Analysis of Desired Air Flow Characteristic inside Dew Point Cooling system

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Abstract. Air cooling process is energy intensive processes in air conditioning which a lot of energy consumed due to usage of traditional systems based on the compressor cycle and the usage of refrigerants. Consequently, these system give harmful to the environment. These factors led to the active research and development of compressor free air conditioning. The former soviet scientist Valery Maisotsenko improved evaporative technology and called the resulting cycle as Maisotsenko cycle (M-cycle). This type of cycle is one type of dew point cooling system which is has very low power consumption and the ability to cool the air below the wet bulb temperature. The aim of this work is to analyze the desired air flow characteristic inside dew point cooling systems. Besides, the possibility to apply the dew point cooling system in Malaysia climate will be estimated.

1. Introduction

Remarkably, comfortable air conditions must be created for comfort living environment. In this regard, air condition systems such as vapour-compression cooling system, direct evaporative cooling system (DEC) and indirect evaporative cooling system (IEC) have become more prominent to supply comfortable environment. The energy used for air conditioning systems are able to reduce significantly when using evaporative air cooling system up to very high COP (up to 200), which is remarkably higher than typical air conditioning vapour-compression system [1].

The first type of evaporative cooling created was the direct evaporative coolers (DEC) were widely used in the dry climate regions, such as certain parts of India [2]. Direct evaporative air cooling system have direct contact of supply air with the water to utilize the latent heat of water evaporation. The results in evaporation of the water, will cools the air stream while in the same time increases air humidity. Humid supply air reduces the indoor air quality and makes room conditions more uncomfortable for humans. The most comfortable humidity level in the room varies from 40% to 60%. Humidity level below 30% and over 70% are uncomfortable [3]. Even the supply air is cool but the enthalpy of the air stream is constant.

While, an indirect evaporative air coolers (IEC) can supply sensible cooling of the supply air in the same time maintain the humidity. In the heat exchanger, the supply air stream passes over the dry channel while the working air passes over the opposite wet channel. The sensible heat flux from the dry channel is transferred to the wet channel, which results in cooling the supply air flow without adding moisture, because the latent heat of water evaporation is transferred to the working air stream [4]. In this

context, there is a kind of novel indirect evaporative cooling system which is the so-called "Maisotsenko cycle" or "M-Cycle". Besides, this type of cycle is one type of dew point cooling system.

2. Methodology

2.1. Data selection
Two weather data of any month in a year will be selected. April 2014 and October 2015 weather data will be obtained from the UniMAP greenhouse properties of Institute of Sustainable Agro Technology (INSAT). Those are weather data in October 2015 and February 2014. The purpose we use two types of data because here especially in Perlis between Januarys to May the weather is extremely hot and can almost achieved 40˚C. Meanwhile, the October weather data act as normal data in Perlis.

2.2. Psychrometric analysis
Data obtain will be extracted to get only crucial information of desired air properties to use in psychrometric chart. From psychrometric chart, relative humidity and dew point temperature will emerged. After that, all those data will be sort out and plotted onto graph to see the pattern of Malaysia climate for M-cycle implementation.

3. Results
At this moment, average Malaysia temperature throughout a year have been recorded. During the sunny time the dry bulb temperature is 32˚C to 34˚C and the relative humidity is 72 to 78%. Meanwhile, in the night the ambient drops to 24˚C and 26˚C but the relative humidity pops up to 80 to 90%. From this information, all others surface condition, temperature and thermodynamic air properties are known from psychrometric chart, Figure 1 and recorded on Table 1.

Table 1 Temperature differences throughout the day

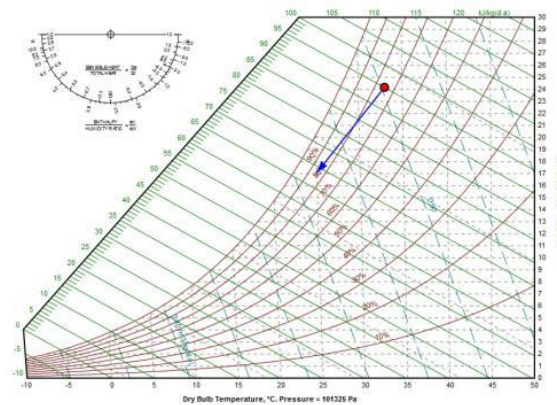|	Observed information	Value, (°C)
Day time	Wet bulb temperature	29.1
	Dew point temperature	28.0
Night time	Wet bulb temperature	23.1
	Dew point temperature	22.3

Figure 1 Results in Psychrometic Chart

All three air characteristic is related to each other. However, only two of the air characteristic were enough for us to plot on the psychrometric chart to get all the air characteristic information. In this case, all the air characteristic is obtained from the raw data taken by the automatic data sensor device in the greenhouse. By that, we can reduce the time to get the information from manual psychrometric chart. The relationship of air characteristic is shown in Figure 2 below.
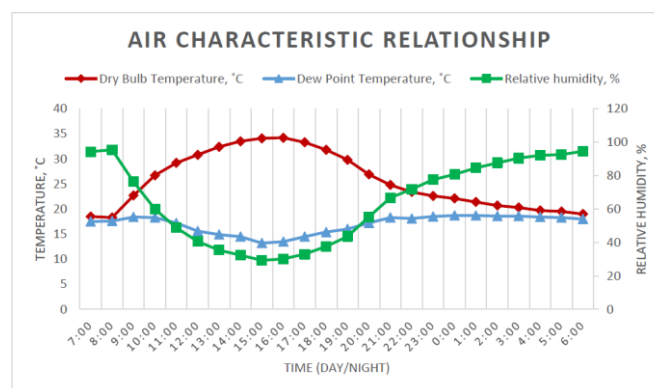

Figure 2 Air Characteristic Relationship

Meanwhile, for relative humidity, we can see that during peak of day time the percentage of relative humidity was about 30% only even though the dry bulb temperature was high that was 34.1 ˚C. Main reason why this situation happen because less water vapor contained in the air as normally Perlis in February was drought.

3.1. Result Comparison
Two types of air characteristic is taken for comparison purpose, (Figure 3) those were dry bulb temperature and relative humidity. Typically, dry bulb temperature for both month did not have any major changes. They were gradually increase and decrease at the same time line which were 28˚C to 32˚C during day time and 22˚C to 25˚C during night time.

Meanwhile, in term of relative humidity, there were huge differences between both months. In February the relative humidity was drastically dropped to minimum of 29.3% during day time cause of drought effect compare to October that was linearly throughout the day about 80% to 81%. Furthermore, because of this relative humidity problem, there were only slight temperature differences between dry bulb temperature and dew point temperature. So, it was meaningless as low dew point temperature is needed to cool the close space such as room unless we alter the relative humidity by drop down it value to human comfort range and the same time to get low value of dew point temperature.
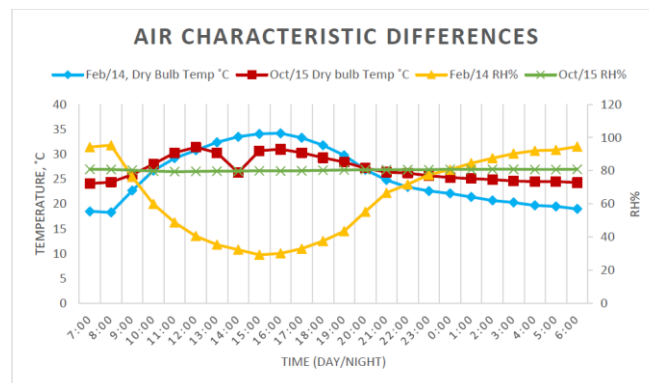
Figure 3 Air Characteristics Differences

4. Conclusion and recommendation

4.1. Summary

In this case, Malaysia does not give a favourable output product due to it climate. Modification is needed to use dew point cooling system based HMX on M-cycle cooling system efficiently. The cooling system need hybrid system to meet the comfort range for all time in the year due to different air characteristic at different time.

4.2. SWOT Analysis

SWOT analysis is the strategic planning method used to evaluate the strength, weakness, opportunity involve in the project. Figure 4 show the SWOT analysis for indirect evaporative cooler for dew point cooling system.

Strength	Weakness
• Low running cost • Environmental friendly • Low power consumption • Greater range of cooling	• Big size • Need air characteristic alteration
Opportunity	**Threat**
• Reduce waste of energy • No air pollution • Prototype not available in Malaysia yet • Everybody can use cooler	• Early stage of development • Product already have in other side of world

Figure 4 SWOT Analysis

References

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