# CLIMA 2016 - proceedings of the 12th REHVA World Congress

*volume 2*

Heiselberg, Per Kvols

*Publication date:*
2016

*Document Version*
Publisher's PDF, also known as Version of record



*Citation for published version (APA):*
Heiselberg, P. K. (Ed.) (2016). *CLIMA 2016 - proceedings of the 12th REHVA World Congress: volume 2*. Department of Civil Engineering, Aalborg University.

# A Study on the Measuring of Solar Heat Gain Coefficient through the Measuring Equipment by Using Natural Sunlight

Soo Cho[#1], Seokhyun Kim[#*2]

[#]*Energy saving Laboratory, Korea Institute of Energy Research*
*152 Gajeong-ro, Yuseong-gu, Daejeon, Republic of Korea*
[1]scho@kier.re.kr

[*]*Department of Architectural Engineering, Yeungnam University*
*280 Daehak-Ro, Gyeongsan, Gyengbuk, Republic of Korea*
[2]ksh7000@kier.re.kr

**Abstract**
*The area of window was increased than the area of wall in building. For that reason the thermal insulation performance of window and the air tightness performance of window was increased by result of many research. But the solar heat gain performance of window differently affects to the energy consumption of heating and cooling. Therefore designer need to carefully select about window. Recently the method of measuring of solar heat gain coefficient of window by solar simulator was proposed in KOREA. The measuring equipment was proposed too. Also this method was regulated to Korea industrial standard. But the use of solar simulator has some problem that difference between solar simulator and natural sunlight. This mean is that the effect of natural sunlight through window to the energy consumption in building do not confirmed. Therefore authors studied many research and previous study about the solar heat gain performance of window and measured the solar heat gain performance of window through using the measuring equipment of the solar heat gain performance by use sunlight. The authors of this study were development of measuring equipment of SHGC. By the operation pre-test of measuring equipment, the application of the measuring method was confirmed. And the results of measuring about solar heat gain coefficients showed to requirement of improvement about equipment.*

***Keywords - Window; Solar Heat Gain Coefficient; Measuring Equpment; Natural Sunlight***

## 1. Introduction

As windows, unlike the envelop of building, possesses property of transmission, it has transmissivity of visible light and solar heat gain performance. Along with the characteristics of the windows, the significance of solar heat gain coefficient, which affects to the summer cooling loads, comes to the fore. Solar heat gain coefficient, as the standard indicator of the performance of solar heat gain of windows, refers to the ratio of solar radiation amount, before and after admitted through windows. Various researches are underway and measuring methods are developing to calculate the performance of solar heat gain of windows. Especially in Korea, measuring technique that applies solar simulator was developed and enacted by Korea Industrial Standard [1]. The equipment that Korea Industrial Standards suggested consists of solar simulator that enables to control the amount of solar radiation and climatic chamber and metering box that create indoor and outdoor environment. Heat flux that flows into indoor is also measured by heat flux meter. Kim(2014) assessed solar heat gain coefficient of double glazing through the SHGC measuring equipment that suggested by Korea Industrial Standard and then compared with simulation analysis results. As a result, validity of the measuring equipment was proved by identifying the errors, which was between 0.13% and 3.31% [2]. As this measuring equipment uses solar simulator, there could be a difference in solar heat gain of windows from natural sunlight. As the irradiation direction of solar simulator can be tested only when it irradiates the front of specimen, it is difficult to figure out the influence of solar radiation incidence of windows in the actual building. The result of the earlier research was the verification only about the glaze rather than the window; and, it even did not deal with the various shapes of windows and shading blinds. On the earlier research, solar heat gain coefficient measuring equipment was developed using natural sunlight.

In this research, the authors identified and proved the availability of SHGC measuring equipment through the experiments.

## 2. Development of the measuring equipment of solar heat gain coefficient

To measure the solar heat gain coefficient of windows, NFRC 201 (i.e., Procedure for interim standard test method for measuring the Solar Heat Gain Coefficient of Fenestration Systems using calorimetry hot box methods) suggests a measurement device [3]. NFRC 201 proposes the measuring equipment that applies calorimeter from natural sunlight exposed external environment. The calculation of SHGC mentions solar irradiation incident on the test specimen and the difference between heat flux through test specimen and heat flux due to air temperature difference of test specimen. Following equation (1) refers to the calculation of SHGC that penetrated the test specimen.

$$SHGC = \frac{Q_S - Q_{U-factor}}{A_S E_S} \tag{1}$$

To confirm the heat flux through test specimen ($Q_S$), it is necessary to check heat flux through solar calorimeter walls ($Q_{Walls}$), heat flux through surround panel($Q_{SP}$), heat flux by flanking loss($Q_{fl}$), heat removed by fluid heat extraction system ($Q_{fluid}$), and heat input into solar calorimeter by pump and fans($Q_{AUX}$). Equation (2) indicates calculation of heat flux through test specimen, and figure 1 illustrates the scheme of the measuring device.

$$Q_S = Q_{Walls} + Q_{SP} + Q_{fl} + Q_{fluid} + Q_{AUX} \quad (2)$$

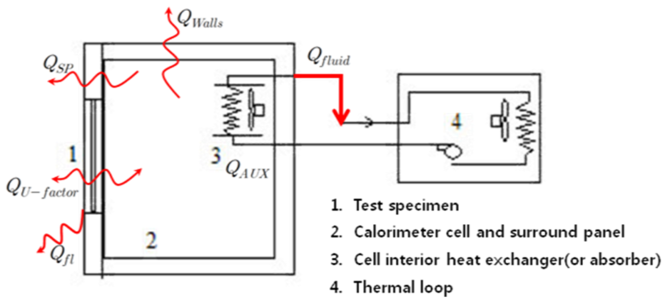


Fig. 1 Typical components used in a calorimeter apparatus by NFRC 201

NFRC 201 SHGC measuring method can be affected by the external environment through the wall of calorimeter and surround panel. After assessing the factor of outdoor environment, it applies to the component of property of material that constitutes the measure equipment; therefore, this method is difficult to calculate the SHGC outdoor temperature, wind velocity and the convection heat transfer coefficient. Thus, to minimize the flow of heat flux that is created from the parts except for the specimen, through installing the thermal guard that surrounds the calorimeter, it was constructed to equally operate the internal temperature of calorimeter and thermal guard temperature. Additionally, specimen surround panel and calorimeter was unitized, and a part of the calorimeter was designed to be filled with the specimen. Then, it does not consider the heat flux through surround panel ($Q_{SP}$), and it is to avoid heat loss and heat gain of another specimen surround wall. Measuring equipment also enables to move and change the direction depends on the solar altitude and direction of the sun to control the incidence angle. For counting the $Q_S$, $Q_{SP}$ was excluded. Equation (3) is the calculation of heat flux through test specimen, and figure 2 indicates the scheme of developed measuring equipment.

$$Q_S = Q_{Walls} + Q_{fl} + Q_{fluid} + Q_{AUX} \quad (3)$$

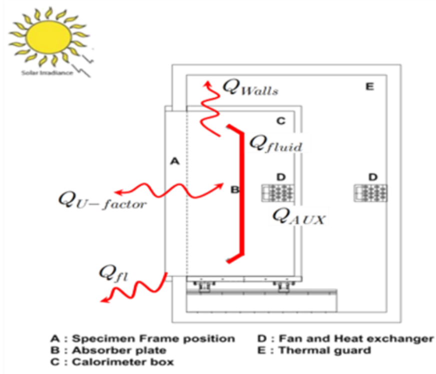


Fig. 2 Scheme of developed measuring equipment

## 3. Measurment of SHGC by developed the measuring equipment

NFRC 201 sets up to maintain the constant internal temperature of calorimeter To verify whether solar heat gain coefficient can be calculated by using the developed SHGC measuring equipment, specimen was installed on the measuring device and it was checked whether set point of internal temperature can be maintained or not. Preceding research proved that set point of internal temperature of the calorimeter can be retained during the nigh time when there is no solar radiation. The quantity of inward solar heat gain, a removed heat flux by absorber plate, or quantity of extraction by heat exchanger at fans should be checked to confirm the solar heat gain coefficient. Thus, 6 mm of clear glass was installed with the size of 1,500 mm (W) Ｘ 1,500 mm (H), and indoor temperature was set at below 15 ℃. The size of indoor absorber plate is 1,240 mm (W) Ｘ 1,240 mm (H). It was tested on March 4th 2015, from 9 a.m. to 9 p.m. Figure 3 illustrates the exterior of measuring equipment of SHGC.

When front and back of air temperature at absorber plate were compared, after 12 p.m., the moment when quantity of solar radiation increases to over 600W/㎡, front part showed higher air temperature, up to a maximum of 5℃, than the back part. Surface temperature at absorber plate also increase up to a maximum of 33 ℃; it is higher than the temperature of flow (i.e., between 12 ~ 16 ℃) of the absorber plate. It explains that not enough to cooling capacity comparing to the solar heat gain quantity of calorimeter. Air circulation also looks problematic because the distance between absorber plate and specimen is only 100 mm. Figure 4 describes internal air temperature of calorimeter and surface temperature of absorber plate, and figure 5 is about the quantity of solar radiation during the experiment periods.

Fig. 3 Exterior of measuring equipment of SHGC

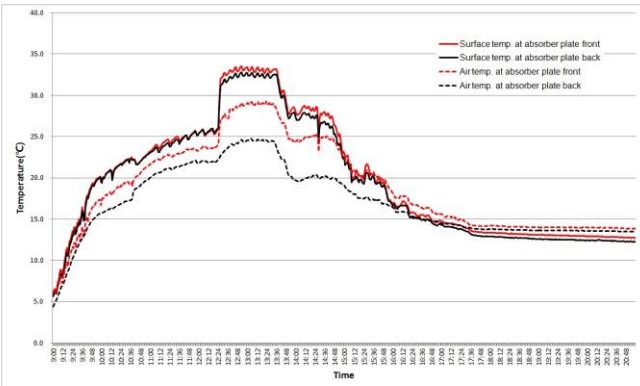


Fig. 4 Comparison of temperature in calorimeter

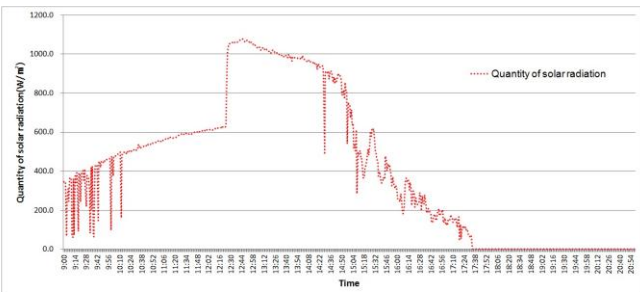


Fig. 5 Measured quantity of solar radiation

## 4. Conclusion

In this study, the authors was approved measuring method of solar heat gain coefficient by the developed SHGC measuring equipment. After the installation of 6mm clear glass, it was discovered that internal temperature of calorimeter was imbalanced. It was also found that heat exchange of absorber plate was not smooth because the temperature of absorber plate was higher than the temperature of the supplied flow. Based on the result of this research, it is essential to improve the newly developed SHGC measuring equipment. On the future research, it is required to discuss about the increase of the heat exchange quantity of absorber plate and necessity of installation of extra equipment to balance the internal air temperature of calorimeter.

## Acknowledgment

This work was supported by R&D program of MSIP/COMPA. [2015K000229, General requirement performance evaluation of commercialized highly insulated vacuum window system).

## References

[1] Korean agency for technology and standards, 2014, KS L 9107:Testing method for the determination of solar heat gain coefficient of fenestration product using solar simulator, www.kats.go.kr

[2] Kim, Tae-Jung, Choi, Hyun-Jung, Kang, Jae-Sick, Park, Jun-Seok, 2014, Development and Evaluation of an Apparatus to Measure the Solar Heat Gain Coefficient of a Fenestration System According to KS L 9107, Korean Journal of Air-Conditioning and Refrigeration Engineering, Vol. 26, 512-521.

[3] National Fenestration Rating Council, 2010, NFRC 201 :Procedure for interim standard test method for measuring the solar heat gain coefficient of fenestration systems using calorimetry hot box methods, www.nfrc.org.

[4] Kim, Seok-Hyun, Park, Jeong-Hwan, Cho, Soo, 2014, A Study on the development of measuring equipment about the solar heat gain performance of window by use natural sunlight, Korea J. Archit. Instit. Spring Conf. 2014, Vol. 33(1), 239-240.