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Characterized Temperature and Humidity for Classroom Comfort Zone in Bali

L P I Midiani, I W A Subagia, and I B G Widiantara

Bali State Polytechnic

putuikemidiani@pnb.ac.id

Abstract. Thermal comfort conditions were result from a desirable combination of temperature, humidity, air movement, and air cleanliness. The thermal comfort have a significant impact on people's productivity and health. This study written as a result of theoretical and practical research, conducted a series of experiments aimed at characterization on classroom comfort zone in a tropical climate in Bali. A series experiment was conducted in an air conditioning simulation process. Through experimental study, temperature and relative humidity are studied. The experiments were conferred with reference literature to correlate the standard comfort. The obtained results indicate to improve comfort in hot-humid environment were to control the temperature and humidity.

1. Introduction

In tropical climates, thermal comfort studies are necessary to obtained the comfort zone, where buildings are exposed to solar radiation throughout the year.

The thermal comfort have a significant impact on people's productivity, health, morale, working efficiency and satisfaction [1,2].

Thermal comfort standards are therefore central to not merely providing comfortable environments but also ensuring a sustainable design through low heating and cooling energy used in buildings [3]. For human's thermal comfort is essential to control temperature and humidity. In every life humidity control is obviously required wherefore humidity usually associated with the risk of infection through germs, bacteria or virus [4].

The behavior of air varies with its temperature, the higher the temperature, the greater its ability to hold moisture. To obtain comfortable conditions, combination of temperature, humidity, air movement, and air cleanliness control obviously required. The process of treating air so as to control simultaneously its temperature, humidity, cleanliness and distribution to meet the requirements of the conditioned space defined as air conditioning [5]. In the summer require automatic control of the air conditioning system to maintain the desired room temperatures, requires dehumidifiers, which pass air to be cooled over cold evaporator surfaces. Humidity controls operate to remove moisture from the air.

Comfort zone represents a considerable area, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recognizes the comfort range for most people when temperature between 70 ºF and 85ºF (21-29ºC dry-bulb temperature) and relative humidity between 30% and 70% as shown Fig. 1.

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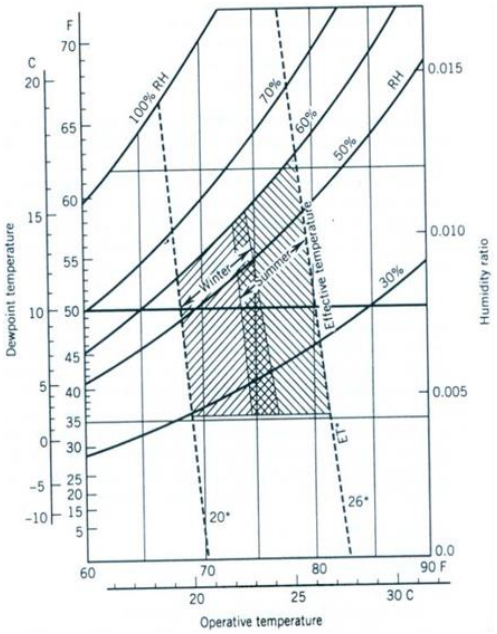

Fig. 1. Graph of comfort zone [Andrew et al, 2004]

There has been widely studied in respect to comfortable. In Japan the highest mean comfort temperature when the occupants felt less humid (dry condition), relevant to air movement [6].

Human thermal comfort under high temperature or high humidity conditions can greatly improve and energy used for air conditioning decrease by airflow. To maintain thermal sensation at a higher air temperature or relative humidity (RH) needed a higher air speed [7].

To improved comfort and reduced warm sensation, combination of cooling ceiling and desk fan were exerted significant effects. The combination had potentials of energy conservation since it could extend acceptable range and reduce the energy for dehumidifying indoor air [8].

Compared to the environment temperature, the local environment humidity has a greater cooling effect. The temperature drop and humidity increase rates under different pressures, droplet diameters, airflow rates, temperatures and humidity levels [9,10] .

To regulate air temperature and humidity, these experiment would conducted air conditioning simulation process were equipped with ducting, adding a humidifier and heater device.

2. Methodology

2.1 Experimental Facilities

The experiments divided into two sections: existing air conditioning simulation process and simulation results and discussion. Air conditioning simulation process were equipped with ducting, therefore can measure and record the data and needed technical information. The experiments carried out in Air Conditioning Laboratory at Bali State Polytechnic, Bali, Indonesia. Bali is one of the islands in Indonesia, is characterized by hot-humid climate in summer and the relative humidity outdoors ranges from 60-90%. The information about outdoor globe temperature were from BMKG (Badan Meteorologi, Klimatologi dan Geofisika). The outdoor globe temperature and the relative humidity were used to support the analysis, and characterize the outdoor conditions during the experiments.

The layout of experimental apparatus as shown in Fig. 2. Ducting dimension were 23.5 cm x 26.5 cm x 271 cm. The important physical parameters were recorded during the experiments. Air temperature, humidity and air velocity were measured with environmeter, while relative humidity, moisture content, wet bulb temperature and other were obtained at Psychrometric chart.

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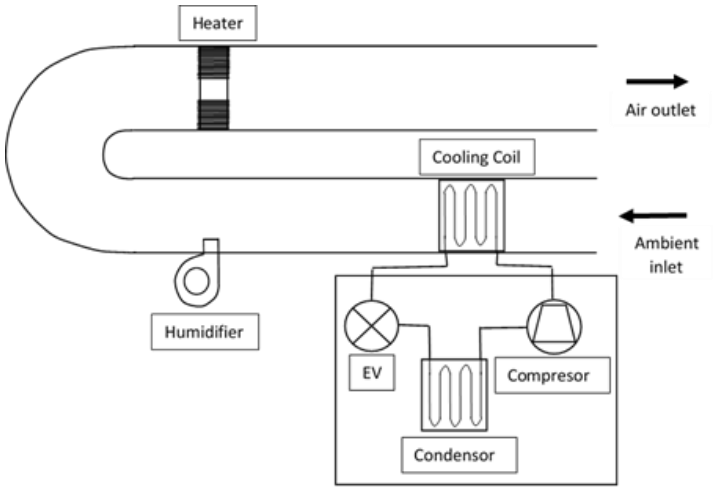

Fig. 2. Experimental apparatus

2.2 Experimental Procedure

The experiments were carried out from July to August 2017. The important physical parameters were recorded during the experiments. The measurements were conducted to obtaine the temperature and humidity therefore determine the relative humidity on Psychrometric chart. First experiments were measure temperature and humidity along the ducting, before evaporator and after pass the evaporator, each lasted for 6 h.

Second experiment was performed by adding a humidifier device placed after the evaporator, then carried out measurements of air temperature and humidity before entering evaporator, after pass evaporator and after pass humidifier device.

Third experiment was performed by adding a heater placed after the evaporator, then carried out measurements of air temperature and humidity before entering evaporator, after pass evaporator and after pass heater device. Detailed information of air temperature and humidity that has been recorded were shown in process in Fig. 3. The Psychrometric chart described process changes to regulate air temperature and humidity.

3. Conclusions

To improve the indoor environment in humid climates, such as Bali, regulate air temperature and humidity is a needed.

Fig.3 explained the process of air conditioning simulation. Three kinds of colors that explained the air conditioner process. The red line stated the ordinary air conditioner process, the green line stated the air conditioner process with added humidifier device, and the yellow line stated the air conditioner process with added heater device. The ordinary air conditioner process, temperature decrease after pass the evaporator. The resulting temperature were fulfill the comfort zone, but the relative humidity not fulfill the comfort zone yet. Humidifier and heater device added in order to change relative humidity so that fulfill the comfort zone.

The results showed that temperature increase and relative humidity decrease when added heater device. Relative humidity decrease caused moisture content and humidity decrease. Temperature constant and relative humidity decrease when added humidifier device. Humidifier device were produce cold steam, so temperature constant.

The obtained results indicate control temperature and humidity would improve comfort in hot-humid environment.

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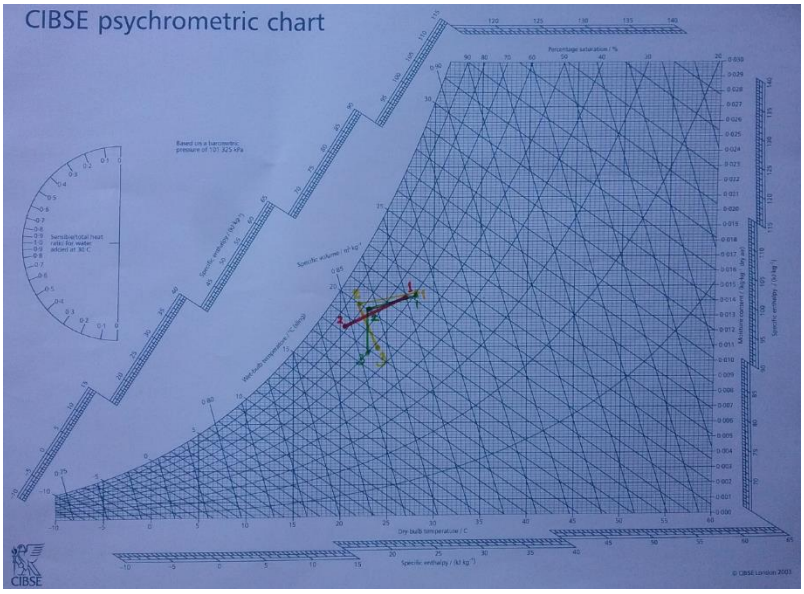

Fig. 3. Air conditioner process

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