Thermal Transmittance (U-value) Test Report

Report number: CHB0058/S0032

Calorimeter Laboratory, SERIS

SERIS
Solar Energy Research Institute of Singapore

Client:	**Inflector (Asia) Limited** 1002, Honest Motors Building 9-11 Leighton Road, Causeway Bay Hong Kong Attention: Mr. Christopher Watson
Laboratory:	**Calorimeter Laboratory, SERIS** Solar Energy Research Institute of Singapore (SERIS) National University of Singapore (NUS) Block E3A, #06-01, 7 Engineering Drive 1 Singapore 117574 Tel: (+65) 6601 1595 Attention: Dr. CHEN Fangzhi (chen.fz@nus.edu.sg, (+65) 6516 5449)
Client's reference:	N/A
Report number:	CHB0058/S0032
Test:	Thermal transmittance (U-value) test
Specimen:	A combined system consisting of an Inflector radiant barrier window insulator and a clear single glazing
Specimen ID:	S0032
Result:	**Thermal transmittance** **U-value = 2.83 ± 0.14 W/(m^2 K)**
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Date of test:	01/12/2011
Date of report:	08/12/2011

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1. Description of the Combined System

The objective of the test is to evaluate the thermal transmittance of the combined system, consisting of an Inflector radiant barrier window insulator specimen (hereafter referred to as "specimen") and a clear single glazing (hereafter referred to as "single glazing"). The specimen was installed as panel, with the silver side facing outdoor. Figure 1 shows a schematic representation of the combined system.

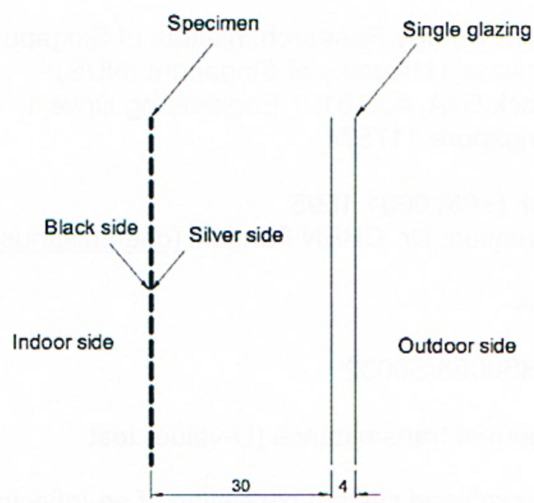

Figure 1. Schematic representation of the combined system consisting of the specimen and the single glazing (unit of length: mm)

The specimen, as specified in the table below, was selected and delivered by the client. The original specimen is of trapezoidal shape, with constant width and one side slightly longer than the other.

Specimen ID	S0032
Date of receipt	10/11/2011
Product	Inflector radiant barrier window insulator
Total thickness	0.3 mm
Total width	1367 mm (constant)
Total length	1013 mm (shorter side), 1067 mm (longer side)

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One side of the specimen is of silver color (Figure 2 left) and the other side of the specimen is of black color (Figure 2 middle). There are uniformly distributed small circular holes of the diameter approximately 1 mm over the entire specimen, except the 4 mm wide edge area (Figure 2 right). The hole grid is of rectangular pattern, with 6 holes for every 10 mm. The black side of the specimen is covered by a layer of thin transparent plastic film. The plastic film is continuous, i.e. without holes on it, and is not permeable to airflow. The specimen is flexible and allows a see-through view through it.

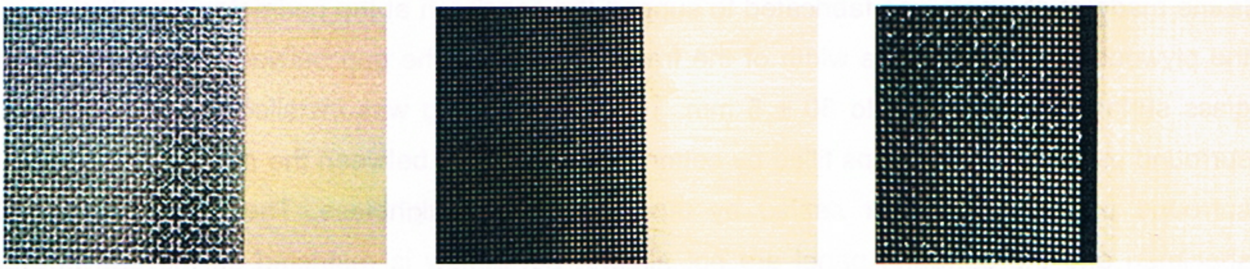

Figure 2. Detailed views of the specimens. Left: silver side of the specimen; middle: black side of the specimen; right: edge of the specimen

The single glazing is an in-house sample provided by SERIS, with known thermal transmittance value. The table below lists the specification of the single glazing.

Specimen ID	S0033
Product	Clear single glazing
Total thickness	4 mm
Total width	1000 mm
Total length	1000 mm
Glass pane type	4 mm thick clear tempered glass (without coating)
Thermal transmittance	5.22 ± 0.15 W/(m^2 K), summer condition

According to the client's website information, the Inflector radiant barrier window insulator is to be used as window attachment for improved thermal insulation, solar heat gain control. The window insulator can be installed as panel, roller blinds or vertical blinds on the indoor side of existing windows. In the summer, the silver side of the window insulator faces outdoor to reflect solar radiation back and achieve low solar gain; in the winter, the black side of the window insulator faces outdoor to absorb more solar radiation and achieve high solar gain. When installed as panel, the window insulator is usually attached onto the frame of the window by Velcro hooks, with a gap size of 20 mm – 40 mm between the window insulator and glass surface. The laboratory installation of the combined system simulates the summer operation mode of the window insulator and the window insulator was installed as panel.

The specimen was cut into the same dimension of the single glazing, i.e. 1000 mm x 1000 mm. A frame made of plywood was fabricated to support the specimen at the perimeter. The thickness of the plywood is 6 mm and the width of the frame is 12 mm. The gap between the specimen and glass surface was adjusted to 30 ± 5 mm. The single glazing was installed into the opening of surround panel with small gaps filled by cotton wool and joints between the single glazing and the surround panel were further sealed by tape to ensure airtightness. The joints between the specimen and the surround panel are not airtight, but airflow is restricted as the gap between plywood frame and surround panel opening is very small (less than 2 mm). Figure 3 shows photos of the installation, taken before testing.

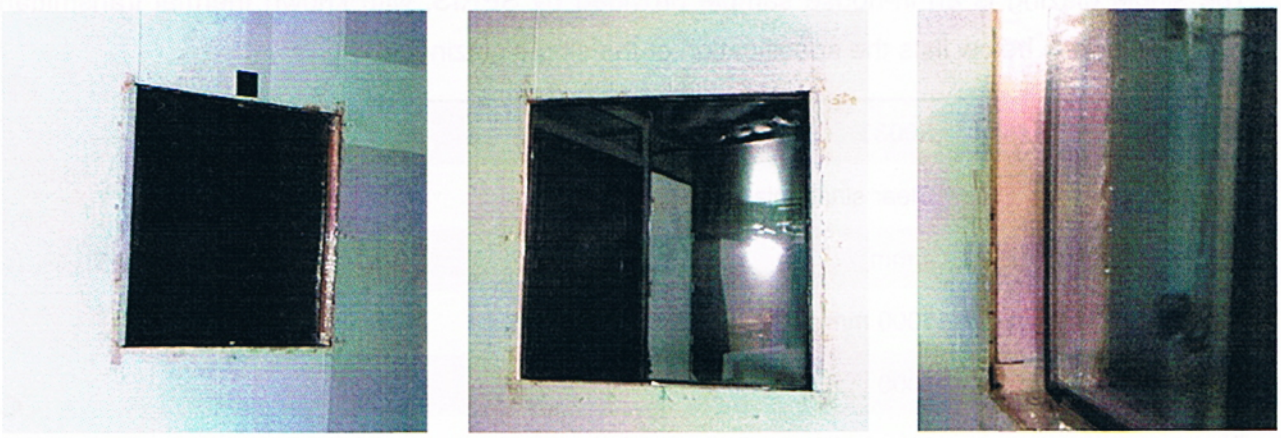

Figure 3. Photos of the installation. Left: view from outdoor side; middle: view from indoor side; right: zoom-in view of the gap between specimen and single glazing (the specimen is on the left)

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2. Test Procedure

2.1 Test Method

The measurement equipment and procedure are in compliance with ASTM C 1199 – 09e1.

Method	Standard test method for measuring the steady-state thermal transmittance of fenestration systems using hot box method
Exception	N/A

2.2 Test Apparatus

Calorimetric hot box was used in the measurement. Figure 4 shows the schematics of calorimetric hot box in thermal transmittance measurement mode. The specimen is mounted onto the opening of a well-insulated surround panel.Temperatures in room side and weather side are kept constant with a difference (refer to Section 2.3 for details). Air flow velocities, surface temperatures and emittances on both sides are controlled or monitored in order to maintain a desired surface heat transfer coefficient. Steady state heat flow through specimen due to temperature difference is measured to deduce the thermal transmittance value.The method defined in ASTM C 1199 is used for thermal transmittance calculation.

Test apparatus	Guarded hot box
Dimension of metered area	1.7 m (width) x 1.9 m (height)
Surround panel ID	SP001 (nominal opening size 1.0 m x 1.0 m)
Latest calibration date	CTS calibration: 18/07/2011 Wall loss calibration: 05/10/2011 Flanking loss calibration: 28/11/2011

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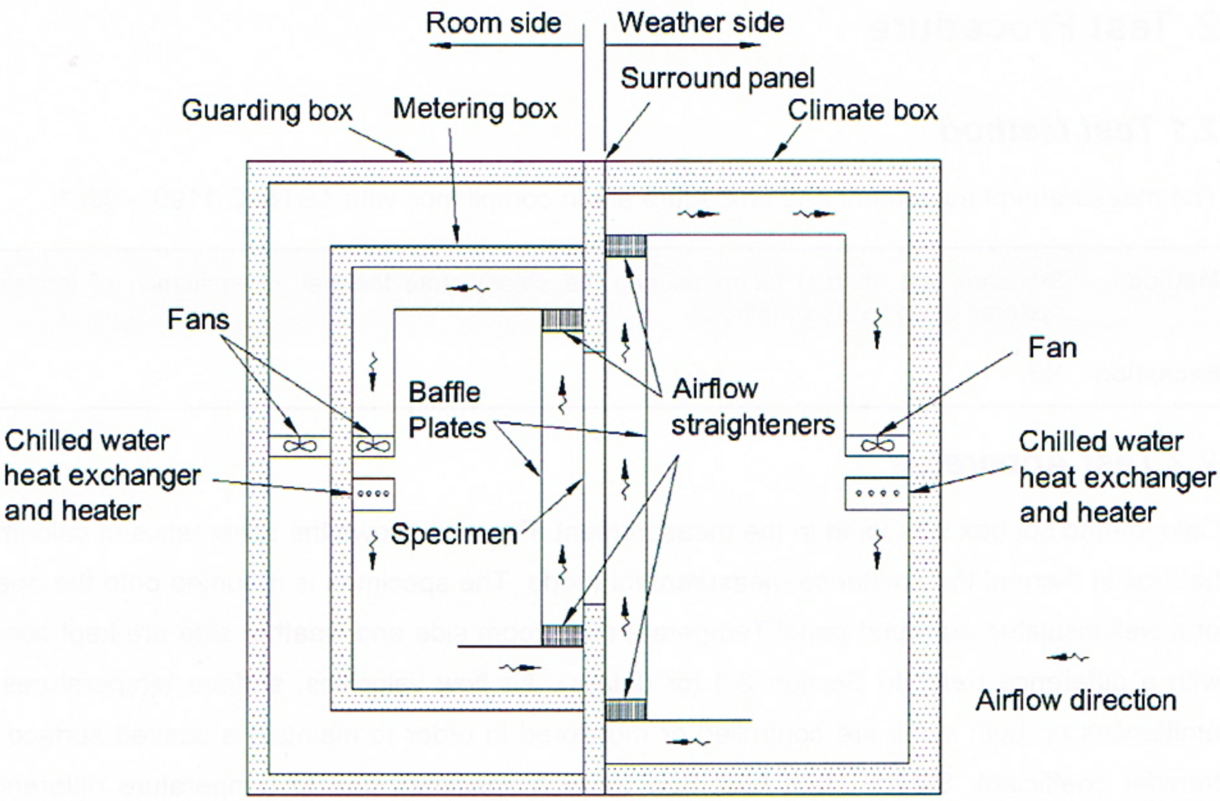

Figure 4. Schematics of the SERIS calorimetric hot box in thermal transmittance measurement mode

2.3 Boundary Conditions

The thermal transmittance test was carried out with summer environmental condition, as given in the table below.

Room side surface heat transfer coefficient	7.7 W/(m^{2}K) ± 5%
Weather side surface heat transfer coefficient	18 W/(m^2 K) ± 10%
Room side airflow direction	Vertically upwards
Weather side airflow direction	Vertically upwards
Room side temperature	24 ± 0.025 °C
Weather side temperature	32 ± 0.025 °C

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3. Test Results

Date of test	01/12/2011
Test duration	11 hours
Operator	Mr. DU Hui, Laboratory Technologist
Laboratory ambient temperature	25.7 °C
Laboratory relative humidity	46 %
Laboratory barometric pressure	100286 Pa
Pressure differential across the specimen	Less than 10 Pa
Metering air temperature, $T_{Metering}$	24.0 °C
Climate air temperature, $T_{Climate}$	32.0 °C
Metering airflow velocity	0.3 m/s
Climate airflow velocity	2.8 m/s
Heat exchange with chilled water loops, $Q_{Chilled\ water}$	-80.58 W
Heat exchange with electrical devices, $Q_{Electrical\ devices}$	45.29 W
Metering box wall heat transfer, Q_{Wall}	4.84 W
Flanking heat transfer, $Q_{Flanking}$	3.48 W
Surround panel heat transfer, $Q_{Surround\ panel}$	4.36 W
Specimen heat transfer, $Q_{Specimen}$	22.61 W
Specimen area, $A_{Specimen}$	1.0000 m^2
Thermal transmittance (U-value), U	2.83 W/(m^2 K)
Estimated uncertainty of thermal transmittance	± 0.14 W/(m^2 K)

Note:

a) $Q_{Specimen} = -(Q_{Chilled\ water} + Q_{Electrical\ devices} + Q_{Wall} + Q_{Flanking} + Q_{Surround\ panel})$;

b) $U = \frac{Q_{Specimen}}{A_{Specimen} \times (T_{Climate} - T_{Metering})}$;

c) The estimated uncertainty is the expanded uncertainty estimated with a coverage factor of k = 2 and a level of confidence of approximately 95%.

4. Disclaimer, Limitation of Liability

The test method ASTM C 1199 does not include procedures to determine the heat flow due to either air movement through the specimen or solar radiation effects. As a consequence, the thermal transmittance results obtained do not reflect performances which may be expected from field installation due to not accounting for solar radiation, air leakage effects, and the thermal bridge effects that may occur due to the specific design and construction of the fenestration system opening. The later can only be determined by in-situ measurements. Therefore, it should be recognized that the thermal transmittance results obtained from this test method are for ideal laboratory conditions and should only be used for fenestration product comparisons and as input to thermal performance analyses which also include solar, air leakage and thermal bridge effects.

The results stated in this test report only relate to the specimen tested. This test report shall not be reproduced, except in full, without the approval of the laboratory.

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