Paper ID: AM-07

Development of an Automatic Humidity Control System

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Abstract

This paper presents an automatic humidity control system using microcontroller. The developed system actually consists of three parts. These are mechanical, electrical or electronic parts and software or logic parts. The mechanical part consists of a square shaped room, a cylindrical shaped chamber (humidification and dehumidification chamber) connected with the flexible pipes and two electric blowers. The electrical part consists of a ATmega-32 microcontroller, HSM-20G humidity sensor, LM-35 temperature sensor, LCD monitor, relays, transformer, diode, capacitor, transistor, etc. The logical part consists of an automatic humidity control system that is controlled by microcontroller. For automatic humidity control system, a humidity sensor is used that is attached in the room to measure the humidity. If the humidity of the room is greater than comfortable range (50%-70%R.H) then the humidity sensor (HSM-20G) senses this condition of air and sends this information to the microcontroller. The microcontroller executes this information and starts the blower, which is attached to the dehumidification chamber. In this way, the system acts as an automatic humidity controller using micro-controller. Finally the performance of the system is evaluated experimentally.

Keywords: *Automation, Microcontroller, Air conditioning.*

1. Introduction

Control of humidity is the regulation of the degree of saturation (relative humidity) or quantity (absolute humidity) of water vapor in a mixture of air and water vapor [1-4]. Controlling the humidity is critical to staying comfortable and avoiding problems**.** Too much humidity during summer can cause allergies and promote the growth of mold, which can be a health risk and cause structural damage of different parts. Too little humidity during winter can cause colds and other infections as well as nosebleeds and dry skin [4], [5]**.** Control of humidity is most required condition of comfort or industrial conditioning systems. Humidity control can be highly critical in some areas such as hospitals operating rooms, electronic data processing equipment rooms, textile mills and many printing operations. [5]

Proper greenhouse humidity is important both in preventing plant diseases and promoting healthy plant growth. High humidity can promote the Botrytis and other fungal diseases. High humidity also restricts plant transpiration, which in turn limits evaporative leaf cooling and can lead to overheating of plant foliage. If high humidity persists for a long time, the restriction of transpiration can limit the transpiration stream of nutrients and can lead to nutrient deficiencies. Low humidity is best avoided because it may increase foliar transpiration to the extent that the root system cannot keep up. Humidity control system largely used in power plants requires protection against moisture. This system is used in defense, storage of fertilizer, cheese, sugar, coating and packaging etc. Humidity control system is used in air conditioning both in summer and winter seasons.[1-5]

Humidity can be controlled in two ways either manually or automatically. Hygrometer is used to measure the humidity in manual humidity control system and the blower is switched on-off the blower for humidification and dehumidification process manually. The automatic system has a great advantage than manual system because no labor needed to start the humidifying and dehumidifying blower. Therefore, labor cost is reduced in this system. Automatically humidity can be controlled in various ways such as using digital signal processor (DSP), programmable logic controller (PLC), microcontroller etc.[10] The DSP, PLC systems are very much expensive and large in size, therefore microcontroller is used as controller in the developed system because it is very cheap and small in size. In this work, a square shaped room is constructed, with a cylindrical chamber. With the help of ATmega32 microcontroller, HSM-20G humidity sensor, LM-35 temperature sensor, LCD monitor and other necessary components, the system is operated automatically.

2. Construction of the Automatic System

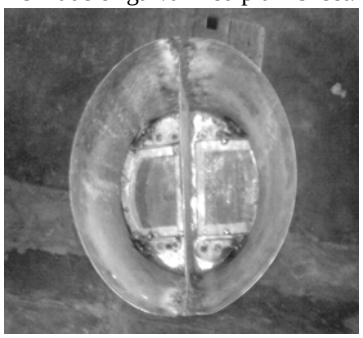
The automatically operated humidity controller consist of several parts such as cylindrical shaped chamber, square shaped room, flexible pipe, ATmega-32 microcontroller, HSM-20G humidity sensor, LM-35 temperature sensor, LCD monitors, blower, flexible pipe, sponge etc. which are described in the following.

Cylindrical shaped chamber

This is a cylindrical shaped chamber and acts as a heart in this control system. The chamber is internally divided into two equal portions and both the portions has inlet and outlet ports The cylinder is required to hold the drawers that contain silica gel and sponge which wet with water. The cylinder is made of galvanized plain sheet.

(a) Front view of the chamber

(b) Side view of the chamber



(c) Inside view of the chamber

Fig.1. Photograph of the cylindrical shaped chamber

Square shaped room

This room is another important part in this system. This room is considered as a testing room where the control of the humidity can be tested. This room has also inlet and outlet ports.

Fig. 2. Photograph of square shaped room

ATmega-32 Microcontroller

The ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption verses processing speed.[8-9]

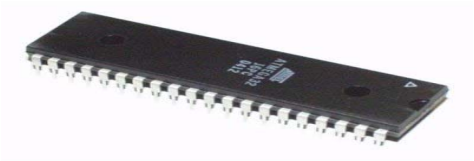


Fig. 3. ATmega-32 Microcontroller

HSM-20G Humidity Sensor

Humidity sensor is used to sense the value of humidity in the square room whose humidity is to be controlled. It use voltage 7V DC, Storage temperature Tsg-40 to 85^0 C. Storage humidity range Rhstg 0 to 100% RH. Operating temperature range Ta -30 to 80C.

Fig. 4. HSM-20G Humidity Sensor

Blowers

Two blowers are required to force the process air and reactivation air through the cylindrical shaped chamber from the square shaped room.

LCD Monitor

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals.

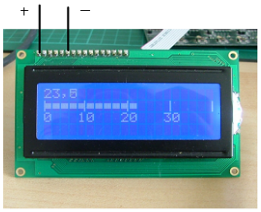


Fig. 5. LCD monitor

3. Experimental Set-up

Description of the set up

In this control system, two parts are essential. One is the room where the humidity is controlled and the other is a chamber by which the humidity can be controlled. Both room & chamber have inlet & outlet ports. The inlet ports of the chamber are connected with electric blowers and the outlet ports of the chamber are connected with the inlet ports of the room. On the other hand, the outlet ports of the room are connected with the blower. The chamber which is used to control the humidity is partitioned into two portions. Both the portions have inlet & outlet ports. Now at the middle of the chamber, there are two trays which are connected with the chamber. Trays are constructed with nets. The structure of one tray will be made of honey comb. In this tray silica gel is placed and in another tray a wet cloth is placed. In the portion where silica gel is placed, maintains the dehumidification process and in another portion humidification process.

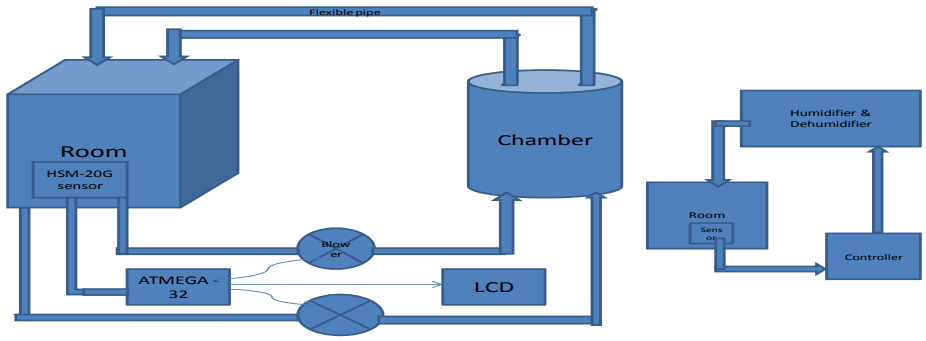


Fig. 7. Schematic Diagram of humidity control system using microcontroller and feedback control

Fig. 8. Photograph of the complete assembly of humidity control system

Working principle

For the automatic control system, the main components are ATMEGA-32 micro-controller and a HSM-20G humidity sensor that is attached in the room which helps to measure the humidity. If the humidity of the room is greater than comfortable range (50%-70%R.H) then the humidity sensor (HSM-20G) senses this condition of air and sends this information to the microcontroller. The microcontroller executes this information and starts the blower which is attached with dehumidification chamber. After certain period the humidity falls down to comfortable range (50%-70% RH) after absorbing water particle by the silica gel. If the humidity of the room is less than the comfortable range similarly this condition of air is sensed by humidity sensor and is sent to the microcontroller. Similarly humidity is increased to the comfortable range. In this way the system acts as a automatic humidity controller.

4. Experimental Results

Dehumidification

In this section, dehumidification is done by using Blue type silica gel and humidity is decreased from high range to low range within the comfortable range and the change of relative humidity with temperature is shown in the figure 9.

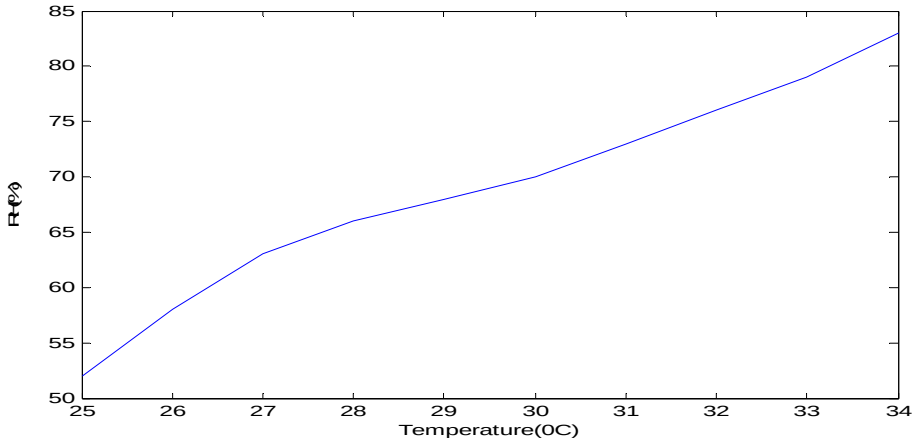


Fig. 9. Relative humidity Vs. Temperature diagram for dehumidification process

Humidification

In this section, humidification is done automatically by using wet sponge and humidity is increased from low range to high range and the change of relative humidity with temperature is shown in the figure 9.

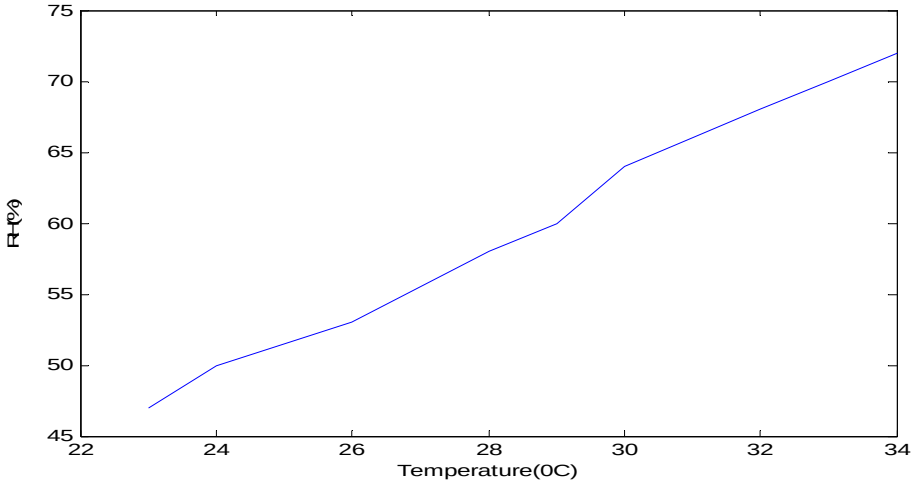


Fig. 10. Relative humidity Vs. Temperature diagram for humidification process

Performance of the Controller

The Fig. 9 indicates the relative humidity vs time for humidification and dehumidification. The increasing and decreasing region of the figure represent the humidification and dehumidification, respectively. Since the comfortable range of humidity is 50-75%, when relative humidity decreases below the comfortable range humidity sensor sense the condition of room and send the signal in the microcontroller which turn on the humidifier and humidity gradually increases with time. It is also shown that after 11 min humidity reaches above the comfortable range, then microcontroller turn off the humidifier and turn on the dehumidifier. After 23 mins again humidifier turn on and dehumidifier turn off. In this way system control the humidity of a room.

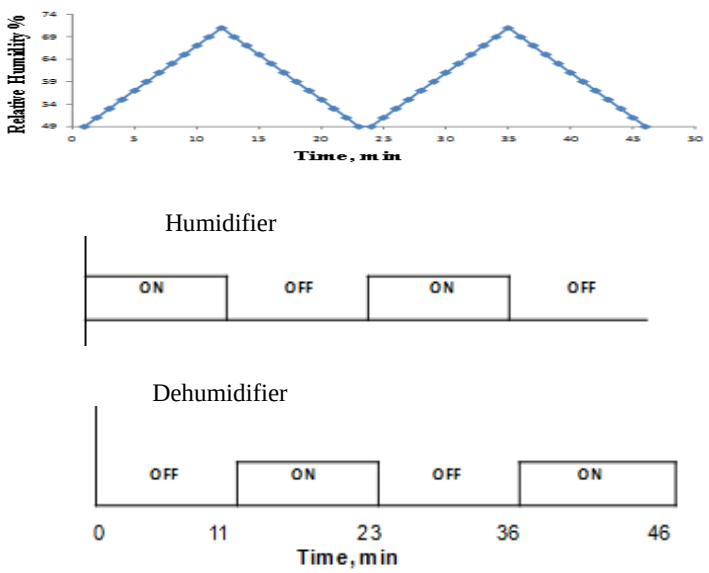


Fig.11. Relative humidity vs. Time for humidification and dehumidification and automatic on-off of humidifier and dehumidifier

Since the comfortable range of humidity is 50-75%, when relative humidity decreases below 50% humidity sensor sense the condition of room and send the signal in the microcontroller which turn on the humidifier and humidity gradually increases with time which is shown in the figure 9. From the figure it is shown that after 11 min humidity reaches approximately 74% then microcontroller turn off the humidifier and turn on the dehumidifier. After 23 mins again humidifier turn on and dehumidifier turn off. In this way system control the humidity of a room.

7. Conclusion

An automatic humidity control system has been designed and fabricated. The humidification and dehumidification process of the system is done automatically. In case of dehumidification, humidity is reduced from 85 to 50% step by step. For this purpose, silica gel is used. On the other hand, humidity is increased from 50 to 85% by using wet sponge that contained water. It is seen from the result that developed humidity control system can provide the comfortable range of humidity automatically using microcontroller. Finally, this system is able to control the humidity of a room.

8. References

[1] Stoecker. Wilbert F. and Jerold W. Jones, Refrigeration & Air Conditioning, 7th Edition, L. Heuber Publisher, 2010.
[2] R.S. Khurmi & J. K. Gupta, Refrigeration& Air Conditioning**,** 6thEdition, S. Chad Publishing House (Pvt) Ltd., Ram Nagar, New Delhi-110055**,** 2009.
[3] V. K. Jain, Refrigeration & Air Conditioning, 4th Edition, L. Heuber Publisher, 2010.
[4] S.C Arora and S. Domkundwar (2009), Refrigeration & Air Conditioning, 8th Edition, Dhanpat Rai and Sons Publisher
[5] Robert Chatenever, House & Home Heating, Ventilation & Air Conditioning, Arlington Publisher, 7th edition, 2010.
[6] V.K.Metha (2009), Principles of Electronics, 9th Edition, S. Chand & Company Ltd.
[7] R.P.Malvino (2010),Electronics Principles, 6th Edition, Tata McGraw-Hill, Arlington Publisher, 7th edition, 2010.
[8] S. R.Fergusan& P. K. Devision, A Text Book of Mechatronics Engineering, 5th Edition, Washing D.C.: American Institute for Convertion.
[9] T.S.William& V. K. Metha, Mechatronics Engineering, 8th Edition, Copyright © 2010.
[10] WilliamGodfride& R.G. Pique, A Text Book of Programming, C++", 4th Edition, 2009.
[11] Grant McFarland, Microprocessor Design, McGraw-Hill Professional, 2010 ISBN 0071459510.
[12] A.S. Sedra and K.C. Smith (2009), Microelectronic circuits,5th Edition,New York: Oxford University Press. pp. 397 and Figure 5.17.ISBN 0-19-514251-9.
[13] V.K.Metha (2009), Principles of Electronics, 9th Edition, S. Chand & Company Ltd.

[14] R.P.Malvino (2010),Electronics Principles, 6th Edition, Tata McGraw-Hill, Arlington Publisher, 7th edition, 2010.