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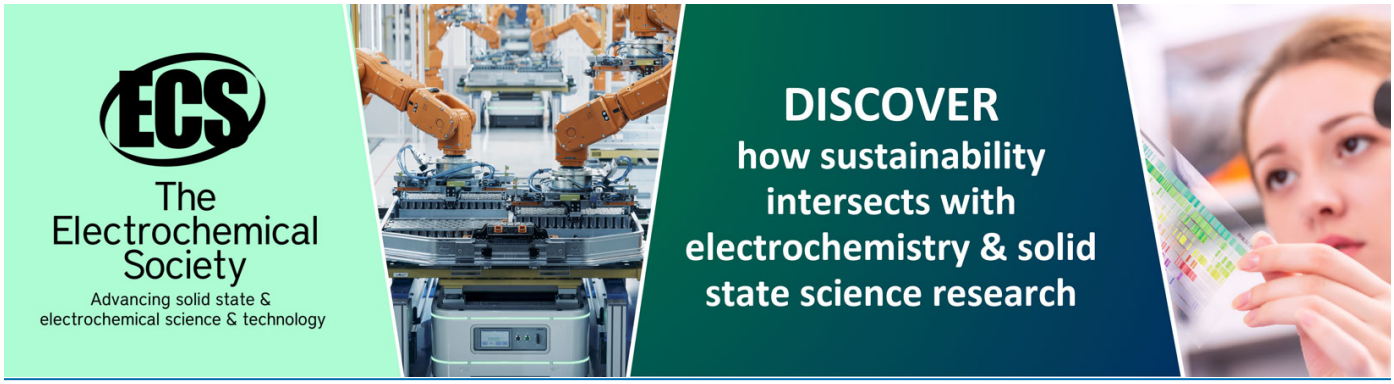


Relative air temperature analysis external building on Gowa Campus

Tayeb Mustamin[1], Ramli Rahim[2], Baharuddin[2], Nurul Jamala[2] and Asniawaty Kusno[2]
[1] Graduate Student, Architecture Program, Faculty of Engineering, Universitas Hasanuddin, Makassar, Indonesia
[2] Building Science and Technology Laboratory, Department of Architecture, Faculty of Engineering, Universitas Hasanuddin, Makassar, Indonesia

E-mail : m.tayeb_m@yahoo.com

Abstract. This study aims to data analyze the relative temperature and humidity of the air outside the building. Data retrieval taken from weather monitoring device (monitoring) Vaisala, RTU (Remote Terminal Unit), Which is part of the AWS (Automatic Weather Stations) Then Processing data processed and analyzed by using Microsoft Excel program in the form of graph / picture fluctuation Which shows the average value, standard deviation, maximum value, and minimum value. Results of data processing then grouped in the form: Daily, and monthly, based on time intervals every 30 minutes. The results showed Outside air temperatures in March, April, May and September 2016 Which entered in the thermal comfort zone according to SNI standard (Indonesian National Standard) only at 06.00-10.00. In late March to early April Thermal comfort zone also occurs at 15.30-18.00. The highest maximum air temperature occurred in September 2016 at 11.01-11.30 And the lowest minimum value in September 2016, time 6:00 to 6:30. The result of the next analysis shows the level of data conformity with thermal comfort zone based on SNI (Indonesian National Standard) every month.

1. Introduction

The thermal comfort of building users has resulted in many thermal studies on various types building. Comfort is influenced by several factors, namely air temperature, movement wind, air humidity, radiation, subjective factors, such as metabolism, clothing, food and beverages, body shape, and age and sex (1).

According to Soegijanto (10), Climatic factors greatly affect the design of buildings including radiation And sunlight, temperature and humidity, wind direction and speed as well condition of the sky. Thermal comfort refers to a metabolic rate that can be assessed with variables that include activity, clothing resistance, air temperature, relative humidity, velocity airflow, and light intensity (3). Two groups of variables are (a) physiological personal include activities / activities and heat resistance clothing, and b) climate variables that include air temperature, air velocity, relative humidity and radiation temperatures help to define thermal comfort expectations (4).

The state of the air temperature at a place on the surface of the earth will be determined by factors as follows:

The duration of solar radiation. The longer the sun radiates in a region, the more heat it receives. The bright atmosphere of the day will be hotter than if it were cloudy since morning. Tilt of the Sunlight. Somewhere where the position of the sun is perpendicular above it, then the sun's radiation given will be greater and the temperature of the place will be high, compared to the place Whose sun position is more oblique.

Cloud Condition. The presence of clouds in the atmosphere will be cause a reduction in solar radiation received at earth surface. Because radiation is roughly the clouds, by the water vapor that is in the clouds will be emitted, reflected, and absorbed.

Earth Surface Condition. Differences in land and sea properties will affect the absorption and reflection of solar radiation. Surface ground will more quickly receive and release the heat of solar radiation energy accepted on the surface of the earth and consequently cause a difference in the temperature of the air above it.

Air temperature. Indonesia is a humid tropical climate with relatively hot air temperatures reaches an average maximum value of 27^0C-32^0C. Minimum average air temperature of 20^0C-23^0C, air humidity averaging 75% -80%, year-long rainfall between 1000-1500 mm. Conditions the sky is generally cloudy between 60% -90%, daily global solar radiation averages 2-4 w / m^2. Luminance of the sky covered by thin clouds high enough to reach more than 7000 candela / m^2 and covered with thick clouds of 850 candela / m^2.

Climatic characteristics on the surface of the earth differ from place to place influenced by its position relative to the solar line (latitude position), existence oceans, wind patterns, existence surface forms, vegetation density. Earth's revolution circling the sun and the rotation of the earth on its axis causes the whole the surface of the earth can alternately receive solar radiation. Solar radiation affecting the average temperature in each region, the greater the amount of radiation energy which a region receives causes higher surface temperatures in the sector. The air temperature will fluctuate markedly at every 24 hour period. Maximum air temperature Is reached sometime after the maximum light intensity is reached when the light falling perpendicular, ie midday (5).

- Thermal Comfort. According to Nugroho (8), Thermal comfort can be defined as a state of mind Express satisfaction with the thermal environment. ASHRAE (American Society of Heating Refrigating Air Conditioning Engineer) provides the thermal comfort definition as a condition thought that expresses a person's level of satisfaction with his or her thermal environment. So that thermal comfort as a state of mind at the level of one's satisfaction with the environment thermal. Thermal comfort thus involves three elements: physical, physiological and psychological, so thermal comfort based on a psychological approach is a meaningful one most complete.

The difficulty of achieving a neutral temperature corresponding to the thermal comfort zone is affected by several factors Such as the design that causes the radiation of sunlight is high enough (8), air circulation caused by relatively small air velocity (9) and its height humidity due to climatic factors (tropical moist).

According to Mannan (6), to create thermal comfort, there are known four factors Affect the ability of the human body to channel the heat, namely:

- Temperature / temperature (° C);
- Relative Humidity (%);
- Air Speed (m / s.);
- Mean Radiant Temperature (MRT).

According to baharuddin (2), thermal comfort consists of air temperature, humidity, and speed of airflow. There are several standards related to thermal comfort among them is the thermal comfort standard of Indonesia SNI T-14-1993-03, which divides the zone into three parts:

- Convenient Comfort, 20,5-22,80C;
- The Optimal Comfort 22,8-25,80C;
- Almost Comfortable 25,80C-27,10C, with 50% relative air humidity.

2. Method

The research method used quantitative analysis. The data source is obtained from weather monitoring devices (Weather monitoring) Vaisala, RTU (Remote Terminal Unit), which is part of the tool AWS (Automatic Weather Stations) at Campus Data Station of Hasanuddin University Faculty of Engineering gowa.

The computer as the receiver of data transmission from the logger box, equipped with a specific program, that is logger Net (8). The data is collected and then inputted, processed and analyzed using Microsoft Excel program in the form of graph / picture fluctuation.

3. Results and Discussions

The data obtained from Logger Net is arranged based on the time interval every 30 minutes, from the interval per minute to thirty minutes, daily and monthly, in March, April, May and september 2016. This study aims to analyze relative temperature and humidity data air outside the building. The amount of data recorded in 2016 in March 31 days, April 30 days, may 18 days and september 9 days. With 88 days total measurement day. Data are arranged in table form in order of: average value, total data, maximum value, value minimum and standard deviations with graph/image fluctuations.

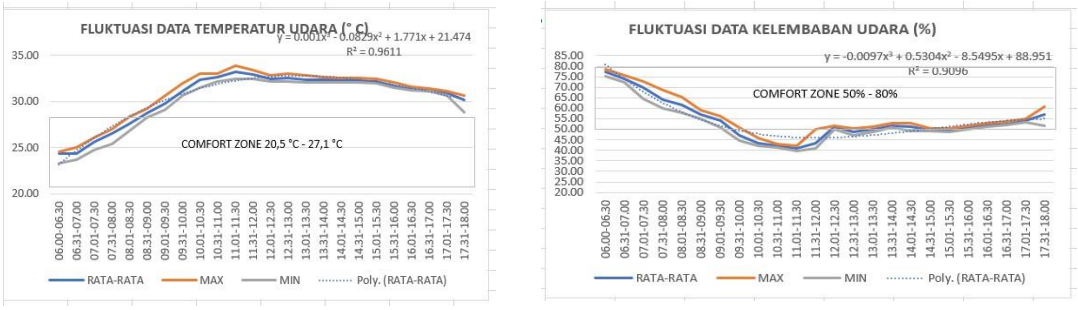
This study is limited to relative air temperature and humidity analysis. Research result shows the maximum air temperature reached the highest in September 2016 with temperature (0 C 33.90 24.50 0 C) and the lowest minimum in September 2016 (C-32,50 23,30 0 0 C). The daily average value for the monthly temperature entering the standard thermal comfort zone of SNI (20.5 0 C-27.1 0 C) for four months of the measurement, the temperature is around (8% -83%), the lowest starting May, March, April and September. The lowest order to the highest of the Moon included Indonesia National Standard Temperature in May was in the range (8% -54%), in September the range (13% -50%) in April is approximately (13% -54%), and March between (13% - 83%), among the four months the most zones in thermal comfort of SNI standards occur in March (83%).

Monthly data for maximum air relative humidity for four months of equipment recorded is ranged (80% -90.30%), the highest occurring in May that is 90.30% and lowes on in september (75.60%). Minimum relative humidity between (39.47% -71%). Height in march 2016 and lowest in September 2016. Average value daily for the monthly air relative humidity that falls within the thermal comfort zone accordingly SNI standard (50% -80%) is about 22% in September which is included in the National Standard Indonesia, May 33%, April 47% and March to 50%.

Table 1. Average, maximum and minimum air temperature value in September.

26 September 2016	*Air Temperature (ºC)*				
Time	*Average*	*STDY*	*Data*	*Max*	*Min*
06.00 – 06.30	24.40	0.21	30	24.50	23.30
06.31 – 07.00	24.39	0.41	30	25.00	23.67
07.01 – 07.30	25.64	0.36	30	26.08	24.70
07.31 – 08.00	26.59	0.38	30	27.00	25.37
08.01 – 08.30	27.59	0.51	30	28.40	26.81
08.31 – 09.00	28.78	0.31	30	29.40	28.30
09.01 – 09.30	29.81	0.47	30	30.67	29.13
09.31 – 10.00	31.17	0.40	30	31.97	30.66
10.01 – 10.30	32.41	0.38	30	33.00	31.47
10.31 – 11.00	32.64	0.26	30	33.07	32.20
11.01 – 11.30	33.27	0.46	30	33.90	32.50
11.31 – 12.00	32.96	0.26	30	33.38	32.47
12.01 – 12.30	32.42	0.21	30	32.87	32.20
12.31 – 13.00	32.52	0.26	30	33.00	32.20
13.01 – 13.30	32.37	0.20	30	32.87	32.10
13.31 – 14.00	32.36	0.17	30	32.70	32.06
14.01 – 14.30	32.34	0.13	30	32.60	32.13
14.31 – 15.00	32.32	0.12	30	32.53	32.10
15.01 – 15.30	32.16	0.14	30	32.50	32.00
15.31 – 16.00	31.70	0.19	30	32.13	31.50
16.01 – 16.30	31.33	0.12	30	31.60	31.20
16.31 – 17.00	31.25	0.10	30	31.40	31.10
17.01 – 17.30	30.94	0.11	30	31.30	30.70
17.31 – 18.00	30.22	0.41	30	30.70	28.80

Table 1 shows the value of air temperature in September as the highest temperature and in September also the lowest temperature in between four months, the daily average value of 00.06-18:00 is around (24.39 0 C-33.27 0 C), the maximum temperature is (C-33.90 24.50 0 0 C) and minimum (C-32,50 23,30 0 0 C). At 8:00 to 18:00 the daily average value is above the standard thermal comfort (27.59 0 C-33.27 0 C) by 83%. At 06.01-18.00 the temperature conditions Is at a standard of comfort. Graph of air temperature and thermal comfort zone can be seen in figure 1.



(a) (b)

Figure 1. Air Condition Temperature Flucutation External Environment: Air Temperature and Zone thermal comfort (ISO standard: C-20.5 0 27.1 0 C) and at (b) Thermal environmental conditions: Relative humidity and comfort zone Thermal (standard SNI: 50% -80%).

For the air humidity of September can be seen in table 2, where the average value humidity from 06:01 - 18:00 ranged from 42.14% -77.26%, maximum humidity between 42.22% -78.00%, and a minimum of about 39.60% -75.15%. The average daily value of relative air humidity which entered the comfort zone of 100% occurred on September 26, 2016 at 06.00 - 6 PM.

Figure (1) shows the relative humidity conditions Air during the day between 10:00 - 12:00 has decreased to below minimum comfort limit or less than 50%, because the condition of air temperature is experiencing Increase due to solar radiation.

Table 2. Maximum and minimum values, averages and relative humidity deviation standards air in September at the Gowa Unhas Technical Campus data station.

26 September 2016	***Air Temperature (ºC)***				
Time	***Average***	***STDY***	***Data***	***Max***	***Min***
06.00 – 06.30	77.26	0.21	30	78.40	75.15
06.31 – 07.00	74.21	0.41	30	75.73	72.23
07.01 – 07.30	70.07	0.36	30	72.68	64.54
07.31 – 08.00	64.11	0.38	30	68.81	59.96
08.01 – 08.30	61.56	0.51	30	65.21	58.00
08.31 – 09.00	57.12	0.31	30	59.20	55.16
09.01 – 09.30	53.99	0.47	30	56.26	50.66
09.31 – 10.00	47.24	0.40	30	50.82	44.66
10.01 – 10.30	43.57	0.38	30	45.87	42.20
10.31 – 11.00	42.14	0.26	30	42.96	41.30
11.01 – 11.30	40.96	0.46	30	42.22	39.60
11.31 – 12.00	43.41	0.26	30	49.87	40.86
12.01 – 12.30	51.07	0.21	30	51.74	50.06
12.31 – 13.00	48.80	0.26	30	50.44	47.13
13.01 – 13.30	50.09	0.20	30	51.10	48.60
13.31 – 14.00	51.68	0.17	30	52.74	50.84
14.01 – 14.30	51.08	0.13	30	53.02	49.27
14.31 – 15.00	49.75	0.12	30	50.42	49.13
15.01 – 15.30	49.78	0.14	30	50.41	48.67
15.31 – 16.00	50.91	0.19	30	51.82	49.90
16.01 – 16.30	52.23	0.12	30	52.95	51.12
16.31 – 17.00	52.68	0.10	30	53.65	51.93
17.01 – 17.30	54.26	0.11	30	55.00	53.46
17.31 – 18.00	56.93	0.41	30	60.71	51.69

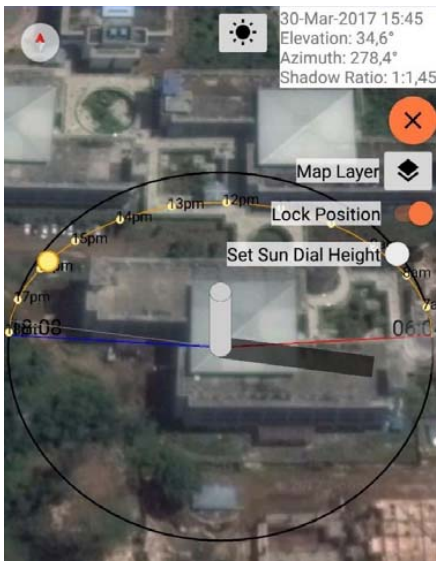


Figure 2. The position of the solar path to the new campus of Faculty of Engineering Unhas Gowa

Figure 2 shows the position of the solar path on the new Faculty of Engineering Unhas Gowa campus From the east to the west which is dominant in the latitude of North and South.

Table 3. Recapitulation of Temperature In March, April, May and September. The highest temperature (a) and at (b) the lowest temperature

TANGGAL	WAKTU	SUHU TERTINGGI ^{O}C
10 Maret dan 20 Maret	11.01-11.30	32.90
30-Apr-16	11.31-12.00	33.80
15 MEI 2016	14.31-15.00	33.60
20-Sep-16	11.01-11.30	33.90

(a)

TANGGAL	WAKTU	SUHU TERENDAH ^{O}C
23 MARET 2016	06.00-06.30	23.60
8-Apr-16	06.31-07.00	23.44
3 MEI 2016	06.31-07.00	24.00
20-Sep-16	06.00-06.30	23.30

(b)

The highest temperature on September 20 at 11:01 to 11:30 namely 33.90 0 C while the lowest temperature took place on 20 September at 06:00 to 6:30 namely 23,30 0 C. The difference in temperature is not experienced a significant difference each month as seen in table 3.

4. Conclusions

Data obtained from measurements at New Campus Faculty of Engineering Hasanuddin University in Gowa processed and analyzed air temperature outside the building. Processing and presenting the data by using Microsoft Excel program. Percentage of data tables : daily and monthly. Data is organized by : time interval every 30 minutes. Other forms Is shown in the graph/picture fluctuation which shows the average value, standard deviation, value maximum, and minimum value.

Based on research results, that the state of temperature and relative humidity of air in outer space Campus building Faculty of Engineering Unhas in Gowa not every month can support the application of the system for thermal comfort in the room Due to the condition of the clear sky availability solar radiation is quite a lot compared to the cloudy sky conditions, and rain.

References

[1] Auliciems, A. and Szokolay, S 2007 Thermal Comfort *PLEA Note 3 LEA International University Of Queensland*

[2] Baharuddin, Ishak, MT, Beddu, S and Osman, MY 2013 *Comfort and Environmental Analysis Thermal in Lecture Room with Natural Ventilation (Case Study: Campus II Faculty of Engineering Unhas Gowa)* (Universe Architecture Nusantara SAN 2, Malang: San 111213)

[3] Fanger 1982 *Thermal Comfort, Analysis and Aplications in Environmental Enginering* (Malabar, Robert E Krieger Publishing Company)

[4] Humphreys M and Nicol JF 2002 The validity of ISO-PMV for predicting comfort votes in every-day Thermal environments *Energy and Buildings* **34** 667-84

[5] Lakitan, Benjamin 2002 Climatology Basics (Jakarta: Raja Grafindo Persada)

[6] Mannan, A 2007 Leisure Factor In Building Design (Leisure Temperature – Thermal On Building) *Journal of Ichsan Gorontalo* vol 2 no 1 466-73

[7] Martosenjoyo, T *et al* 2016 Measurement and Data Processing of Climate Components in Makassar *Proceedings of IPLBI Scientific Meeting* (Malang, 2016)

[8] Nugroho, MA 2011 A Preliminary Study of Thermal Environment in Malaysia's Terraced Houses *Journal and Economic Engeneering* **2** (1) 25-8

[9] Roonak, D., S.Kamaruzzaman and M Jalil 2009 Thermal Comfort in Naturally Ventilated Office Under Varied Opening Arrangements: Objective and Subjective Approach European *Journal of Scientific Research* (Euro Journals Publishing, Inc, 2009)

[10] Soegijanto 1999 *Building In Indonesia With Tropical Climate Humidity Viewed From Physical Aspects Building* (Bandung: Institute Teknologi Bandung)