



De Rondom 1
P.O. Box 6235
5600 HE Eindhoven
The Netherlands

TNO report
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Truseal Technologies
EN1279 part 2, 3 and 6 (Annex B4.2) assessment
of insulation glass: Duraseal™

www.tno.nl

T +31 40 265 00 00
F +31 40 265 03 01
info@ind.tno.nl

Date	December 20, 2005
Author(s)	L. van der Ven-le Comte, B.Sc.
Authorisation	K.K. Pahnke, M.Sc.
Number of pages	10
Sponsor	Truseal Technologies 23150 Commerce Park BEACHWOOD OH 44122 USA
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1 Introduction

Truseal Technologies has commissioned TNO Science & Industry, section TC Materials with initial type testing according to the EN1279-2, EN 1279-3 and some relevant parts of EN1279-6.

It is the manufacturer's responsibility that the samples delivered for initial type test are representative to the production and that normal production variations are included in the test samples. If any changes in applied materials or other deviation of the system description are introduced, the validity of this initial type test report shall be evaluated on validity. This could mean new tests or additional tests. According to the rules this decision and full responsibility belongs to the manufacturer. The system description (No document available) is the base document for this evaluation.

For any other manufacturer this initial type test (ITT) report is not automatically valid. The manufacturer for this ITT report is defined as **Truseal Technologies**.

TNO is a fully Notified Test Laboratory for EN tests for the CPD guideline 89/106/EEG under Lab.no.1154 at the Technical Committee of the European Commission in Brussels. This report has been issued under this reference.

The following chapters describe the tested configuration(s), the results and the conclusions.

2 Experimental

2.1 Delivered samples and materials

The following materials and insulation glass units (IGU's) were delivered for the durability assessment according EN1279: version 2003.

The following materials were used for preparation of the samples:

Number of IGU's	Type of glass	Thickness glass [mm]	Approx. spacer width [mm]	Single seal system	Assessment
15	Clear float	4	12	Duraseal™	EN1279-2
6	Clear float	4	12	Duraseal™	EN1279-3
5	Clear float	4	12	Duraseal™	EN1279-6 [annex B4]

The following materials were used for preparation of the samples:

- Production date: 27-06-2005
- Single seal system: Duraseal™

The following process parameters were applicable:

- Temperature production hall: 23.9°C
- Air pressure production hall: 1012.5 mbar

2.2 Tests

2.2.1 Moisture penetration test according EN1279-2:2003

Insulation glass IGU's shall fulfil their functions during an economical reasonable working life. Therefore the following requirements were verified on test specimens submitted to the long-term climate test as specified in the EN1279-2. The average moisture penetration index I_{av} over five test specimens shall not exceed 20% and the highest moisture penetration index on the individual test specimens shall not exceed 25%. For the determination of the moisture penetration index I_{av} a set of insulation glass IGU's was exposed to a long-term climate test. One set of insulation glass consists of 15 test pieces. The test specimens should be representative of the system description and consists of two panes of 4 mm clear float glass in accordance of EN572-1 and EN572-2. The length should be (502 ± 2) mm and the width (352 ± 2) mm. The gap should be 12 mm or as near as possible. The cavity should be filled with air (however other gas fillings are allowed). Construction details of the edges and corners should correspond to the edge and corner details in IGU's supplied to the market.

The 15 test specimens were conditioned for minimum two weeks at standard laboratory conditions. After this period the dew points were measured. Dew point temperatures less than -60°C are passing the minimum requirement for random usage of the IGU's. When dew-point temperatures are found above -60°C then the IGU's must be ranked,

commencing with the highest dew point value as number 1 and ending the lowest dew point as number 15. IGU's with dew point values below -60°C are numbered randomly.

The initial moisture content T_i was measured on four pre-selected samples. At least five pre-selected samples were submitted to the long-term climate test.

The long-term climate test consists of two parts. The first part consists of 56 cycles of 12 hours from -18°C to $+53^{\circ}\text{C}$ with slopes of 14°C where at -18°C and at $+53^{\circ}\text{C}$ the temperature is constant for 1 hour. The cycle is followed by a second part consisting of a period of seven weeks at a constant temperature of 58°C . For both parts a relative humidity of $> 95\%$ is applied in case the temperature is above 0°C . The exact specification of the temperature, humidity and time, and their tolerances, is given in the EN1279-2 standard.

After submitting the selected IGU's to the full climate test, these IGU's are stored for two weeks under standard laboratory conditions and then the final moisture content T_f of five IGU's is determined.

The calculation of the individual penetration index was based on the average initial moisture content $T_{i,av}$, the fixed value T_c and the individual measured T_f of each of the five test specimens subjected to the long-term climate exposure.

2.2.2 *Gas loss rate determination according EN1279-3: 2003*

The 6 test specimens were conditioned for a minimum of one week at standard laboratory conditions. At least five pre-selected samples were submitted to the specified climate test.

The climate test consists of two parts. The first part consists of 28 cycles of 12 hours from -18°C to $+53^{\circ}\text{C}$ with slopes of 14°C where at -18°C and at 53°C the temperature is constant for 1 hour. The cycle is followed by a second part consisting of a period of four weeks at a constant temperature of 58°C . For both parts a relative humidity of $> 95\%$ is applied in case the temperature is above 0°C . The exact specification of the temperature, humidity and time, and their tolerances, is given in the EN1279-2 standard.

After submitting the selected IGU's to the climate test, these IGU's are stored for four weeks under standard laboratory conditions and then the procedure of the gas loss rate determination is started.

Two IGU's are installed into separate frames. The frame encloses the IGU with some space left between the IGU and the frame. The IGU and frame are hermetically closed.

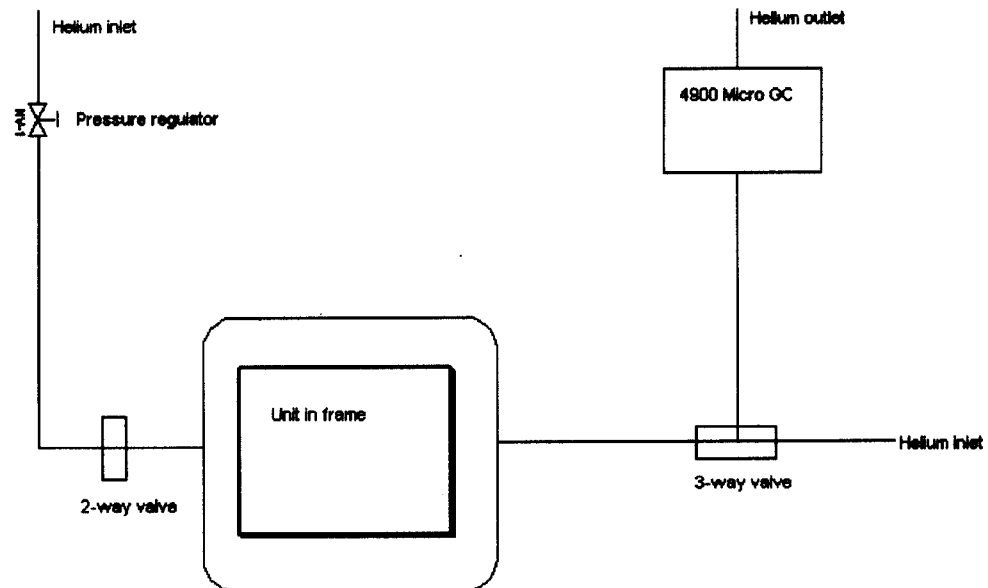
After introduction of the unit, the frame is closed and the sample frame is purged with a helium flow of ± 400 ml/min for 1 hour. At the end of the purge time, the inlet and outlet valves are closed in succession to ensure an atmospheric pressure inside the frame (starting leak time). After a minimum of 6 hours leak time, the helium in the frame is measured for its argon, oxygen and nitrogen concentration using gas chromatography (4900 Micro GC).

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The amount of Argon is then determined and by calculation based on the measured amount of Argon gas and the collection time, the amount of gas loss per time (year) can be determined. The requirement is that the Argon gas loss rate is less than 1% per year.

The method and calculation formulas are described in more detail in the EN1279-3: 2003.

The schematic diagram of the equipment is as follows:



2.2.3 Gas filling percentage according EN1279-3: 2003

After the determination of the gas loss rate based on a theoretical assumption of 90% filling percentage, the actual gas filling percentage was determined on 2 units. This measurement is done by injection of samples taken out of the IGU's into the gas chromatograph. After these results are known, the real gas loss rate is recalculated.

2.2.4 Short climate test, reference moisture penetration index for FPC (EN1279-6:2003)

The EN1279-6 describes the mandatory factory production control (FPC). The FPC requires that the manufacturer executes a number of tests. Aspects of these tests aim to ensure that the IGU's are sufficiently durable. One practical requirement is that the manufacturer periodically carries out a shortened accelerated ageing climate test on five IGU's. This establishes the penetration index I_{sh} . When applying for an ITT, it is advised to include do a shortened accelerated ageing climate test as reference for the I_{sh} . The product standard describes this as I_{ref} . This I_{ref} is then available as a reference when evaluating the results of later periodic shortened accelerated moisture penetration tests in which a maximal increase of +2.5 % in comparison with the penetration index I_{ref} is permitted. The short-term climate test consists of 2 IGU's to be measured on $T_{sh,i}$ (initial moisture content) and the moisture content ($T_{sh,f}$) of 2 IGU's after exposure to 3 weeks at a constant temperature of 58 °C and a relative humidity of >95%. In this report the determination of the I_{ref} is included.

3 Results

3.1 Results

3.1.1 Moisture penetration test according to EN1279-2: 2003

The 15 IGU's were visually inspected. No special deviations above variations due to the production process were found. After the visual inspection the test specimens were analysed on dew points. All IGU's showed dew points lower then -60°C . The test specimens were randomly numbered and the moisture contents (T_i & T_f) were determined. From these results the individual penetration indices I and I_{av} were calculated. The results are as follows:

EN 1279-2: Duraseal				
				T_c [%]
Initial values				7.95
Test specimen no.	Sample [mg]	KF-titration [ml]	T_i [%]	$T_{i,av}$ [%]
1	1820.3	1.851	0.39	0.34
2	1049.0	1.057	0.30	
3	1282.8	1.279	0.33	
4	1136.0	1.179	0.33	
After climate exp.				
Test specimen no.	Sample [mg]	KF-titration [ml]	T_f [%]	I
1	1518.7	0.905	0.16	< 0.01
2	2002.3	1.190	0.19	< 0.01
3	1295.8	0.979	0.21	< 0.01
4	1475.9	1.074	0.22	< 0.01
5	1256.2	0.892	0.19	< 0.01
				I_{av}
				< 0.01

* T_c is based on the fixed value of 7.95% given by the manufacturer (DMP-RPT-02-377)

The conclusion is that the insulation glass IGU's in this configuration are **complying** with the requirements of durability according the EN1279-2.

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3.1.2 Gas loss rate determination according to EN1279-3: 2003

The 6 IGU's were visually inspected. No special deviations above variations due to the production process were found. The test specimens were randomly numbered and the units were aged. After ageing the gas loss rate was determined on two IGU's.

For calculation of the gas loss rate are values used for pressure ($p = 1013$ hPa) and temperature ($T = 297$ K) during production of the samples. The results are as follows:

EN1279-3: Duraseal						
Test specimen no.	$m_{i,1}$ [$\mu\text{g/hr}$]	$m_{i,2}$ [$\mu\text{g/hr}$]	$m_{i,3}$ [$\mu\text{g/hr}$]	$m_{i,4}$ [$\mu\text{g/hr}$]	M_{avg} [$\mu\text{g/hr}$]	L_i [%/y]*
1	1.11	1.30	1.28	1.22	1.23	0.4
4	0.80	0.79	1.01	1.00	0.90	0.3

* corrected for actual gas filling degree.

3.1.3 Gas filling percentage according to EN1279-3: 2003

Two IGU's were measured on the gas filling degree. The results are as follows:

EN1279-3: Duraseal						
Test specimen	Ar_1 [%]	Ar_2 [%]	Ar_3 [%]	Ar_4 [%]	Ar_5 [%]	Ar_{avg} [%]
	89.6	89.8	NA	NA	NA	89.7

The conclusion is that the insulation glass IGU's in this configuration are **complying** with the requirements of durability according the EN1279-3.

3.1.4 Short climate test, reference moisture penetration index for FPC

All IGU's were visually inspected. No special deviations above variations due to the production process were found. The test specimens were randomly numbered and the moisture contents ($T_{\text{sh},i}$ & $T_{\text{sh},f}$) were determined of two IGU's before and after ageing. From these results the individual penetration indexes I_{ref} was calculated. The results are as follows:

EN1279-6: Duraseal				
				T_c^* [%]
Initial values				7.95
Test specimen no.	Sample [mg]	KF-titration [ml]		Tf [%]
1	1820.3	1.851		0.39
2	1049.0	1.057		0.40
After climate exp.				
Test specimen no.	Sample [mg]	KF-titration [ml]	Tf [%]	I
1	1684.5	1.285	0.26	< 0.01
2	1498.8	1.049	0.21	< 0.01
				I_{av}
				< 0.01

* T_c is based on the fixed value of 7.95% given by the manufacturer (DMP-RPT-02-377)

The conclusion is that the I_{ref} as reference of the short-term climate test for FPC purpose is < 0.010 or < 1.0%.

4 Conclusion

The following summary demonstrates the consistence of the ITT and other measurements towards the requirements of the product standard EN1279:2003.

Tested IGU system:	
EN 1279-2:2003, Long term moisture penetration index	PASS
EN 1279-3:2003, Gas loss rate	PASS
EN 1279-6:2003, Short Climate test	$I_{ref} < 0.010$

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5 Signature

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TNO Science and Industry



L. van der Ven-le Comte, B.Sc.
Author



K.K. Pahnke, M.Sc.
Head of Department