THE EVALUATION OF AN UNFAVOURABLE USED OF HUMIDIFIER AIR COOLER

EVALUASI KETIDAKTEPATAN PENGGUNAAN PADA PENDINGIN UDARA DENGAN *HUMIDIFIER*

Ihsan Supono, Wuwus Ardiatna
Research Center for Testing Technology - Indonesian Institute of Sciences
ihsan.supono@gmail.com

ABSTRACT

The humidifier cooler (or commonly known as air cooler) is a common device used by individuals to gain a more comfortable space and widely available in Indonesian market. Regarding either prices or power consumption, this device is an intermediate choice among household appliances with similar purpose, such as air fan and refrigerator-based air conditioner (AC). However due to the device working mechanism, there could be a possibility transfer of evaporated liquid from cold water flow to the output air flow that probably makes an increase of the relative humidity of the room space. This phenomenon raises a concern because the rise of the relative humidity during an attempt to reduce air temperature is undesirable due to the thermal comfort principle. Through simulations, it can be evaluated that room temperature could be kept at 28,1°C and 26,4°C for a normal and an unfavourable condition, respectively. However, in the unfavourable condition, there is an increase of room humidity by 38,1% which is significant enough to shift room condition toward an unhealthy state.
Keywords: humidifier, air cooler, safety, health

ABSTRAK

Pendingin dengan fungsi humidifier (atau biasa dikenal sebagai air cooler) adalah perangkat yang umum digunakan untuk mendapatkan ruang yang lebih nyaman serta banyak tersedia di pasar Indonesia. Terkait dengan harga atau konsumsi daya, perangkat ini merupakan salah satu pilihan di antara peralatan rumah tangga lain, seperti kipas angin dan pendingin berbasis refrigeration (AC). Namun karena mekanisme kerja perangkat ini, ada kemungkinan terjadi kontribusi air yang teruapkan dari aliran air dingin ke aliran udara output yang memiliki dampak pada peningkatan kelembaban relatif dari ruangan. Fenomena ini menimbulkan kekhawatiran karena kenaikan kelembaban relatif, yang dilakukan dalam upaya untuk mengurangi suhu udara, menimbulkan efek yang tidak diinginkan dari sisi

kenyamanan termal. Melalui simulasi operasi pada kondisi normal dan pada kondisi tertentu, temperatur ruangan dapat dipertahankan pada 28,1°C dan 26,4 °C. Akan tetapi, pada penggunaan yang tidak tepat, terjadi peningkatan kelembaban ruangan sebesar 38,1% yang cukup signifikan untuk menggeser kondisi ruangan menuju keadaan yang tidak sehat.
***Kata kunci**:* humidifier*,* air cooler*, keselamatan, kesehatan*

1. INTRODUCTION

The humidifier cooler (or commonly known as the air cooler) is a device whose main function is blowing the air and altering the properties of the air flowing through. It is a common device used by individual(s) to gain a more comfortable space and widely available in Indonesian market; a survey to three well-known on-line shops, showed that at least there are ten brands offer this device. Regarding either prices or power consumption, this device is an intermediate choice among household appliances with similar purpose, such as air fan and refrigerator-based air conditioner (AC).

Its working principle is likely to be a combination of air fan and refrigerator-based air conditioner (AC). Its resemblance to fans is because their function to blow air to surrounding area, while the similarity to an AC is their function in modifying air flow temperature. Different to the refrigerator that use refrigerant as cooling substance, humidifier cooler employs a heat exchanger between cold water flow and the air flow, to reduce the output air flow temperature. The schematic of a humidifier cooler is displayed in Figure 1. During the exchange of heat from the input air flow to the colder water flow, there is air-water contact, consequently, there could be a transfer of evaporated liquid from cold water flow to the output air flow that probably makes an increase of the relative humidity of the room space. This phenomenon raises a concern because the rise of the relative humidity during an attempt to reduce air temperature is unfavourable due to the thermal comfort principle.

In this project, the humidifier cooler is operated in a normal and an unfavourable condition, for the purpose of the measurement of the room temperature and humidity so that the different effect of humidifier cooler to the room temperature and humidity can be evaluated. The obtained data are then compared to the values stated in the guidance of healthy room.

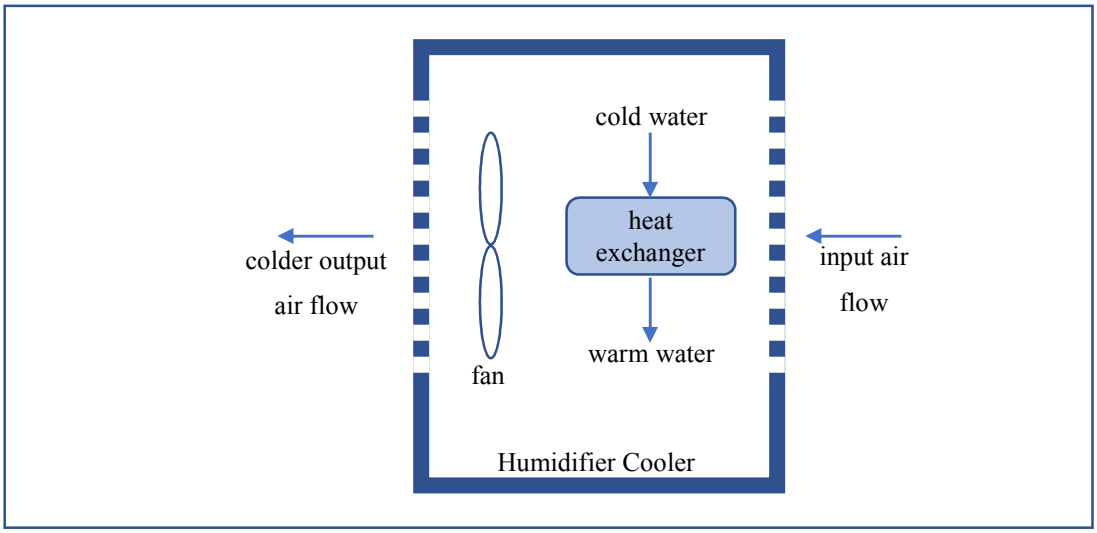

Figure 1. Humidifier cooler schematic

Thermal comfort, to a certain degree, is essential for every individual since they need a comfortable thermal condition in assurance for performing appropriately. Similar to electronic instruments that required certain working temperature in which they can operate properly, the unsuitable thermal condition will affect either individuals physiology or psychology (Fang, Clausen, & Fanger, 1998). Naturally thermal comfort is a subjective matter, hence any thermal environment condition that is categorized comfortable by an individual could be different to other people perception. The standard for thermal environmental conditions for human occupancy (ASHRAE, 2013) stated that air temperature and humidity are the key parameters in determining thermal comfort, along with metabolic rate, clothing insulation, radiant temperature and air speed. In regard of Ministerial Decrees, as depicted in Figure 2, which are the directives in providing healthy room in workplace and household (Kemenkes, 2011, 2016), it is essential to provide 30% to 70% of relative humidity and 23°C to 26°C of temperature in offices (orange lines), while air quality in the household (black lines) should be in 40% to 60% of relative humidity and 18°C to 30°C of temperature. These requirements of healthy room will be a base of the discussion.

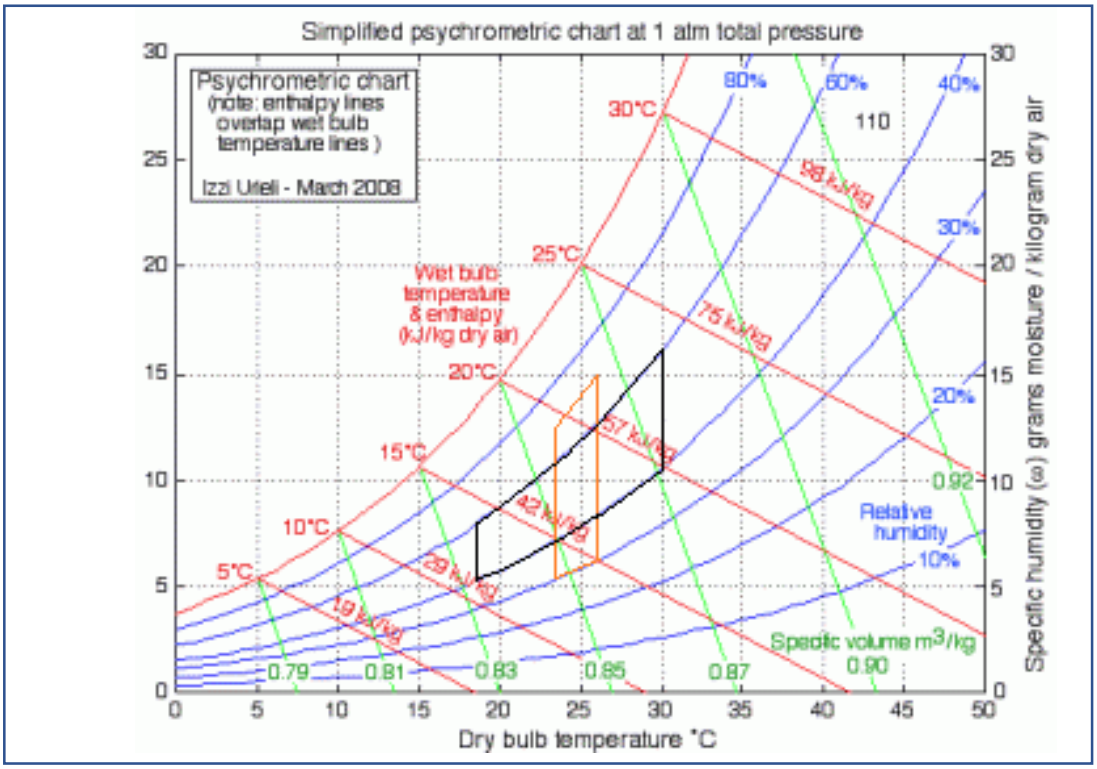

Figure 2. Healthy room in accordance with ministerial decree in simplified psychrometric chart

Like other household electrical equipment, the humidifier cooler is also accompanied by user manual that must comprise all necessary detail for the device to perform. It should be assumed that following instructions stated in the manual will avoid user from any possible risks. For example, when the manual stated a high limit of ambient relative humidity of 40%, user should not operate such device if the ambient relative humidity is above the permitted value. Another statement that requires for the device should be placed near an opening should be construed that the device must not be operated in a close room. However, there are some tendencies that the step of reading the user manual before operation, somewhat, ignored especially for devices that easy to use (Mehlenbacher, Wogalter, & Laughery, 2002; Novick & Ward, 2006; Young & Wogalter, 1990). This ignorance could lead to an unfavourable condition of operation, hence, in this evaluation such unfavourable condition is also considered.

2. MEASUREMENT

The measurement setup was designated to simulate the normal condition of the cooler in daily use and was executed in several days following the local working hours from 9am to 3pm; the time interval was chosen with an assumption that thermal conditioning is necessary during the time.

The measurement take place in P2TP LIPI at Kawasan Puspiptek Tangerang Selatan which is located at the border between two counties (Tangerang Selatan and Kabupaten Bogor) both climatic profiles ("Layanan Database Badan Meteorologi, Klimatologi dan Geofisika,") are displayed in Table 1.

Table 1. Annual average temperature and relative humidity of Tangsel and Bogor

Annual	Tangsel Daily				Bogor Daily			
	T-rate	T-min	T-max	RH-rate	T-rate	T-min	T-max	RH-rate
Ave	27,8	24,5	32,8	78,2	21,5	18,5	26,0	84,5
Max	30,1	27,4	36	96	24	20,4	30	99
Min	24,3	21	25	60	18,5	15,8	21	62

All measurement was conducted in the same room to provide the same physical room properties. The room has dimension of 4,8 (length) x 3,6 (width) x 3 (height) in meter scale, with plastering wall, and there was no special treatment for the room condition. We let the room empty, only table and chair remain inside the room. The possible opening of the room are a single door and the windows that could swing and make 10 cm opening. During the measurement, we assume that there is no vapour absorption from the wall.

The device under test (DUT) is a 50W household indoor air cooler with a water reservoir and ice packs. In the evaluation of its performance, the DUT was put in two conditions. The first condition was to simulate a normal use and the later was to simulate a condition when there was faulty in the use of the device. Regarding to the instruction for use, the DUT must be run in a room with air circulation, therefore, in normal use condition, the room door and windows were open to let air circulation. Vice versa, they were close to simulate unfavourable condition. Since the device is intended to use in a household, a room preconditioning is not necessary. There is no other room conditioner operated during measurement. The measurement set up of this work is shown in Figure 3.

All the measurement was conducted using a GL240 midi logger. The K-thermocouple and B-530 humidity sensor were set on the logger, in different channels.Three measurement points were setup. The M_0 sensor was placed 30 cm to the wall outside of the room, to measure the outside temperature and humidity during the measurement.

The M1 and M2 sensors were put inside the room, 1m from the windows and 1m from the adjacent walls, close to the DUT.

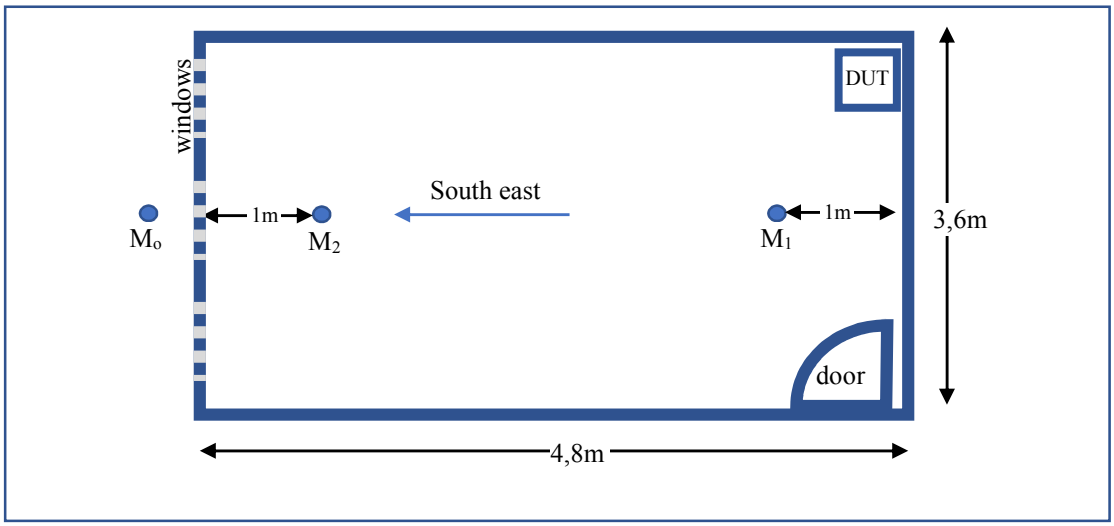

Figure 3. Measurement setup

3. DISCUSSION

The humidity and temperature measurement of both conditions (normal use and unfavourable condition) are plotted in **Error! Reference source not found.** and **Error! Reference source not found.**. In the normal condition from Figure 4, the average humidity at M1 (RH1) and M2 (RH2) are 75,1% ± 1,04% and 74,7% ± 1,16%, and based on the graph, the humidity of the room is slightly steady, even though there are increasing value but it's lower than the normal condition, which are 3,6% - 4,1% as for the average temperature at the M1 (T1) and M2 (T2) are 28,1 ºC ± 0,05 ºC and 28,2 ºC ± 0,49 ºC, even the average of the room the same, but temperature is increasing from 26,5 ºC ± 0,49 ºC to 29 ºC ±0,5 ºC.

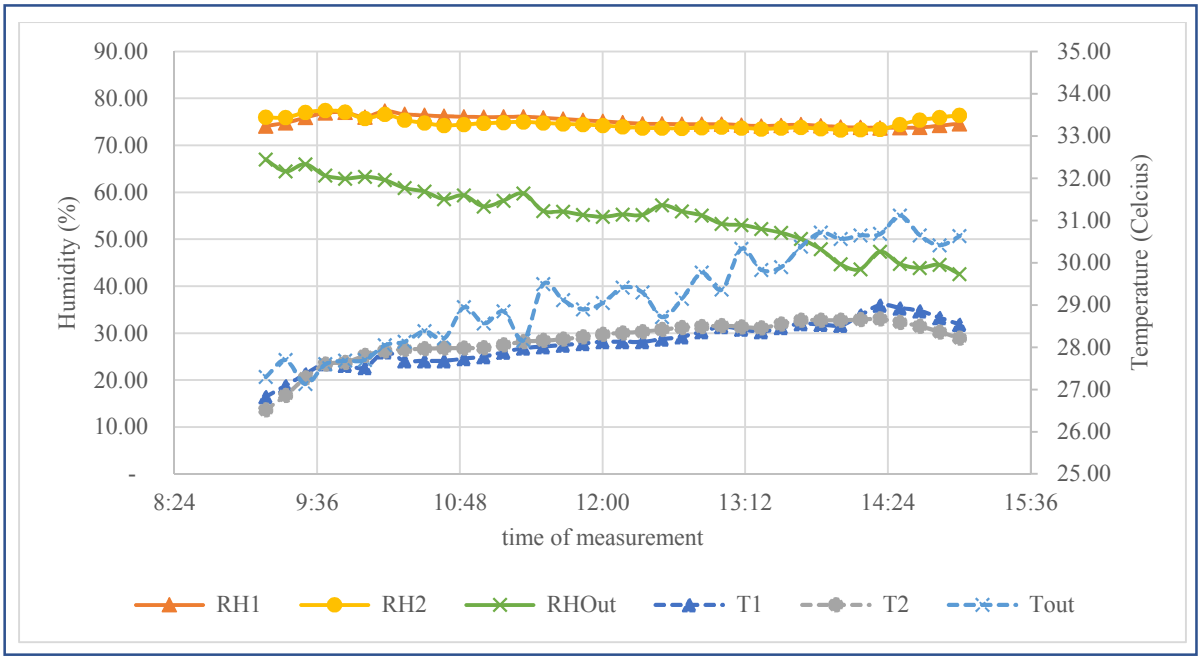

Figure 4. Humidity and temperature measurement in a normal use

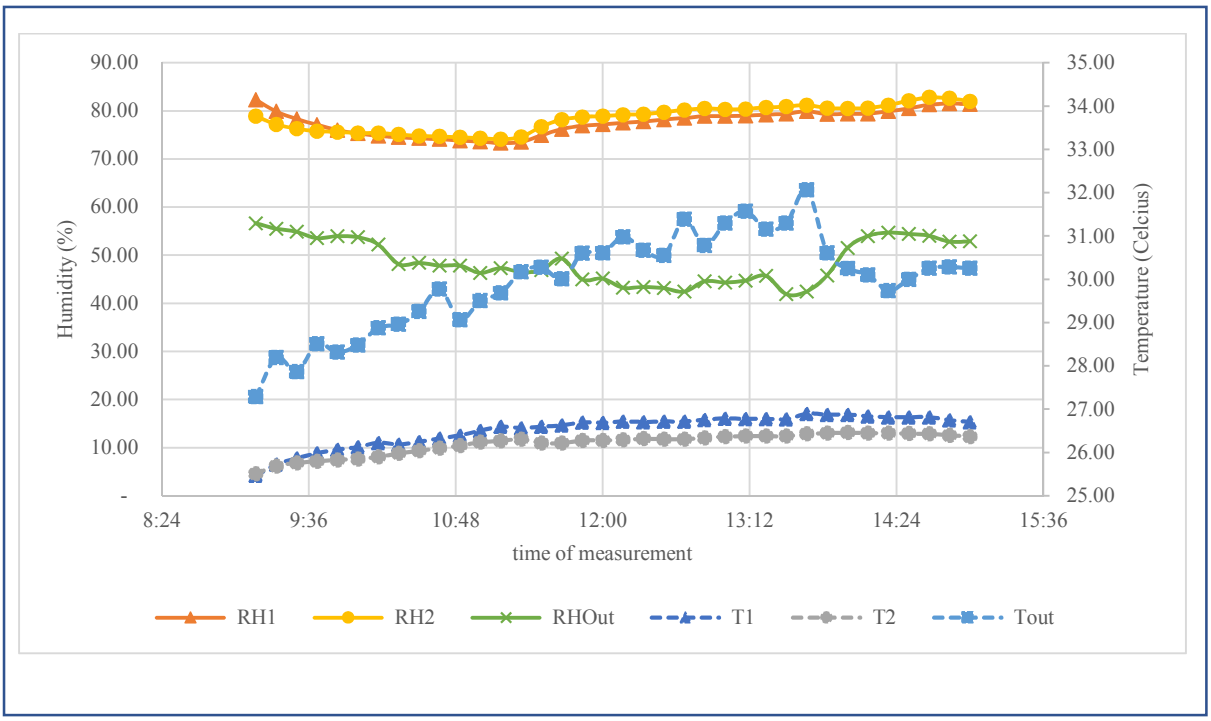

Figure 5. Humidity and temperature measurement in unfavourable condition

Figure 5. shows the average humidity at M1 (RH1) and M2 (RH2) are 77,7% ± 2,56% and 78,4% ± 2,73%. The humidity measurement increase by 8,7% to 9%, as for the average temperature at the M1 (T1) and M2 (T2) are 26,5ºC ± 0,35ºC and 26,2ºC ± 0,25 ºC, although at the first measurement it shows that the temperature is low at 25,5 ºC and the temperature increment is not more than 2 degree from

the start. Based on this result, it is mean that the room temperature is homogenic. The differences between the normal and the unfavourable conditions were then evaluated using t-test, to analysing the significance of the differences between the two conditions. The result shows that our two-tailed tests were not significant difference at 0,05 alpha levels for the humidifier air cooler usage at normal and unfavourable condition for T1 and T2.

In the same way, the humidity t-test two tail at 0,05 result shows that there was not significant difference for one tail test for RH1 and RH2. It seems that the unfavourable condition of the humidifier air cooler does not significantly affect the temperature and humidity of the room.

However, considering the restriction for workplace and household, the measured data could infer another implication. During the unfavourable condition (room without ventilation), the room temperature could be kept at the average temperature of 26,5°C ± 0,35 °C; it is lower than 28,1°C ± 0,05 °C, the average temperature for the normal condition (room with ventilation), but this is not a substantial difference.

However, either **Error! Reference source not found.** or **Error! Reference source not found.** show that despite the RH values outside the room tends to decrease, all of the measured RH values (span from 73,3% ± 3% to 77,4% ± 3% for normal condition and from 73,3% ± 3% to 82,8% ± 3% for unfavourable condition) are higher than the upper limit of RH stated by the regulation for the relative humidity of a healthy room (2011, 2016).

The unfavourable condition also causes a higher humidity differences. Compared to the outside-room humidity, the room humidity differs at the average of 19,8% ± 6% for the normal condition and 29,3 ± 5% for the unfavourable condition. The room in unfavourable condition has the highest relative humidity difference of 38% ± 6%.

4. CONCLUSION

Throughout the description and the discussion, it can be concluded that the use of humidifier air cooler is able to keep room temperature lower than the outside-room temperature. The absence of ventilation during the unfavourable condition simulation could result in a lower room temperature than that during the normal use. However, in both conditions, the normal and the unfavourable condition, the room relative humidity is on a level higher than the level stated by regulation as the healthy condition; even when the outside-room relative humidity decrease. Therefore, the use of humidifier could still be considered

as long as the relative humidity is observed and controlled.

5. REFERENCE

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