (single values)
– Final dew point temperature of all tested units after the climate test: $t_E \leq -20°C$

EN climate test procedure

– Measurement of the initial dew point temperature of all test units
– Determination of the initial moisture content of the desiccant $T_i$ of four test units
– Climate test: according to EN 1279-2 (1993), section 6.2 on 5 test units
– Determination of the final moisture content $T_f$ of the desiccant of the 5 tested units
– Calculation of the Moisture Penetration Index I, using the following equation:

$$I = \frac{T_f - T_{I,av}}{T_{c,av} - T_{I,av}} \qquad (1)$$

In accord with prEN 1279-2 (1993), clause 7.3, $T_{c,av}$ = 20 % was taken for the Average Standard Moisture Adsorption Capacity of the desiccant (zeolite 3A).

Pass criterion:

– Average Moisture Penetration Index of the five units exposed to the climate test: $I_{av} \leq 20$ % (single values I ≤ 25 %)

All climate tests were carried out by the 'Institut für Fenstertechnik e.V' in Rosenheim, Germany.

# Results of the climate tests and discussion

*1. DIN versus EN climate test*

First of all, it can be stated that the IG test units have passed the EN as well as the DIN climate test with a significant safety margin (*Table 1*).

Having said this, however, the test results exhibit interesting differences resulting from the different test procedures as well as from the differences in the evaluation of the experimental data. The climate test procedures as specified in the European and in the German Standards, respectively, deviate from each other mainly in the following parameters:

Cycling climate:

EN test: 56 temperature cycles between –18 and +53°C within 4 weeks
DIN test: 32 temperature cycles between –15 and +52°C within 8 weeks
(including 1,5 weeks storage at 18–28°C under UV-radiation)
Constant climate:
EN test: 7 weeks storage at 58°C and ≥95%RH
DIN test: 4 weeks storage at 52°C and 100%RH

From the higher number of temperature cycles and the longer storage time one may conclude that in the EN climate test the IG units are subjected to stronger mechanical stress than in the DIN climate test.

Our test results support this assumption. After the DIN climate test, an average increase in the initial moisture content of the desiccant of 0,8 %wt. was found (*Table 1*), whereas after the EN climate test an average increase of the moisture content of the desiccant of 1,42 %wt. was measured. It is

*Table 1. DIN- versus EN-climate test.*

| | Desiccant Filling Amount (g) | Desiccant Water Pre-loading (%wt.) | Moisture Increase during Climate Test (%wt.) | Moisture Penetration Index (%) |
|---|---|---|---|---|
| EN Test Result | 50 | 2,3 | 1,42 | 8,0 |
| Lower $T_{I,av}$ | 50 | 1,3 | 1,42 | 7,6 |
| Higher $T_{i,av}$ | 50 | 4,3 | 1,42 | 9,0 |
| Higher moisture increase | 50 | 2,3 | 2,6 | 17,4 |
| Lower filling amount | 25 | 2,3 | 2,84 | 16,0 |
| EN Limit Value | | | | 20,0 |
| EN Test Result/Limit Value | | | | 40,0 |
| DIN Test Result | 50 | 2,3 | 0,8 | |
| DIN Limit Value | | | 2,5 | |
| DIN Test Result/Limit Value | | | | 32,0 |


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important to note, however, that in the future EN climate test, the relevant criterion for passing the test is not the absolute increase in the moisture content of the desiccant during the climate test, but the Moisture Penetration Index which is calculated according to formula (1).

If one relates the experimentally determined average increase in the moisture content of the desiccant in the DIN test (0,8%wt.) and the Average Moisture Penetration Index of the EN test (8%), respectively, to the corresponding limit values, the differences between both test results become much smaller (32% and 40%, respectively, see *Table 1*).

If one compares the influence of the relevant molecular sieve parameters on the results of the EN or DIN climate tests, important differences emerge.

*Table 1* shows that the influence of the average initial moisture content of the molecular sieve ($T_{i,av}$) on the Moisture Penetration Index I is relatively small. Even IG units with a $T_{i,av}$-value of 4,3%wt., which do not meet the requirements of the DIN test, pass the EN test and give I-values which are only slightly higher than those of the test units with an average initial moisture content of 2,3%wt. (*Table 1*). Similarly, the influence of the moisture capacity of the desiccant on the Moisture Penetration Index, is also small. Moreover, IG units failing in the DIN test because of too high increase in the moisture content of the desiccant during the climate test (e.g. 2,6%wt., see *Table 1*, column 5), pass the EN test with an I-value of 17,4%, corresponding to 74 % of the limit value of the Average Moisture Penetration Index.

A significant influence on the test result has the amount of desiccant filling. A 50% reduction in the filling amount (e.g. 2-side filling) doubles the increase in the relative moisture content of the desiccant during the climate test, corresponding to I=16,0 % or 80% of the limit value of the Moisture Penetration Index (*Table 1*, column 6).

*2. Performance of IGU's with spacer bar corner keys versus IGU's with bended spacer bars in the EN climate test.*

To compare the influence of bended spacer bars versus spacer bars with corner keys (corner keys with additional butylene injection!) on the water ingress into the Insulating Glass Unit during the EN climate test, 15 Standard IGU's with bended spacer bars have been exposed to the EN test.

The test results are compiled in *Table 2*. It is interesting to note, that the Insulating Glass Units with bended spacer bars gave worse results (higher Moisture Penetration Indexes) than the IGU's made with conventional corner keys. From *Table 2*, however, can be seen, that this follows from the lower amount of desiccant contained in the bended spacer bars (39 grams versus 50 grams). The water ingress into the Insulating Glass Units with bended spacers is – as expected – somewhat lower than for IGU's with corner keys.

*Table 2. EN-climate tests: IGU's with spacer corner keys versus IGU's with bended spacers.*

| | Spacers with corner keys | Bended spacers |
|---|---|---|
| EN Test Result | | |
| Desiccant Filling Amount in g | 50 | 39 |
| Water Ingress during climate test in g | 0,71 | 0,64 |
| MPI in % | 8,0 | 8,8 |
| EN Test Result/Limit Value in % | 40 | 44 |
| 2-side Filling | | |
| Desiccant Filling Amount in g | 25 | 20 |
| MPI in % | 16 | 17,6 |
| EN Test Result/Limit Value in % | 80 | 88 |

A significant influence on the I-value again has the decision whether four or two sides of the spacer shall be filled. In our case the two side filling (1 long side, 1 short side) would increase the Moisture Penetration Index up to 80 or 88% of the permissible limit value, respectively.

## Conclusions

*The major findings of this study are:*

1. The EN climate test is more severe than the corresponding DIN test. However, if one relates the primary results, i.e. the amount of water diffusing into the IGU during the climate test, to the respective pass criteria, it is seen that the quality requirements to IGU's, as defined in the EN and the DIN climate test, are close to each other.
2. Desiccant parameters like water pre-loading and water capacity have a relatively small influence on the result of the EN climate test compared to the decision, whether 4 or 2 sides of the spacer bar shall be filled with desiccant. This is especially important if spacers with low filling volume are used.
3. IGU's made with spacers with conventional corner keys, may reach I-values which are close to those of IGU's with bended spacer bars, provided that the corner keys have been additionally sealed with polyisobutylene .

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