International Journal of Trend in Innovative Research (IJTIIR)
Available Online @ www.ijtiir.com | ISSN: 2582-0354

Performance and Analysis of Desiccant Operated Air Conditioning System

[1]Ajay R padhiyar, [2]Prof. Avdhoot jejurkar, [3]Darshan Gajdhar

[1] Student Mechanical Department DJMIT, College
[2]Assistant Professor Mechanical Department DJMIT, College
[3] Assistant ProfessorMechanical Department DJMIT, College

Abstract- Now Modern era, due to energy crisis and higher energy costs, novel methods for air conditioning are to be explored. The project explains how novel method can be used for air conditioning or dehumidification purpose and applies the same method to gain economical more benefits. This Project work presents study, performance, and experimental analysis of a Desiccant-based air conditioning system. The main aim of the project is to improve the efficiency of air conditioning. The conventional air conditioning system cooling coil has two loads latent load and sensible load. Cooling has to cool the air and simultaneously dehumidify the air. It increases the load on the cooling coil and affects the performance to the system. To increase the efficiency of the air conditioning system desiccant materials are used at the inlet of the air conditioning test rig. Desiccant materials attract moisture based on differences in vapor pressure. Due to their enormous affinity to absorb water and considerable ability to hold water. Due to the use of desiccant material load on the cooling coil reduces since moisture is absorbed by the desiccant. The working of desiccant dehumidifier & Conventional dehumidifier air conditioner is studied and perform of the project with help of experiment, a comparison is also done for better understanding. According to observation and analysis, power consumption before and after desiccant is calculated. This conclusion will make that desiccant material improves the efficiency of the air conditioning test rig.

***Key Words*:Desiccant materials, Cop,Humidity, Compressor work**

I. INTRODUCTION

The global environmental problem is a serious issue worldwide. Decreasing conventional energy Resources are other major issues that are a threat to the developing world. The world population is increasing day by day the day after Human demand for better and comfortable conditions is increasing rapidly. Urbanization Is happening around the world. Industrialization is taking place in every part of the world. Above The problems are complex because many parameters and ideas have to be paid in-depth attention. In Circumstances have become a political, economic and technical issue globally that concerns everyone Planets. Handling of these problems requires achieving a common goal.

1.1 Desiccant Material

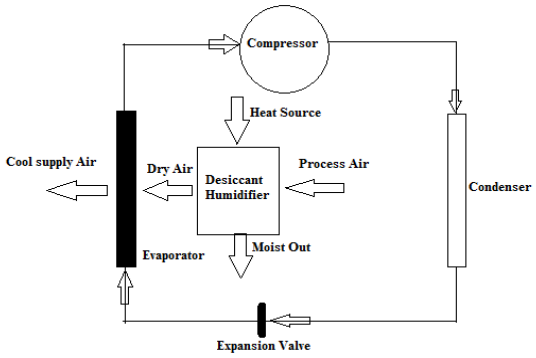
Generally, materials that attract and hold other gases or liquids are called sorbents. This sorbet Mainly used in chemical separation processes and used to absorb gases or liquids Steam. Desiccants are a subset of sorbents, which is particularly an attraction to water. This The process of absorbing and holding water vapor by desiccants can be defined as either absorption or Adsorption based on whether or not it is undergoing chemical changes upon attracting moisture (Absorption) or not (adsorption). Materials like wood, natural fiber, clay sand various synthetic materials Water can also attract and hold vapor, but their holding capacity is low. Generally, a desiccant attracts Between 10 and 1100% of the dry mass of its vapor, depending on the amount of moisture available in Ambient and the type of indigenous material used. Desiccants consistently draw in dampness, even from Dry air, until it arrives at harmony with the climate. Desi ghee is warmed and dampness is taken out. Exposing the material to temperatures of 50 ° to 150 ° C and to the airflow of our generation. After The desiccant has dried completely, it must be cooled so that it attracts water vapor again. The desiccant materials either adsorb or absorb according to their solid or liquid which attracts moisture. These materials are used in places where a low dew point for dehumidification of air is required.

1.2 Solid Desiccant

Solid desiccants are highly porous materials that absorb water by various mechanisms such as chemical Adsorption of water molecules onto the walls of pores or continuously layered physical adsorption or Capillary condensation in capillaries. These have a large internal surface area per unit mass, as large as 4600 M 2 And the surface area that attracts water is always in the crystalline structure of the material. In The material attracts moisture due to the electric field present on the desiccant surface, which uses it Atomic and electrostatic forces to attract water molecules into the microscopic pores of the desiccant Surface. Solid desiccants are usually classified into the following classes.

II. METHODOLOGY

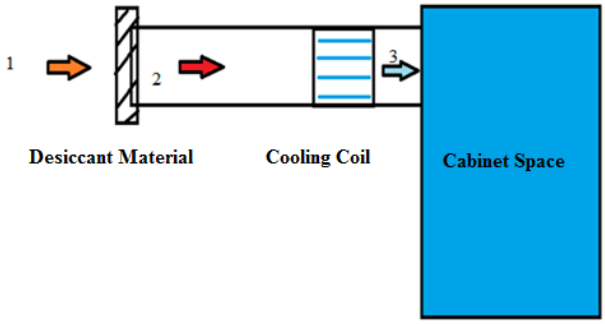
2.1 Development of an Experimental Setup



The desiccant consists in dehumidifying the incoming air stream by forcing through a desiccant in cooling Drying the material and then air to the desired indoor temp. Make the system work continuously, water the vapor absorbed must be taken out of the desiccant material (regeneration) so that it can be drained sufficiently. To absorb water vapor in the next cycle. This is done by heating the material to its temperature. The uptake which is dependent on the nature of the desiccant used. A cooling system therefore, it mainly consists of three components, namely regenerative heat source dehumidifier (desiccant) Material), and cooling unit

2.2 Experimental Procedure and Working

The external atmospheric air is sucked through a blower that is located at the end of the duct. While The air passing through the duct, it passes through the uninhabited bed. Like - to absorb the property of evil Moisture from the air, relative humidity of the air is going to decrease and the air temperature is being increased. As per the objective, to cool the air, it passes over a cooling coil. Cooling coil is nothing but the evaporator coil of a VCR system. Now supply dehumidified and cold air in the cabinet the temperature and humidity have to be maintained as per the requirement.



Methodology

- To observe relative humidity
- To analyses compressor work before and after desiccant material for power consumption
- To analyses COP of the unit before and after desiccant material.

III. EXPERIMENTAL PROCEDURE AND INVESTIGATION

Modified experimental setup work on vapor compression refrigeration systems with desiccant materials. Four components such as compressor, condenser, expansion equipment and evaporator are connected With each other. Two pressure gauges are installed on the compressor that

are suctioned and indicated discharge pressure. The thermometer and humidity meter are also installed on the system which is the measurement Temperature and humidity respectively. The interior of the air conditioner was covered by the cabinet.

Important components and material

There are more components used in experimental setup which is listed below.

1. Base Stand:

This is made up of square pipe and sheets this is painted specially with powder coating.

All equipment is mounted on base stand.

2. Cabinet:

this is made up of expanded polyethylene.Its size is 122cm X 90cm. This also hasheater load bank and evaporator blower.

3. Silica Gel:

Silica gel is a synthetically latent, non-poisonous material made out of indistinct silicon dioxide. It has an internal Network of micro holes to be interconnected, producing 700-800 square meters per specific surface area Village; Or, told another way; The internal surface area of a spoon filled with silica gel is equal to one Football field. Water molecules are adsorbed or desorbed by these micro-capillaries up to vapor pressure the equilibrium is achieved with the relative humidity of the surrounding air.

4. Desiccant pad:

Here the desiccant pad for the experiment is made. Here two pads used for experiment which have different thickness 5mm and 10mm. The size of pad is 75 X 25 cm fitted before evaporator.

Test procedure: The outside atmospheric air is sucked through a blower that is located at the end of the duct. In form of The property of the desiccant is to absorb moisture from the air, the relative humidity of the air is going to decrease. And the air temperature is going to rise. According to the requirement of the project, to cool the air, it is Passed over a cooling coil. The cooling coil is nothing but the evaporative coil of a VCR system. Now Dehumidified and cold air is supplied in the cabinet where the temperature and humidity are to be maintained accordingly Needed

IV. RESUALT AND DISCUSSION

From experiment we have moisture levels at different temperatures. Data condition taken Before desiccant and after desiccant content. There are two conditions for processed air before passage Silica gel and silica gel after passing. Taking data for 5 mm thickness of desiccant pad and 10 mm desiccant Ped. Before taking the data, room temperature and room humidity are considered

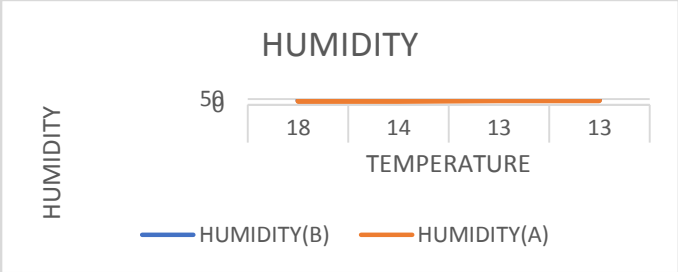
4.1 Performance and Emission reading

- **For 5mm thickness pad**

Room temperature – 34.5 ^{0}C After silica gel Humidity – 33.8 %			**Day -1**
Sr. No.	Temperature (^{0}C)	Humidity (%)	Time (Min)
1	18	34	10 min
2	14	36	10 min
3	13	38	10 min
4	13	37	10 min

Room temperature – 34.5 ^{0}C Before silica gel Humidity – 33.8 %			Day -1
Sr. No.	Temperature (^{0}C)	Humidity (%)	Time (Min)
1	18	39	10 min
2	14	43	10 min
3	13	42	10 min
4	13	43	10 min

Room temperature – 34 ^{0}C Before silica gel Humidity – 40 %			Day -2
Sr.No.	Temperature (^{0}C)	Humidity (%)	Time (Min)
1	19	43	10 min
2	14	45	10 min
3	13	46	10 min
4	12	47	10 min



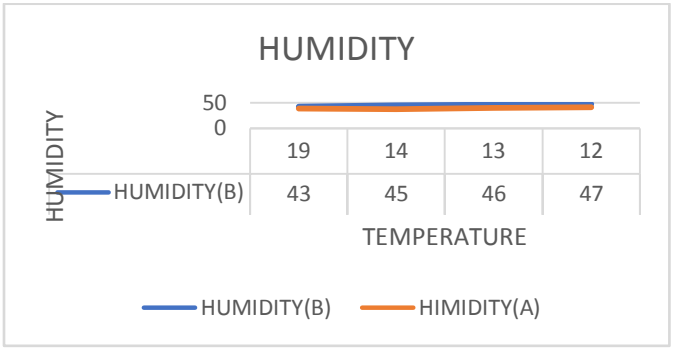
Graph 4.1 Temperature vs Humidity

Data of temperature and humidity for processed air as shown in graph. Humidity of air is decreased when temperature is increased.

As shown in the graph, the air humidity increases by 5.1 as the air temperature rises. Went through the air in the case of desiccant the desiccant bed humidity decreased as compared to before. Humidity difference 4 to 7% Between the two conditions for air.

- **For 5mm thickness pad**

Room temperature – 34 ^{0}C After silica gel Humidity – 40 %			Day -2
Sr. No.	Temperature (^{0}C)	Humidity (%)	Time (Min)
1	19	38	10 min
2	14	37	10 min
3	13	40	10 min
4	12	41	10 min



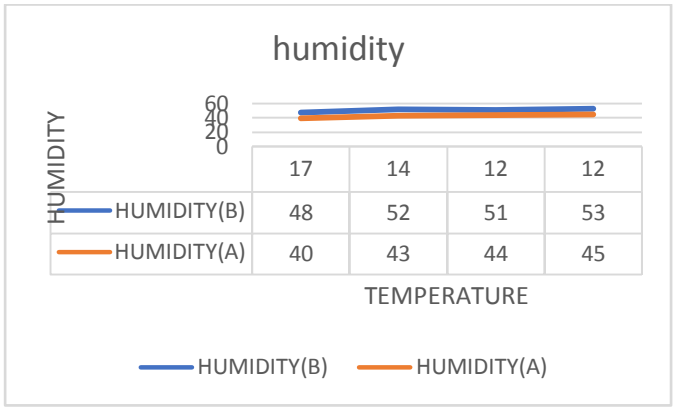
Graph 4.2 Temperature vs Humidity

Graph no. 3 according to which the air temperature decreased from 190C to 120C and humidity increased by 38% 41% for air passing before silica gel.

Regarding the temperature change, the humidity in graph number 2 decreased from 38% to 41%. Comparison Between 3 and 8% are between table number 3 and table number 4 for before and after silica gel. As Graph No.4 is sown in humidity Reduced by 37%.

- **For 10mm thickness**

Room temperature – 33 ^{0}C After silica gel Humidity – 41 %			**Day -3**
Sr. No.	Temperature (^{0}C)	Humidity (%)	Time (Min)
1	17	40	10 min
2	14	43	10 min
3	12	44	10 min
4	12	45	10 min



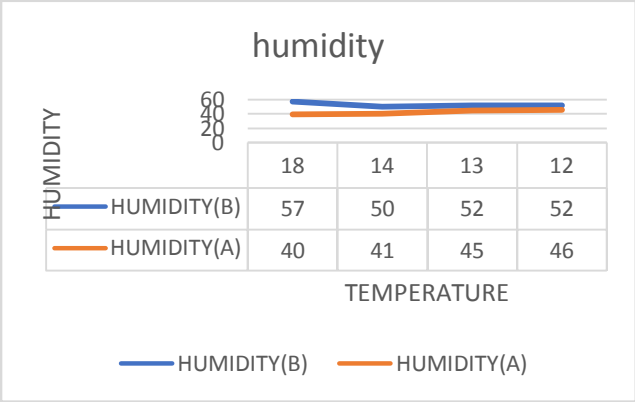
Graph 4.3 Temperature vs Humidity

Above represents after passing air through desiccant pad. According to graph humidity variation is small from first point to final point of humidity. From the graph humidity decrease in large variation.

- **For 10mm thickness pad**

Room temperature – 33 ^{0}C Before silica gel Humidity – 43 %			**Day -4**
Sr. No.	Temperature (^{0}C)	Humidity (%)	Time (Min)
1	18	57	10 min
2	14	50	10 min
3	13	52	10 min
4	12	52	10 min

Room temperature – 33 ^{0}C After silica gel Humidity – 43 %			Day -4
Sr. No.	Temperature (^{0}C)	Humidity (%)	Time (Min)
1	18	40	10 min
2	14	41	10 min
3	13	45	10 min
4	12	46	10 min



Graph 4.4 Temperature vs Humidity

From graph humidity difference between two condition also in large variation. The variation between two conditions is 6 to 17% which is good result for humidity.

4.2 Sample calculation

For before silica gel

Temp 35℃

$$\text{Refrigeration effect} = \frac{mcp\Delta t}{time\ taken} = \frac{1.29*1.0*(35-18)}{10*60} = 0.0365\text{kw}$$

$$\text{Working by compressor} = \frac{10*8600}{40*1400} = 0.642\text{ kw}$$

$$\text{COP} = \frac{Refrigeration\ cycle}{workdone} = \frac{0.0365}{0.642} = 0.0568 = 5.6$$

Same for after silica gel

temp= 35°C

$$\text{Refrigeration Effect} = \frac{mcp\Delta t}{time\ taken} = \frac{1.29*1.0*(35-18)}{10*60} = 0.0365\text{kw}$$

$$\text{Working by compressor} \frac{10*2600}{42*1400} = 0.6271\text{ kw}$$

$$\text{COP} = \frac{Refrigeration\ cycle}{workdone} = \frac{0.0365}{0.6271} = 5.82$$

CONCLUSION

Desiccant technology has the potential to make major contributions to energy conservation, improve indoor air quality. From above study and experimental test rig we will assume some assumption using desiccant material in air conditioning unit listed below.

- COP of Air conditioning unit marginally improve using desiccant material.
- Desiccant material absorbs moisture, so it will reduce the relative humidity of the air.
- If high-thickness pads are used, a large variation of humidity decreases. Difference between two Conditions is 6 to 17% which is a good result for moisture.
- According to the reduction in performance of moisture after the processed air in each silica gel Event.
- Humidity improves if pad thickness is increased.
- Compressor work reduced with modified unit. It decreased from 0.642 kw to 0.6271 kw Therefore, the power consumption of the modified system was reduced

- The air-conditioning unit's COP makes minor improvements using the desiccant material.

References

[1] R P Singha, V K Mishra, R K Das. Desiccant materials for air conditioning applications –A revie Material science and engineering 404(2018)012005.

[2] Ali Alahmer, Sameh Alsaqoor, Gabriel Borowski. Effect of parameters on moisture removal capacity in the dessicant cooling systems. Department of mechanical engineering, tafila technical university ,p.o.box 179,66110 tafila,Jordan.

[3] M.M. Bassuoni. Experimental performance study of a proposed desiccant based air conditioning system. Mechanical power Engineering Department, faculty of Engineering, Tanta, University, Egypt.

[4] Zan Lia, Deyin Li, Study on the Dehumidification and Indoor Air Cleaning Performance of Rotary Desiccant Rotor, 10th International Symposium on Heating,Ventilation and Air Conditioning, ISHVAC2017, 1922 October 2017, Jinan, China

[5] S.Bouzenada, C.McNevin, S.Harrison, A.N. Kaabi. An experimental study on the dehumidification performance of a low-flow falling-film liquid desiccant air-conditioner. The 5th International Conference on Sustainable Energy Information Technology(SEIT 2015).

[6] D.B.JANI, MANISH MISHRA, P.K.SAHOO. EXPERIMENTAL INVESTIGATIONS ON HYBRID SOLID DESICCANT – VAPOR COMPRESSION AIR-CONDITIONING SYSTEM FOR INDIAN CLIMATE. Department of Mechanical & Industrial Engineering, Indian Institute of Technology, Roorkee, 247667, India.

[7] Gaurav S. Wani. Performance and evaluation of desiccant based air conditioning system.Department of Mechanical Engineering, University of Pune, India.

[8] Ali Mohammad Jafarpour, Farivar Fazelpour, Seyyed Abbas Mousavi. Performance optimization of polymeric porous membrane- based liquid desiccant air dehumidifier used in air conditioning system. Received: 16 July 2019 / Accepted: 24 October 2019 / Published online: 2 December 2019 © The Author(s) 2019.

[9] D A Saputra1, N A Saputra, L Susanti, P Fithri, and D I Putra. Design of solid desiccant air conditioning system. Materials Science and Engineering602 (2019) 012077.

[10] Mr. Tony Jose P, Dr. Mohammad Shekoor .T. Performance Evaluation and Parameter Analysis on a Composite Solid Desiccant based Air Conditioning System. Interna tional Journal of Engineering Research &Technology (IJERT) ISSN: 2278-0181. This work is licensed under a Creative Commons Attribution 4.0 International License.Vol. 4 Issue 08, August-2015.

BIOGRAPHIES

Ajay R padhiyar Pursuing ME Thermal Engineering Final Year (2020-2021) DJMIT Collage Anand Gujarat-388110

Darshan Gajdhar
Assistant Professor
Mechanical Department DJMIT, College