ISSN (e): 2250 – 3005 || Volume, 14 || Issue, 4|| Jul. - Aug. – 2024 ||
International Journal of Computational Engineering Research (IJCER)

Temperature and Humidity Testing and Thermal Comfort Analysis of University Archives Warehouse

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ABSTRACT
Using a thermal comfort meter, the temperature, humidity, wind speed, and black sphere temperature of a certain archive warehouse in a university in Henan Province were measured every 5 minutes for one month, forming 8929 sets of data. Detailed analysis was conducted on the compliance of temperature and humidity with national standards. Then, the thermal resistance and metabolic rate of indoor personnel were set, and the PMV and PPD were calculated to analyze the thermal comfort of the storage room, providing basic data for temperature and humidity control and thermal comfort control of university archives.
KEYWORDS: Archive warehouse, *temperature, humidity, PMV, PPD*

Date of Submission: 14-07-2024 Date of acceptance: 30-07-2024

I. INTRODUCTION

As an important base for knowledge management and cultural inheritance in universities, the archives carry multiple missions of recording history, serving reality, and inspiring the future. It not only comprehensively collects, organizes, and properly preserves various archival materials of the school in teaching, research, management, student activities, etc., but also supports the school's decision-making, teaching research, and personal growth of teachers and students by providing convenient query services. The archives room is a faithful recorder of the school's development history, providing valuable resources for future generations to understand the school's history and inherit campus culture. At the same time, it is also a window for showcasing the school's image to the outside world and enhancing social identity, which is of great significance for enhancing the school's soft power.

According to the "Code for Design of Archives Buildings" (JGJ25-2000), the "Interim Regulations on Temperature and Humidity Management of Archives" (issued by the National Archives Administration in 1985), and the "Code for Archives Work in Higher Education Institutions" (issued by the National Education Commission in 1994), the temperature and relative humidity of archive warehouses should be controlled between 14 ℃~24 ℃ and 45%~60%. The main reason for this setting is that when the temperature is below 24 ℃ and the relative humidity is below 60%, it can basically achieve no mold or pests.

At present, it is rare to see literature on long-term measurement of temperature and humidity in archive warehouses, and it is also difficult to know the actual situation of warehouses meeting national standards. Therefore, this article chose to measure the temperature and humidity of a certain archive warehouse in a university in Henan Province for one month in a hot summer in Zhengzhou City, and analyzed the degree of compliance between the temperature and humidity and national standards. Then, PMV and PPD were calculated to analyze the thermal comfort of the storage room, providing basic data for temperature and humidity control and thermal comfort control of the storage room.

Figure 1 Thermal Comfort Meter

II. METHOD

To analyze the actual temperature and humidity situation in the archives room, the author placed a thermal comfort meter in the storage room of our school's archives (see Figure 1, MI6401). The placement position is in the center of the storage room, and the temperature measurement of the black sphere is about 1.5 meters high from the ground. The storage period is from July 30th to August 30th, 2023. This is the hottest time of summer in Zhengzhou, and students are on vacation.

The storage room is located on the shaded side of the first floor, and during the measurement, the air conditioning was not turned on in the storage room. The measurement data of the thermal comfort meter includes four data points: temperature, humidity, wind speed, and black sphere temperature. Set the indoor personnel's clothing to short sleeved shorts with a thermal resistance of 0.6 col. Assuming that the personnel are seated with a metabolic rate of 1.0met. Calculate PMV and PPD based on temperature, humidity, wind speed, black sphere temperature, clothing thermal resistance, and metabolic rate.

III. RESULT

A. Indoor temperature

There are a total of 8929 sets of temperature data, as shown in Figure 2. From the graph, it can be seen that the days above 24 ℃ are concentrated from August 2nd to August 24th. Around August 30th, the temperature began to significantly decrease.

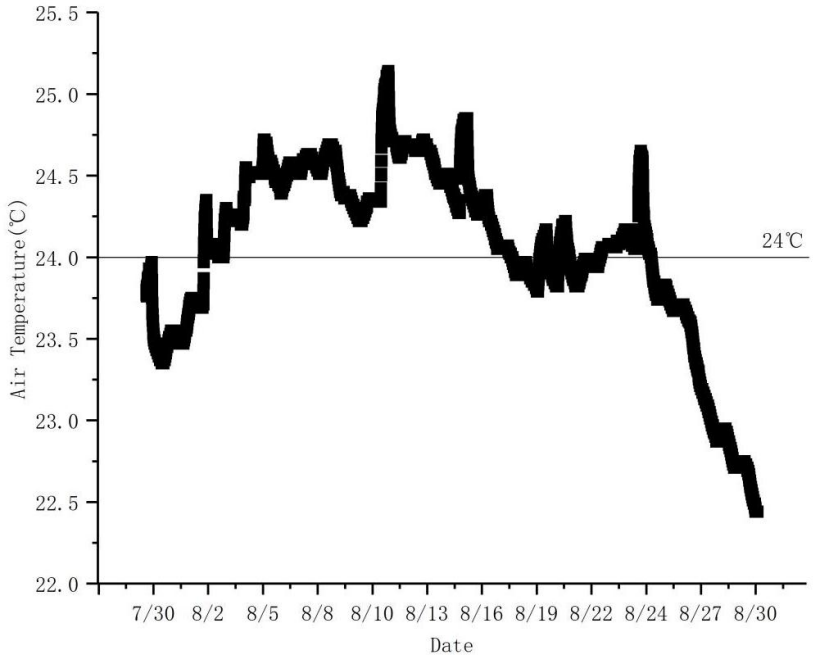

Figure 2 Indoor temperature measured continuously for one month

According to the above temperature data, there are 5548 temperatures above 24 ℃, accounting for 62%. The data between 23 ℃ and 24 ℃ is 2701, accounting for 30%. 680 data points below 23 ℃, accounting for 8%, as shown in Figure 3.

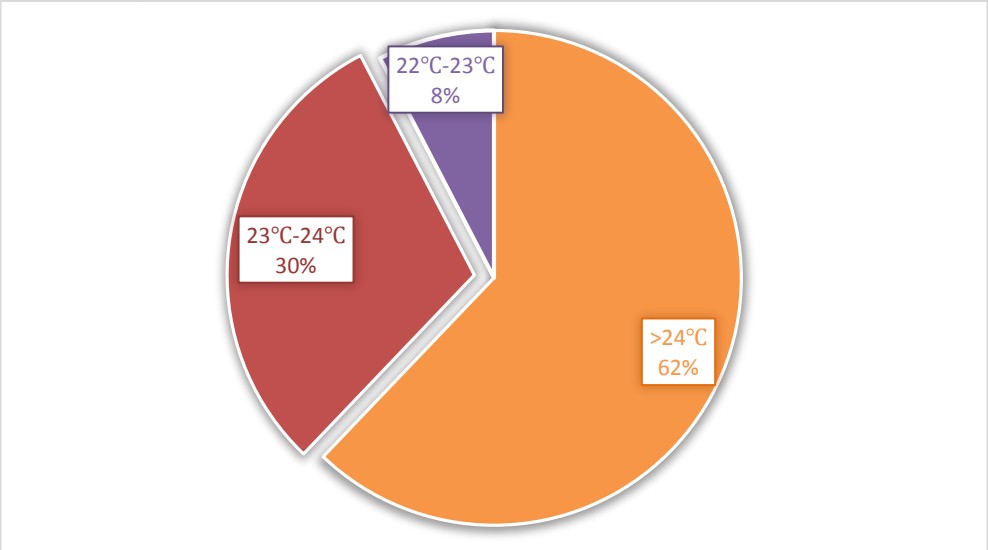

Figure 3 Temperature Ratio of Measurements

B. Relative humidity

There are a total of 8929 sets of relative humidity data, as shown in Figure 4. From the graph, it can be seen that the relative humidity of all days is higher than the standard requirement of 60%. The relative humidity is relatively higher from August 5th to August 23rd, and relatively lower around August 30th.

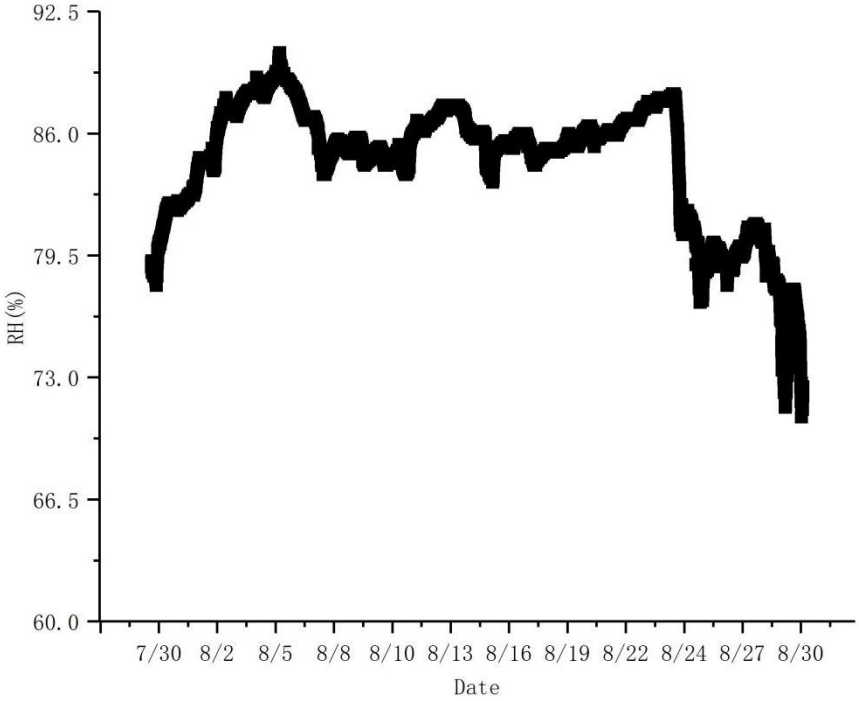

Figure 4 Relative humidity measured for one consecutive month

According to the statistics of the above relative humidity data, there are 7718 cases with relative humidity above 80%, accounting for 87%. The data between 75% and 89% is 1086, accounting for 12%. There are 125 data points between 70% and 75%, accounting for 1%, as shown in Figure 5.

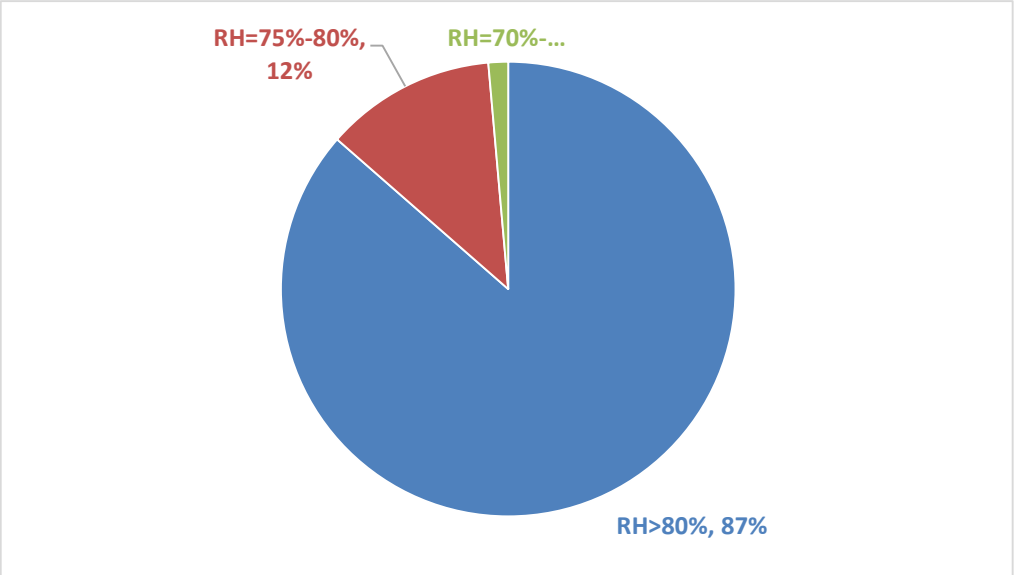

Figure 5 Relative humidity ratio measured

During the one month measurement period, the relative humidity was significantly higher than the 60% required by the standard JGJ25-2000. Excessive relative humidity can cause oil leakage, fading, and other phenomena in the handwriting on the archives, resulting in blurry handwriting and reducing the readability and durability of the archives. It can also cause fiber damage: cellulose in paper is prone to hydrolysis in high

humidity environments, further reducing the strength and durability of archives. The high humidity environment provides suitable growth conditions for harmful organisms in archives, such as molds, moths, etc. These organisms accelerate reproduction and feed on paper, paste, glue, etc., causing serious erosion and damage to archives.

C. PMV

The measured temperature of the black sphere is not much different from the air temperature, generally within 0.5 ℃. Due to the lack of regulations and requirements for the black ball temperature in standard JGJ25-2000, the black ball temperature will not be analyzed here. Due to the lack of ventilation and air conditioning in the archive room, the measured air flow velocity is 0m/s. Therefore, we will analyze the calculated PMV data below.

There are a total of 8929 sets of PMV data, as shown in Figure 6. From the graph, it can be seen that all measured PMVs are below 1.0, with most data above 0 and only a small portion below 0. The measured PMV data was relatively high in mid August and reached its lowest point around August 30th.

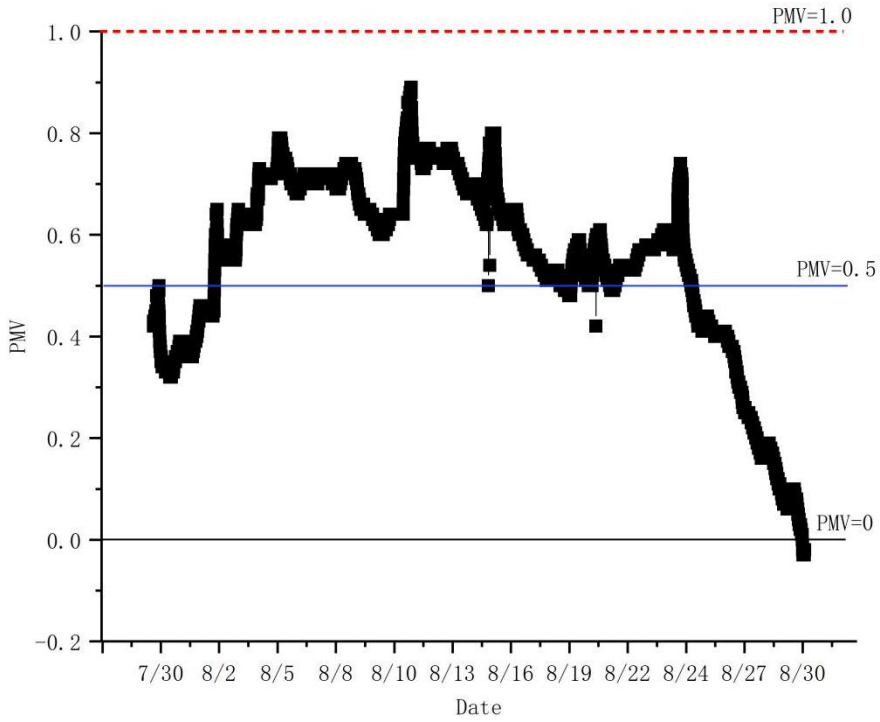

Figure 6 PMV values calculated for one consecutive month

According to the statistics of the above PMV data, there are 6440 PMVs above 0.5, accounting for 72%. There are 2456 PMV data between 0 and 0.5, accounting for 28%. There are 33 PMV data points below 0, accounting for nearly 0%, as shown in Figure 7.

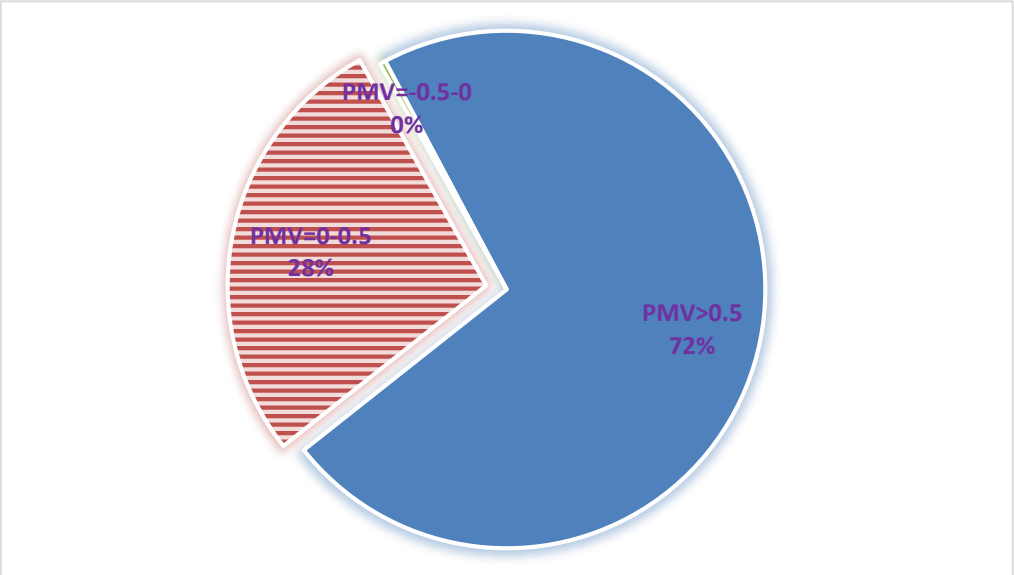

Figure 7 Proportion of PMV Calculated

The Chinese national standard "Design code for heating ventilation and air conditioning of civil buildings" (GB 50736-2012) stipulates that -0.5 ≤ PMV ≤ 0.5 is a Class I comfort zone, and 0.5<PMV ≤ 1 is a Class II comfort zone. According to the measured data, 6473 points are in the Class I comfort zone, accounting for 72%. The remaining measurement periods were 2456, located in the Class II comfort zone, accounting for 28%. This indicates that the archive warehouse is suitable for people to live and study even in the hot summer.

D. PPD

There are a total of 8929 sets of PPD data, as shown in Figure 8. From the graph, it can be seen that all measured PPDs are below 27%, with most data above 5% and only a small portion below 5%. The measured PPD data was relatively high in mid August and reached its lowest point around August 30th.

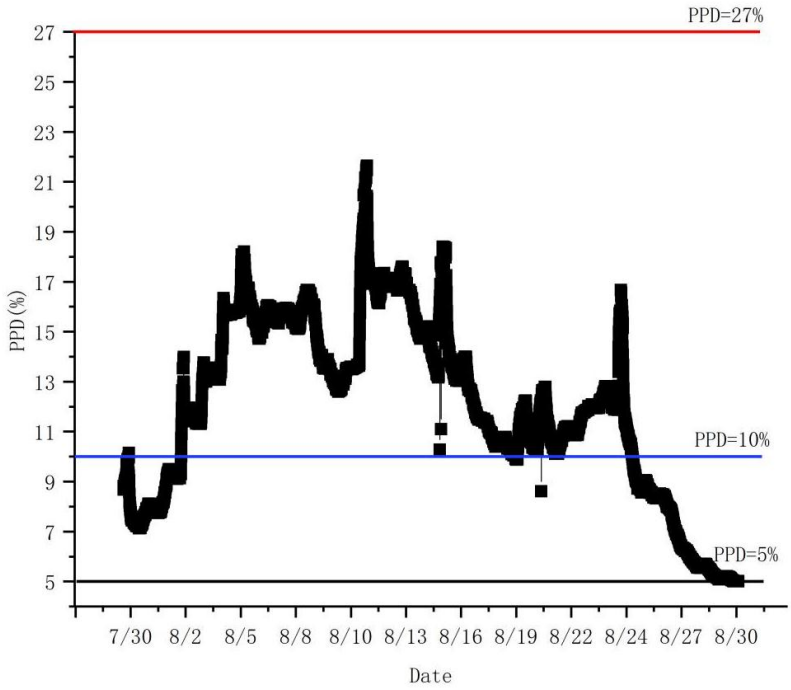

Figure 8 PPD values calculated for one consecutive month

According to the statistics of the above PPD data, there are 6524 PPDs above 10%, accounting for 73%. There are 2405 PMV data between 5% and 10%, accounting for 27%. There is no PPD data below 5%, as shown in Figure 9.

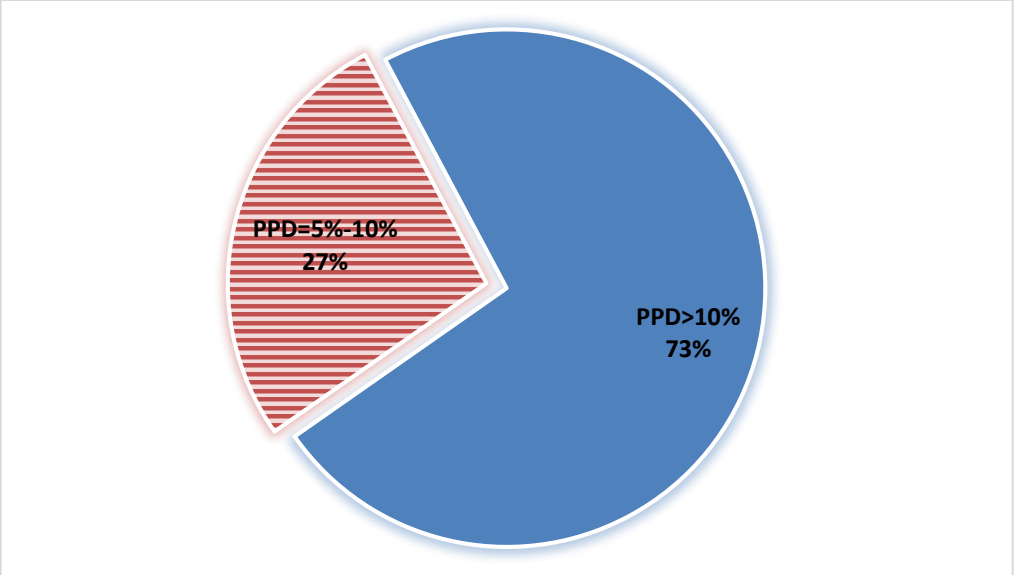

Figure 9 Proportion of PMV Calculated

The Chinese national standard "Design code for heating ventilation and air conditioning of civil buildings" (GB 50736-2012) stipulates that PPD ≤ 10% is a Class I comfort zone, and 10%<PPD ≤ 27% is a Class II comfort zone. According to the measured data, 6524 points are in the Class I comfort zone, accounting for 73%. The remaining measurement periods are 2405, located in the Class II comfort zone, accounting for 27%.

IV. CONCLUSIONS

Using a thermal comfort meter, indoor environmental parameters of an archive warehouse in a university in Henan Province were measured every 5 minutes for a consecutive month, and the following conclusions were drawn.

There were 5548 measurement periods with temperatures above 24 ℃ (i.e. not meeting the standard JGJ25-2000), accounting for 62%; There are 8929 measurement periods with relative humidity above 60% (i.e. not meeting the standard JGJ25-2000), accounting for 100%, which means that all measurement periods do not meet JGJ25-2000; According to the calculation results of PMV and PPD, about 72% of the measurement periods are located in the Class I comfort zone, and 28% of the measurement periods are located in the Class II comfort zone, indicating that the archive warehouse is suitable for people's living and learning even in the hot summer. The biggest problem with the archive warehouse is the high humidity, and ventilation should be strengthened during the summer season.

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