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Education,in a global sense,is a right since we are born. Every experience has a formative effect on the constitution of the human being,in the way one thinks,feels and acts. One of the most important contributions resides in what and how we learn through the improvement of educational processes,both in formal and informal settings. the world Congress of research in education seeks to provide some answers and explore the processes,actions,challenges and outcomes of learning,teaching and human development. Our goal is to offer a worldwide connection between teachers,students,researchers and lecturers,from a wide range of academic fields,interested in exploring and giving their contribution in educational issues.

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Experimental Studies on Desiccant Cooling System

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Abstract

Indonesia lies in the tropical climate which requires air conditioning to increase working productivity of the people. Up to now people are still using the compressive cooling system which uses Freon as the refrigerant, which have been known to be ozone layer depleting. Therefore, new cooling system which is environmentally friendly is now in need. Desiccant cooling system manipulates the humidity condition of outside air in such a way so that the final temperature should be at 25 oC and RH of 65%. Since it does not require refrigerant which can cause environment problem, a desiccant cooling has the potential to develop in tropical country like Indonesia. In this study an experimental desiccant cooling system has been designed and constructed and tested under laboratory condition. Experimental results has shown that the resulting air temperature was 26.1 ^{o}C with RH of 55.6%. The COP was found to be 0.2

Keywords: desiccant cooling; air condition;desiccant wheel,;sensible heat exchanger

Introduction

Indonesia lies in the equator with average temperature of 30 ^{o}C and average RH above 80%. Under this weather condition it is not fit for people to work in the office or stay at home. Therefore, there is an urgent need for air conditioning facilities in order to be able to live in a better condition. There is also need for industry to increase their productivity by creating better working environment... Heretofore, people have been using the compressive cooling system which Freon as the refrigerant. Aswe know Freon has a bad impact on ozone depletion. This study a desiccant cooling system was selected, due to its environmentally friendly nature. This cooling system does not emit green house gasses since the principle is on how to manipulate the condition of the air so that a pleasent air condition can be achieved. This can be obtained by using silica gel to reduce the humidity of the outside air and using evaporative cooling component of the desiccant cooling system ideally the air temperature will be reduced to 25 ^{o}C and its RH will be increased so that 65% RH can be created. For the purpose of this study a laboratory scale desiccant cooling system was designed and constructed and later a series of test was conducted to obtan the performance of the system.

2. Lierature study

Research on desiccant cooling system is quite new in Indonesia and very rare if any attempt to apply the system in Indonesia. Research by Chadi Maalouf. at al in France (2006) indicated that the use of solar energy they were capable to construct adsorption cooling system for application in several city in France. Daou et al. (2004) and Jurinak (1982) have conducted research to determine the performance of an adsorption cooling machine using silica gel the Pennington cycle. Rajat Subhra Das et al. (2012) study the application of solar energy for liquid desiccant cooling system in India Two dimensionless parameters - enthalpy and moisture effectiveness are taken as performance indices of the absorber. The performance of the overall system is presented in terms of its cooling capacity, moisture removal rate and COP (coefficient of performance). Mavroudaki et al. (2002) and Halliday et al. (2002) reported two studies related to the feasibility of adsorption cooling machine using solar energy Pennington cycle in South Europe and in England.

Davangere et al. (1999) had applied a desiccant cooling system with capacity 10 kW (2.85 ton refrigeration) assisted by vapor compression machine. The resulting room temperature 26.7 ^{o}C with humidity ratio of W=0.01183 kg/kg dry air for the condition Florida which have outside air of 36 ^{o}C. They conducted analysis using Psychrometric chart and the result of their simulation works were applied to four cities in the USA.

Bellia, et al (2000) had studied several hybrids cooling system using various desiccant wheels and using DesiCalc^{TM} computer program and applied to four cities in Italy. They concluded that the maximum saving in cost was 22%, and for the theater the saving were greater from 23% to 38% with electricity saving of up to 55%.

2.1.*Working principle of the desiccant cooling system*

Fig. 1 shows the major component of a desiccant cooling system which comprises of a desiccant wheel containing silica-gel, sensible heat exchanger wheel, a hot water heater supplied from solar collector, blowers and evaporative cooler (Pons and Kodama, 2014). Outside air is introduced through point (1) passing the hot desiccant wheel where the humidity is reduced to point (2). The air will further passed through the sensible heat exchanger (point 3) where its temperature will be reduced while keeping its RH constant. From the sensible heat exchanger the air will be introduced into the evaporative cooling chamber where its temperature will be reduced due to evaporative cooling action while its RH will be increased (point 4). When entering the room the temperature and RH will reach 25 ^{o}C and 65 %, respectively, a comfortable condition for air conditioning. The air condition in the desiccant cooling system can also be traced using the Psychometric chart in Fig.2. When the air is leaving the air condition room under condition of point (5) the air will be passed again through the evaporative cooling unit which will reduced its temperature and increase its RH. After passing through the sensible heat exchanger its temperature will increase while its RH is kept constant as in point (6). After passing through the heater the air temperature increase again heating the desiccant within the desiccant wheel to the condition of point (8). After passing the desiccant the air will be exhausted to the environmnet at lower temperature.

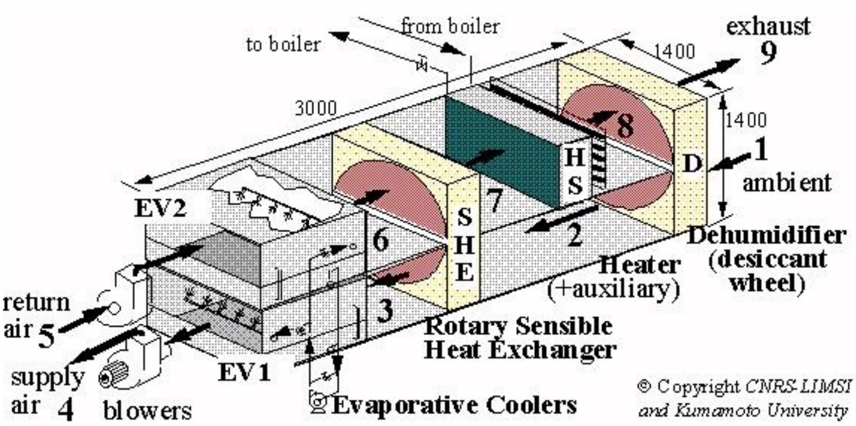

Figure 1. Main component of desiccant cooling system (CNRS-LIMSI and Kumamoto University, 2014)

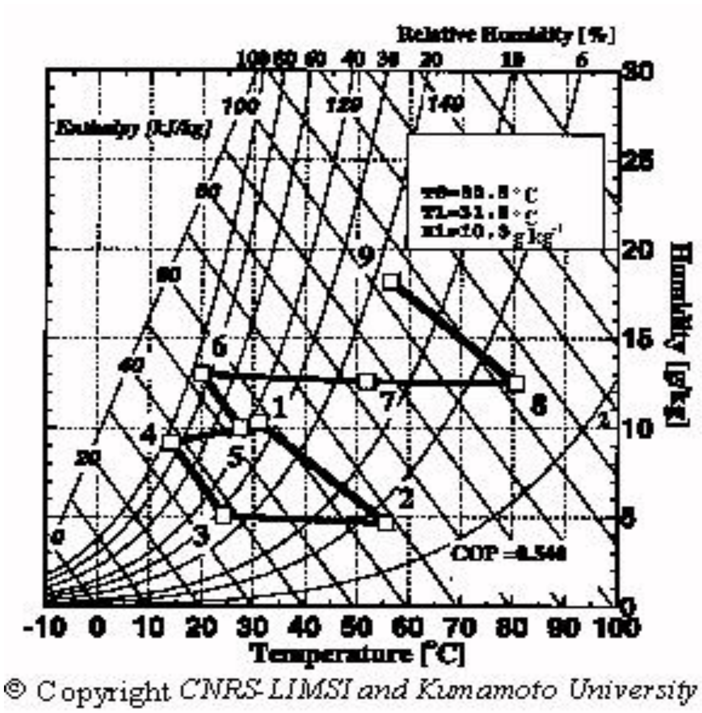

Figure 2. The condition of the air as represented by a Psychrometric chart (Pons and Kodama,2014)

The Experiment

The appartus

The appratur used in the experiment is as hown in Fig.3. It consisted of dessicant wheel (1) equipped with a motor to turn it , a blower with heater (2) to function as solar collector, a sensible heat exhanger (3) and an evaporative cooling system (4). In addition there was a blower located in front of the diesiccant wheel to draw out side air into the 0.35 m x 0.35 m ducting cross section and lebgth of 1.5 m. During the test all component of the system was started simultaneously and the outside air was introduced through the duct inlet and passing through the desiccant wheel. The condition of the air will change otomatically as it passed through each component of the system as explained in the section 2.1. on working principle of the desiccant cooling system. For measring each parameters an automatic data aquisition system shown in Fig. 3 was used. Several DHT 11 sensors for measuring temperature and RH as shown in Fig.5 were placed according to the number point in Fig.1 and then connected to Arduino UNO microcontroller, shown in Fig.4.and then to the computer For measuring air flow rate an electronic anemometer shown in Fig.6 was used while for measuring water flow rate in the evaporative cooling system an electronic sensor shown in Fig. was used. For measuring the RPM of the desiccant wheel a Laser & Touch Tachometer DT-2236B and sensible heat exchanger a tachometer was used.

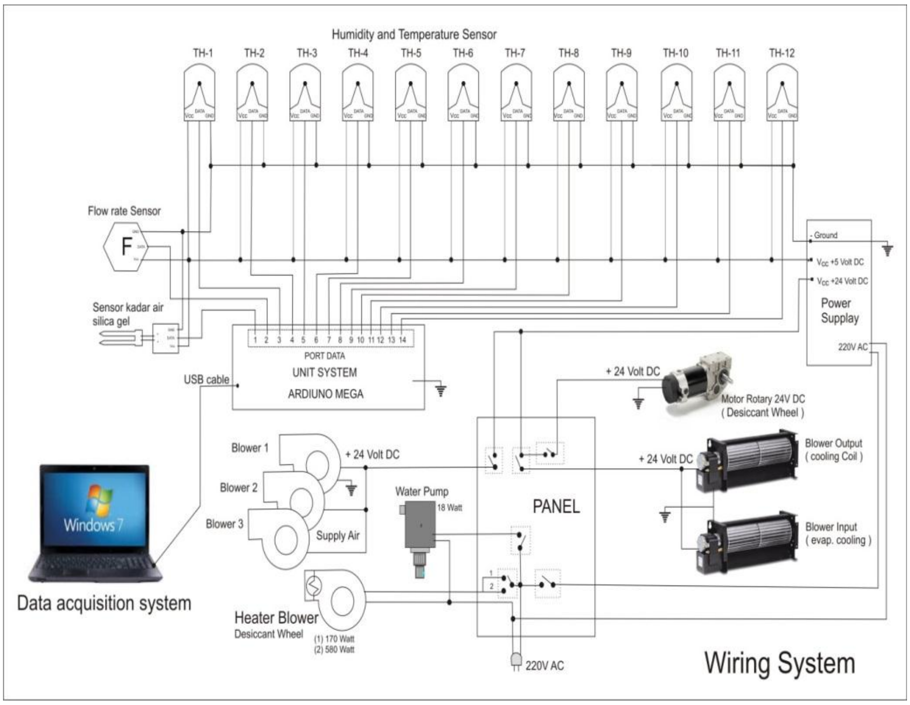

Figure 3. Automatic data acqusition system

Figure 4. A microprocessor used as the automatic data acqusition system

Figure 5. A DHT 11 sensor

Figure 6. An anemeter for measuring air flow rate

Figure 7. A tachometer for measuring RPM of desiccant wheel.

2.2., Experimental results

A typical experimental results indicated that the tempeature of air leaving the sensible heat exchanger was at 33.5 oC while the air temperature leaving the evaporatve cooling system was at 26.1^{o}C, while the RH was at 55.6%. As the air flow rate passing through the evaporative cooling system was at 44.5 m/s then the calculated cooling power of the system was 20.55 kW (see Table 1). When the heat input from the heater was used the COP was found to be 0.2 was less then the recorded data by Davangere et al (1999), which was 0.66.. Table 1. Shows the results of experimental run for temperature difference between the sensible heat exchanger exit and the evaporative cooling exit which indicate the cooling capacity of the system

Table 1. Experimental results for temeprature difference between sensible heat exchanger exit and evaporative cooling exit

Run	T3(oC)(Evaporative cooling exit)	T4(oC)(sensible heat exit)	Air flow rate (m/s)	Cooling capacity kW	RH (%)
1	24.6	33.15	15.5	16.23	58.9
2	25.2	33.5		15.76	53.3
3	25.2	33.8		16.33	52.3
4	24.9	33.1		15.57	52
4	25.7	35.2		18.04	55.4
5	26.3	39		24.11	57
6	26.8	39		23.16	51.9
7	27.3	40.2		24.49	51.9
8	27.5	41		25.63	62.2
9	27.2	41		26.20	61
Average	26.07	36.90		20.55	55.59

3. **Conclusions and recommendations**

1) An laboraorium sacle dessicant cooling system hase been designed constructed and tested
2) From experimental results it was found that the average cooling capacity of the system achieved was 20.55 kW
3) The final temperature and RH was 26.1 oC and 55.59, repectively
4) The COP of the system was found to bw 0.2.
5) It was recommended the the evaporative cooling system should be redesigned so that it could create temperature of 25 oC and RH of 65%

Acknowledgement

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