Improved value of temperature different on climatic chamber climatic chamber for thermal conditions

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Abstract. Climatic chamber machine at Climatherm laboratory was used for thermal test on wall model. This climatic chamber machine allows the measurement of different environmental variables. In this research, thermal performance tests were conducted on wall model imposing boundary condition vary the cavity distance between two wall elements and then these tests were performed in steady-state conditions. Wall model prepared from aluminum composite and was maintaining controlling the air temperature difference between the two chambers 20°C and the air debit constant. In the first part of this paper, a description of the climatic chamber machine, operation ranges, and theoretical work principles of the climatic chamber are presented. Then, the second part shows the results for the thermal test on wall model. The thermal test performed with the climatic chamber machine allows simulating environmental conditions accurately during in certain distance of cavity and specific air debit. As a result, the configuration settings value at the climatic chamber machine has to correction to reach the air temperature difference as planned. The air temperature difference at the beginning of the thermal conditions on wall model is less than the planned air temperature difference. However, this correction value of temperature shows agreement result with the value 20°C in temperature different.

1. Introduction

Contribution of this research, in general, is to contribute to the reduction of energy consumption and greenhouse gas emissions. The focus of this research is contributing to the energy performance of buildings through the study of a bioclimatic wall (ventilated wall or parietodynamically insulated wall). In the basic principle of the ventilated wall cavity have an essential role in generating a convection exchange among wall model axis and disturbance of the radial heat flux between the indoor and outdoor environment. Many authors have investigated influence cavity distance to energy performance; principally, these studies deal with the mathematical model and experimental tests [1, 2, 3, 4, 5, 6, 7, 8, 9]. However, little research has been made in laboratory tests to find the proportional value of the input variable, which has an agreement result with the reference value of temperature.

The first tests activity of the climatic chamber climatic chamber in 2017 for thermal conditions of wall model classic and 2018 for the calculation coefficient of $h$ on wall model surface [10, 11]. This apparatus has shown possibilities of controlling some atmospheric variables but also had limitations on ambiance air temperature measurement. This activity has an improved method of the previous one; the ambient air temperature has a good agreement with the reference value of air temperature...
difference and was used for modeling the coefficient of $h$ on wall model of the test; the ventilated cavity wall.

The climatic chamber has two climatic chambers and a specimen holder in between of two climatic chambers. In each climatic chamber, they can guaranty heat production by the electric radiator, and they can guaranty cooling production by compressor cycle.

This paper presents two main items: (i) the climatic chamber machine instrumentations; (ii) preliminary results of improvement to temperature ambiance of the climatic chamber.

2. General diagram of the acquisition system

General diagram of the acquisition system Figure 1 at this studies was used two sensitive acquisition equipment, Keithley 2700 with multiplexer and data acquisition from National Instrument. First one Keithley 2700 with multiplexer was used to communicate data record between the flux meter instrument, type K thermocouple and the computer as the center of data processing. Another acquisition is data acquisition NI-9219 used to communicate data record between the hot-wire anemometer and the computer.

3. Instruments of measurement

The climatic chamber machine equipped with instrument thermo-resistance PT-100 Figure 2 at each climatic chamber for control temperature evolution of the climatic chamber machine.

![General diagram of the acquisition system](image1)

**Figure 1.** General diagram of the acquisition system

![Measuring instrument at each climatic chamber](image2)

**Figure 2.** Measuring instrument at each climatic chamber

Inside of each climatic chamber, there are three pcs of type K thermocouple, as shown in Figure 3, this thermocouple was installed horizontal position at the center of each climatic chamber. The function of this type K thermocouple to measure the air temperature of the climatic chamber. There are also type K thermocouple and flux meter in Error! Reference source not found., respectively, to
measure surface temperature each side of wall model and to measure the quantity of heat flux which traverses on wall model.

![Figure 3. Measuring instrument to measure ambiance air temperature](image)

**Figure 3.** Measuring instrument to measure ambiance air temperature

![Figure 4. Instruments flux meter and type k thermocouple on wall model surface](image)

**Figure 4.** Instruments flux meter and type k thermocouple on wall model surface

4. **Test condition value and calculation coefficient of** $h$

Testing condition use to this study was (0°C, 75%) for climatic chamber cold side and (20°C, 55%) for climatic chamber hot side. Air temperature difference use between two climatic chambers is 20°C. Otherwise, based on Newton’s law as shown in Equation (1) to do a calculation coefficient of $h$, there are variables which mandatory to measure; measure the value of ambience air temperature ($T_a$) of each climatic chamber, measure the value of surface wall temperature ($T_p$) each side of wall model and measure the value of heat flux ($q$) which cross to wall model.

$$h = q/(T_a - T_p)$$  \hspace{1cm} (1)

5. **Preliminary results**

5.1. **Cold junction correction**

Cold junction correction does correct measurement result of data recorder Keithley 2700 data acquisition. Method to use by drowning end section of the type K thermocouple into a jar of mixed water and ice, *Error! Reference source not found.* Based on the measurement result in *Error! Reference source not found.* for temperature 0°C of mixed water and ice, Keithley 2700 showed the measurement result at 0.03°C. Its mean 0°C actual Keithley 2700 resulted in the measurement 0.03°C, so this value has an excellent agreement to the study.
5.2. Temperature measurement at the climatic chamber cold side and climatic chamber hot side

The settings value for the climatic chamber was (0°C, 75%) for climatic chamber cold side, and (20°C, 55%). That value was in condition steady-state, another result there is measurement result by the climatic chamber machine, thermo-resistance instrument PT-100 inside each climatic chamber. Moreover, this study will show measurement result ambiance air temperature from type K thermocouple instruments.

**Figure 6.** Measurement result from cold junction correction test
Measurement result showed that the setting process of temperature hot side climatic chamber at the hot side and cold side are stabilized at the point 20°C and 0°C respectively. Measurement result from thermo-resistance instrument PT-100 at each climatic chamber side respectively showed average value of 19.77°C and 0.06°C, those average value are evolving near the setting process of temperature hot side climatic chamber. Measurement results from type K thermocouples installed in the center of the climatic chamber have a homogeneity result at hot side chamber and cold side chamber, the average value of the ambient air temperature respectively are 15.71°C and -2.63°C. The air temperature difference between the two climatic chambers are 18.34°C; this value needs to be corrected to the value 20°C in air temperature difference.

5.2.1. Corrected value temperature control to ambience air temperature

In order to result in the expecting value from the air temperature difference between two climatic chambers, setting points of temperature to cold side chamber have to change from 0°C to -2°C. So the variable use to input to the climatic chamber machine, (-2°C, 75%) for cold side chamber and (20°C, 55%) for hot side chamber.
The result has shown the average value of air temperature control are show at climatic chamber hot side in Figure 9 and cold side in Figure 10 respectively 15.71°C and -4.52°C, temperature gain is 20.23°C, the result showed a good agreement with the reference temperature value.

5.3. Calculation to coefficient of h on wall model surface
Calculation to coefficient of h on wall model surface for condition wall cavity distance 5 mm and constant air debit 10m³/h with the configuration condition setting to climatic chamber (-2°C, 75%) and (20°C, 55%) resulted the coefficient of h to cold side climatic chamber and to hot side climatic chamber respectively 19 W.m⁻².K⁻¹ and 21 W.m⁻².K⁻¹.

From the calculation result to the coefficient of h, showed that the climatic chamber is capable of conducting the next test with other variables of the study parametric.

6. Conclusion
The climatic chamber at Climatherm laboratory was used in order to perform thermal conditions to wall model. This climatic chamber allows the user to impose specific environmental conditions through a closed circuit of air. Preliminary results of thermal conditions lead to the next conclusions:
The cold junction correction value showed a good agreement value of measurement by the Keithley 2700 data acquisitions.

The value on configuration condition settings to climatic chamber must be corrected to get an excellent agreement value to reference parametric value.

This device will be used in the future to conduct a parametric study on thermal conditions on the ventilated cavity wall in the variable of different wall cavity distance and different value of constant air debit.

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