BELGIAN BUILDING RESEARCH INSTITUTE
INSTITUTION RECOGNISED BY APPLICATION OF THE DECREE-LAW OF 30 JANUARY 1947

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TEST REPORT

Laboratory **Hygrothermal characteristics (Labo HY)**	**O/References**	DE-HY-0055 HY-19-173-10 Page: 1/8

Requested by	**AGC GLASS - GOSSELIES** Mr. Ben Trad Abderrazek Rue Louis Blériot, 12 BE 6041 – GOSSELIES		
Date of request	17 May 2019	**Sample(s) registration**	S-2019-23-015
		Date of receipt of the sample(s)	28 May 2019
Drafting date of report	17 June 2019		
Test carried out	Measurement of the thermal resistance of VIG glazings.		
References	EN 12667 (2001), ISO FDIS 19916-1:2018. *SP / HY / 6.1*		

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Each page of the original report has been stamped (in red) by the laboratory and initialled by the head of laboratory.
The results and findings are only valid for the tested samples.

Sample(s) will be removed from our laboratories 30 calendar days after sending of the report, unless a written request is received from the client.

C.S.T.C. W.T.C.B. HY

Technical in charge of the test
N. Jerkovic

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1. TEST SPECIMEN

Samples descriptions are given in the following table:

Sample Reference	Sample BBRI Ref.
1_4 / 190508 (A)	VIG A
1_4 / 190516 (B)	VIG B
1_5 / 190508 (C)	VIG C

2. SPECIMEN CONDITIONING BEFORE TESTING

No special conditioning has been applied to the test specimen before the measurement.

3. TEST RESULTS

Two constitutive elements of the VIG can interfere with the measurement of the central-of-glazing thermal resistance: support pillars that are present between the two glass panes and the edge seal of the glazing. To limit the impact of pillars, the measurement has been carried-out by placing thin insulating plates on both sides of the glazing ("buffer plates"). The use of these insulating plates has however as a consequence to send the thermal perturbation caused by the edge seal further in the metering zone. The thermal resistance of the buffer plates must therefore remain limited.

Two 6mm thick neoprene panels presenting a total thermal resistance of 0.19 m²K/W have been used to this end.

The thermal resistance of the glazing alone, R_g, has been evaluated by subtracting the thermal resistance of the buffer plates form the total thermal resistance measured.

The evaluation method followed is conform to the annex A of the ISO/FDIS 19916-1 standard.

The measurement results for the buffer plates and the glazing are summed up in the table here bellow.

Sample Reference	Sample BBRI Ref.	Thickness *(mm)*	T_{hot} *(°C)*	T_{cold} *(°C)*	T_{avg} *(°C)*	ΔT *(°C)*	Permeance *(W/m²K)*	Resistance *(m²K/W)*
Buffer plates	Neoprene (Buffer plates)	11.96	12.50	7.49	10.00	5.01	5.3801	0.1859
1_4 / 190508 (A) *	Neoprene + VIG A VIG A	19.80 7.84	17.51	2.52	10.01	14.99	0.7083 0.8157	1.4118 1.2259
1_4 / 190508 (A) *	Neoprene + VIG A VIG A	19.80 7.84	17.48	2.49	9.99	14.99	0.7085 0.8160	1.4114 1.2255
1_4 / 190516 (B)	Neoprene + VIG B VIG B	19.79 7.83	17.49	2.50	10.00	14.99	0.7060 0.8126	1.4165 1.2306
1_5 / 190508 (C)	Neoprene + VIG C VIG C	19.76 7.80	17.49	2.50	10.00	14.99	0.7067 0.8136	1.4150 1.2291

(*) VIG A was tested twice

The U_g-value of the glazing is finally evaluated by applying the following formula:

$$U_g = \frac{1}{R_g + 0.17}$$

Sample Reference	Sample BBRI Ref.	U-value *(W/m²K)*
1_4 / 190508 (A) *	VIG A	0.72
1_4 / 190508 (A) *	VIG A	0.72
1_4 / 190516 (B)	VIG B	0.71
1_5 / 190508 (C)	VIG C	0.71

The complete results of the measurements are given at pages 4/8 to 8/8.

4. EQUIPMENT

The equipment is a heat flow meter apparatus type “LaserComp F606” (BBRI Nb.: HFM 3) with a single-specimen symmetrical configuration. The dimensions of the apparatus are 610 mm x 610 mm, the metering area is 305 mm x 305 mm.
The measurements are carried-out on the specimen in horizontal position.
The specimen is placed between two heat flow meters with the hot plate at the lower level and the cold plate at the upper level.

5. REFERENCE MATERIAL

The equipment is calibrated with the IRMM-440 reference material. This reference material is a resin-bounded glass fibre board (identification number 4) with dimensions of 600 mm x 600 mm and a thickness of 34.35 mm.

Heat flow meter method

Equipment: HFM3

N° DE :	DE-HY-0055
N° Specimen :	HY-19-173 (Neoprene 2 X 6 mm)
Conditioning :	In laboratory (23°C±2 and 50%rh±5)
Date of the test :	4 June 2019
Date of the last equipment control :	30 May 2019

The equipment control is realised with a transfer specimen
The calibration is performed according to IRMM440 reference material

Specimen details	Unit	Values
Length	m	-
Width	m	-
Thickness	m	0.01196
Weight at the start of test	kg	-
Weight at the end of test	kg	-
Weight of the dry specimen	kg	-
Density at the end of test	kg/m³	-
Density of the dry specimen	kg/m³	-
Humidity rate at the end of test	m³/m³	-

Measured data	Unit	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average
Surface temperature of the specimen - hot side	°C	12.50	12.49	12.49	12.50	12.50	12.50
Surface temperature of the specimen - cold side	°C	7.50	7.49	7.49	7.50	7.50	7.49
Density of heat flow - hot side	W/m²	26.9306	26.9235	27.0354	27.0219	27.0033	26.983
Density of heat flow - cold side	W/m²	26.9068	26.9266	26.7988	26.8129	26.8293	26.855
Calculated data							
Temperature difference	K	5.00	5.00	5.00	5.00	5.00	5.00
Mean specimen temperature	°C	10.00	9.99	9.99	10.00	10.00	9.99
Thermal resistance	m².K/W	0.1859	0.1859	0.1859	0.1858	0.1859	0.1859
Thermal permeance	W/m².K	5.3793	5.3799	5.3796	5.3818	5.3797	5.3801
Thermal conductivity	W/m.K	0.0643	0.0643	0.0643	0.0644	0.0643	**0.0643**

The maximum probable error on the thermal resistance, permeance and conductivity, determined according to the EN 1946-3 and EN 12667 standards, is lower than 2%.

C.S.T.C. W.T.C.B. HY

Heat flow meter method

Equipment: HFM3

N° DE :	DE-HY-0055
N° Specimen :	HY-19-173-01 (VIG A + Neoprene 2 x 6 mm)
Conditioning :	In laboratory (23°C±2 and 50%rh±5)
Date of the test :	4 June 2019
Date of the last equipment control :	30 May 2019

The equipment control is realised with a transfer specimen
The calibration is performed according to IRMM440 reference material

Specimen details	Unit	Values
Length	m	-
Width	m	-
Thickness	m	0.01980
Weight at the start of test	kg	-
Weight at the end of test	kg	-
Weight of the dry specimen	kg	-
Density at the end of test	kg/m³	-
Density of the dry specimen	kg/m³	-
Humidity rate at the end of test	m³/m³	-

Measured data	Unit	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average
Surface temperature of the specimen - hot side	°C	17.51	17.51	17.51	17.51	17.51	17.51
Surface temperature of the specimen - cold side	°C	2.52	2.52	2.52	2.52	2.52	2.52
Density of heat flow - hot side	W/m²	10.6631	10.6756	10.6663	10.6956	10.6777	10.676
Density of heat flow - cold side	W/m²	10.5821	10.5674	10.5836	10.5379	10.5636	10.567
Calculated data							
Temperature difference	K	14.99	15.00	15.00	14.99	14.99	14.99
Mean specimen temperature	°C	10.01	10.01	10.01	10.02	10.02	10.01
Thermal resistance	m².K/W	1.4116	1.4118	1.4113	1.4123	1.4118	1.4118
Thermal permeance	W/m².K	0.7084	0.7083	0.7086	0.7080	0.7083	0.7083
Thermal conductivity	W/m.K	0.0140	0.0140	0.0140	0.0140	0.0140	**0.0140**

The maximum probable error on the thermal resistance, permeance and conductivity, determined according to the EN 1946-3 and EN 12667 standards, is lower than 2%.

C.S.T.C. W.T.C.B. HY

Heat flow meter method

Equipment: HFM3

N° DE :	DE-HY-0055
N° Specimen :	HY-19-173-01 (VIG A + Neoprene 2 x 6 mm)
Conditioning :	In laboratory (23°C±2 and 50%rh±5)
Date of the test :	5 June 2019
Date of the last equipment control :	30 May 2019

The equipment control is realised with a transfer specimen
The calibration is performed according to IRMM440 reference material

Specimen details	Unit	Values
Length	m	-
Width	m	-
Thickness	m	0.01980
Weight at the start of test	kg	-
Weight at the end of test	kg	-
Weight of the dry specimen	kg	-
Density at the end of test	kg/m³	-
Density of the dry specimen	kg/m³	-
Humidity rate at the end of test	m³/m³	-

Measured data	Unit	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average
Surface temperature of the specimen - hot side	°C	17.48	17.49	17.48	17.48	17.48	17.48
Surface temperature of the specimen - cold side	°C	2.49	2.49	2.49	2.49	2.49	2.49
Density of heat flow - hot side	W/m²	10.7106	10.7104	10.6490	10.6341	10.6309	10.667
Density of heat flow - cold side	W/m²	10.5325	10.5238	10.5949	10.6260	10.6252	10.580
Calculated data							
Temperature difference	K	15.00	14.99	14.99	14.99	15.00	14.99
Mean specimen temperature	°C	9.99	9.99	9.99	9.99	9.99	9.99
Thermal resistance	m².K/W	1.4118	1.4121	1.4117	1.4106	1.4109	1.4114
Thermal permeance	W/m².K	0.7083	0.7081	0.7084	0.7089	0.7088	0.7085
Thermal conductivity	W/m.K	0.0140	0.0140	0.0140	0.0140	0.0140	**0.0140**

The maximum probable error on the thermal resistance, permeance and conductivity, determined according to the EN 1946-3 and EN 12667 standards, is lower than 2%.

C.S.T.C. W.T.C.B. HY

Heat flow meter method

Equipment: HFM3

N° DE :	DE-HY-0055
N° Specimen :	HY-19-173-02 (VIG B + Neoprene 2 x 6 mm)
Conditioning :	In laboratory (23°C±2 and 50%rh±5)
Date of the test :	5 June 2019
Date of the last equipment control :	30 May 2019

The equipment control is realised with a transfer specimen
The calibration is performed according to IRMM440 reference material

Specimen details	Unit	Values
Length	m	-
Width	m	-
Thickness	m	0.01979
Weight at the start of test	kg	-
Weight at the end of test	kg	-
Weight of the dry specimen	kg	-
Density at the end of test	kg/m³	-
Density of the dry specimen	kg/m³	-
Humidity rate at the end of test	m³/m³	-

Measured data	Unit	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average
Surface temperature of the specimen - hot side	°C	17.49	17.49	17.49	17.49	17.49	17.49
Surface temperature of the specimen - cold side	°C	2.50	2.50	2.50	2.50	2.50	2.50
Density of heat flow - hot side	W/m²	10.6498	10.6503	10.6233	10.5995	10.5925	10.623
Density of heat flow - cold side	W/m²	10.4997	10.5137	10.5331	10.5634	10.5772	10.537
Calculated data							
Temperature difference	K	14.99	14.99	14.99	14.99	14.99	14.99
Mean specimen temperature	°C	10.00	9.99	10.00	10.00	9.99	10.00
Thermal resistance	m².K/W	1.4172	1.4163	1.4168	1.4163	1.4160	1.4165
Thermal permeance	W/m².K	0.7056	0.7061	0.7058	0.7060	0.7062	0.7060
Thermal conductivity	W/m.K	0.0140	0.0140	0.0140	0.0140	0.0140	**0.0140**

The maximum probable error on the thermal resistance, permeance and conductivity, determined according to the EN 1946-3 and EN 12667 standards, is lower than 2%.

C.S.T.C. W.T.C.B. HY

Heat flow meter method

Equipment: HFM3

N° DE :	DE-HY-0055
N° Specimen :	HY-19-173-03 (VIG C + Neoprene 2 x 6 mm)
Conditioning :	In laboratory (23°C±2 and 50%rh±5)
Date of the test :	6 June 2019
Date of the last equipment control :	30 May 2019

The equipment control is realised with a transfer specimen
The calibration is performed according to IRMM440 reference material

Specimen details	Unit	Values
Length	m	-
Width	m	-
Thickness	m	0.01976
Weight at the start of test	kg	-
Weight at the end of test	kg	-
Weight of the dry specimen	kg	-
Density at the end of test	kg/m³	-
Density of the dry specimen	kg/m³	-
Humidity rate at the end of test	m³/m³	-

Measured data	Unit	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average
Surface temperature of the specimen - hot side	°C	17.49	17.49	17.49	17.49	17.50	17.49
Surface temperature of the specimen - cold side	°C	2.50	2.50	2.49	2.50	2.50	2.50
Density of heat flow - hot side	W/m²	10.5947	10.6247	10.6320	10.6882	10.6730	10.642
Density of heat flow - cold side	W/m²	10.6007	10.5803	10.5527	10.5037	10.5190	10.551
Calculated data							
Temperature difference	K	14.99	14.99	14.99	14.99	14.99	14.99
Mean specimen temperature	°C	9.99	9.99	9.99	10.00	10.00	10.00
Thermal resistance	m².K/W	1.4149	1.4143	1.4155	1.4151	1.4150	1.4150
Thermal permeance	W/m².K	0.7068	0.7071	0.7065	0.7066	0.7067	0.7067
Thermal conductivity	W/m.K	0.0140	0.0140	0.0140	0.0140	0.0140	**0.0140**

The maximum probable error on the thermal resistance, permeance and conductivity, determined according to the EN 1946-3 and EN 12667 standards, is lower than 2%.

C.S.T.C. W.T.C.B. HY