SUST Journal of Natural and Medical Sciences (JNMS) vol. 18 (2) 2017
ISSN (Print): 1858-6805 e-ISSN (Online): 1858-6813

عمـــادة البحـــث العلمـــي
DEANSHIP OF SCIENTIFIC RESEARCH

SUST
Journal of Natural and Medical Sciences
Journal home page:
http://Scientific-journal.sustech.edu/

Humidity Measurement by using Device of Humidity and Temperature Sensor (DHT11) by Microcontroller at mega 16

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Received: November 2017 Accepted: December 2017

Abstract

Three brick clay samples were prepared by mixing the garirh and kaolin earth with different percentages for three samples. Refractory brick components were for sample 1 (75% garirh, 25% kaolin), sample 2 (70% garirh, 30% kaolin), and sample 3 (80% garirh, 20% kaolin). Measurement of the humidity of the three samples was performed by a device assembled by the researchers. The electronic device consists of a port connected to Liquid Crystal Device (LCD) screen to display the reading of humidity inside and outside the room, and a microcontroller of 16L mega, which was programmed by the computer using the Bas com AVR program for scientists of the Netherlands (Alf and Vegard Risc prosier). The data was transferred to the electronic port, and finally two DHT11 sensors for measuring the internal and external humidity was connected. After measuring the humidity of the three samples a graph was drawn consisting of humidity versus time. Measurements were performed each hour from 6 am to 10 pm. The results were then graphically drawn, and the results of the three samples were obtained; showing high humidity in the morning, very low humidity at noon and again very high humidity in evening. By comparing the three samples of the Jazeraa and Khartoum states, the best humidity sample was the first sample which consists of (75% garirh, 25% kaolin), because the humidity was very low compared to other samples. It was found that the best sample of humidity was the first sample which consists of (75% garirh, 25% kaolin). After studying these results, the researcher recommends that in areas with high humidity brick type of the first sample, which consists of (75% garirh, 25% kaolin)
should be used

Keywords: Refractory brick, DHT11 sensor, microcontroller at mega 16, Liquid Crystal Device (LCD) screen, Bas Com AVR software program, humidity measurement.

المستخلص

أعدت ثلاثة عينات من طوب الطين بواسطة خلط تراب القريرة والكاولين بنسب مختلفة للعينات الثلاثة .عينات الطوب الحراري ممثله في العينة الاولي (5 % قريرة و5 % كاولين)، العينة الثانية (0 %قريرة و0 % كاولين) والعينة الثالثة (0 % قريرة و0 % كاولين). تم إجراء قياس الرطوبة للعينات الثلاثة بواسطة جهاز تم تجميعه من قبل البا ثور . يتكون الجهاز الا لكتروني من منفذ متصل بشاشة عرض من الكريستال السائل LCD لعرض قراءة الرطوبة

داخل وخارج الغرفة، و متحكمة 16 ميقا والتي تم برمجتها بالكمبيوتر باستخدام برنامج باس كوم. تم نقل البيانات الي المنفذ، وأخيرا حساسين DHT11 لقياس الرطوبة الداخلية والخارجية ورسـ ت نسبة الرطوبة مقابل الوقت بيانيـ . أجريت القياسات كل ساعة من الساعة 6:00 صباحا وحتي الساعة 10:00 مسا ا. وبعد رسم بياني تم الحصول على نتائج العينات الثلاثة، مما يدل على ارتفاع نسبة الرطوبة في الصباح ، و نخفض جدا عند الظهيره، ثم تكون مره احري رطوبة عالية جدا في المساء . ومن خلال مقارنة العينات الثلاثة بولاية الجزيرة والخرطوم، كانت العينة الأفضل في الرطـ بة هي العينة الأولى التي تتكون من (5 % قريرة و5: % كاولين)،لان رطوبتها منخفضة جدا مقارنة بالعينات الاخري. اتضح ان افضل عينة للرطوبة هي العينة الاولي التي تتكون من (5٠ % قريرة و5: % كاولين). وبعد دراسة هذه النتائج يوصي الباحث ان المناطق ذات الرطوبة العالية يجب استخدام نوع الطوب من العينة الاولي الا ي تتكون من (5٠ % قريرة و5: % كاولين).

Introduction

Physicists have long been concerned with moisture exchange through absorbent materials in the walls and roofs of buildings. Water vapor was generally regarded as a nuisance, causing condensation within walls, with consequent mould growth and corrosion of construction materials. However, the stabilization of the interior climate by moisture-active building materials and furnishing was of great value in the world of museums and archives [1]. Humidity buffering by absorbent materials has long been used to stabilise the microclimate in showcases and transport boxes. These have a very low air exchange rate, so the efficiency of moisture exchange between the buffer material and the air in the case was not important [2, 3].

Humidity is the presence of water vapour in air (or any other gas). In normal room air there is typically about 1 % water vapour, but it is widely present in greater or lesser amounts. High humidity makes hot days feel even hotter. Low humidity can give people a feeling of a dry throat, or sensations of “static” when touching things. Humidity is measured using a hygrometer. Humidity affects many properties of air, and on materials in contact with air. Water vapour is key agent in both weather and climate, and it is an important atmospheric greenhouse gas. A huge variety of manufacturing, storage and testing process are humidity-critical.

Air-conditioning systems in buildings often control humidity, and significant energy may go into cooling the air to remove water vapour. Humidity measurements contribute both to achieving correct environmental conditions and to minimising the energy cost of this [4,5].

Clay is one of the oldest building materials on Earth, among other ancient, naturally-occurring geologic materials such as stone and organic materials like wood. Between one-half and two-thirds of the world's population, in traditional societies as well as developed countries, still live or work in a building made with clay as an essential part of its load-bearing structure. Also a primary ingredient in many natural building techniques, clay which is used to create adobe, cob, cordwood, and rammed earth structures and building elements such as wattle and daub, clay plaster, clay render case, clay floors and clay paints and ceramic building material. Clay was used as a mortar in brick chimneys and stone walls [6, 7].

Materials and Methods

A basic clay mixture was prepared from two types of raw materials the kaolin and garirh soil (refractory bricks) [8], as in Fig.1

Figure 1: Refractory brick used in the research

DHT11 - Humidity and Temperature Sensor

The DHT11 is a basic, low-cost digital temperature and humidity sensor. It is made up of a capacitive humidity sensor and a thermistor to measure the surrounding air. It's fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is that you can only get new data from it once every 2 seconds see figure 2.

Features of the sensor

Full range temperature compensated relative humidity and temperature measurement. Calibrated digital signal, outstanding long-term stability and extra components not needed also long transmission distance, low power consumption and 4 pins packaged and fully interchangeable.

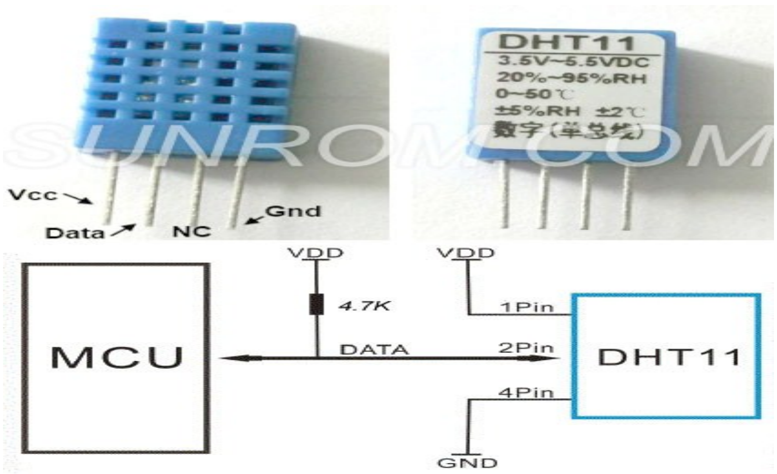

Figure -2: DHT11 Sensor

Details

This sensor includes a resistive-type humidity measurement component and temperature measurement component, connected to a high-performance 8-bit microcontroller, offering excellent quality, fast response, and anti-interference ability with is low in cost. Each DHT11 element was strictly calibrated in the laboratory, and it was made sure that it was extremely accurate on humidity calibration. The calibration coefficients were stored as programmes in the Office of the Prosecutor (OTP) memory, which are used by the sensor's internal signal detecting process.

The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission makes it the best choice for various applications. The component was 4-pin single row pin package.

DHT11's power supply was 3-5.5 Volt direct current (DC). When power was supplied to the sensor, no instruction to the sensor was detected within one second in order to pass the unstable status. One 100nF capacitor can be added between voltameter direct data (VDD) and ground (GND) for power filtering.

Communication Process: Serial Interface (Single-Wire Two-Way)

The interesting thing in this module is the protocol that uses to transfer data. All the sensor readings are sent using a single wire bus which reduces the cost and extends the distance. In order to send data over a bus you have to describe the way the data will be transferred, so that transmitter and receiver can understand each other. On DHT-11 the 1-wire data bus was pulled up with a resistor from voltammeter collector to collector (VCC). So if nothing occurred the voltage on the bus was equal to VCC.

Communication Format can be separated into three stages:

1) Request: To make the DHT-11 to send you the sensor readings you have to send it a request. The request was, to pull down the bus for more than 18ms in order to give DHT time to understand it and then pull it up for 40uS.

2) Response: What comes after the request was the DHT-11 response. This was an automatic reply from DHT which indicates that DHT received your request. The response was ~54uS low and 80uS high.

3) Data Reading: What will come after the response was the sensor data. The data will be packed in a packet of 5 segments of 8-bits each. Totally 5×8 =40bits [(9)].

Logic Analyzer Snapshots:

In the following image you can see the request sent from the microcontroller to the DHT and following the packet. See figure -3

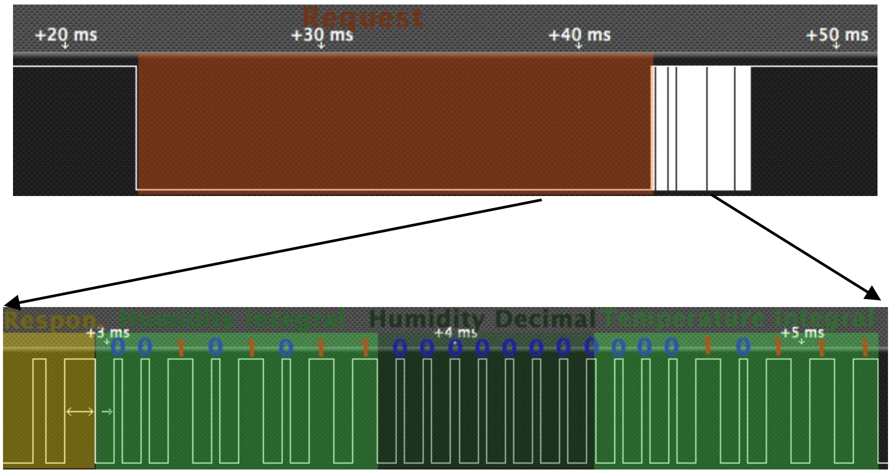

Figure -3 Requests and Response of Humidity Decimal

If we zoom at the data bits we can read the values. You can see the Request follows the Response and Data bits. If we decode the above data we have. Humidity 0b00101011.0b00000000 = 43.0% Temperature 0b00010111 = 23 C. The last two segments can't be seen in this image because of zoom.

Implementation

What we have to do to read a DHT-11 sensor is:

Send request, Read response, Read each data segment and save it to a buffer, Sum the segments and check if the result is the same as CheckSum. If the CheckSum is correct, the values are correct so we can use them. If CheckSum is wrong we discard the packet.

To read the data bits can use a counter and start count uSeconds of High level. For counts > 24uS we replace with bit '1'. For counts <=24 we replace with bit'0'

Humidity measurement of samples was performed by using the following circuit shown in Fig.4a.

Figure-4 (a): The circuit used for humidity measurement collected by researcher

The flowchart of the above device is given in Fig.4 (b)

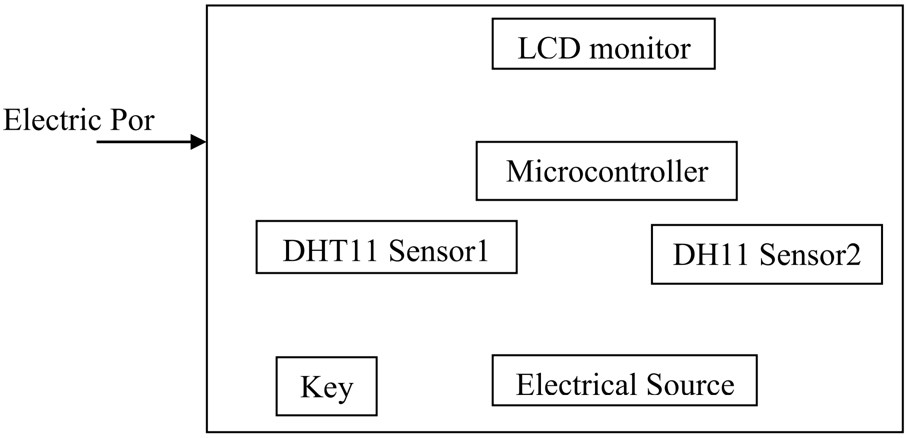

Figure-4(b): Flow chart circuit of the Humidity measurement device collected by researcher

Results

The readings were obtained in Khartoum and the Jazeera States. See tables.1 (a). The Readings of humidity were recorded within three days. First in the Jazeera State, readings were measured within Saturday 16 \ 9 to Monday18 \ 9\2017, from 6 am until 10 pm.

Second in the Khartoum state, readings were measured within Wednesday 20\ 9 to Friday 22 \ 9\2017, from 6 am until 10 pm.

Table 1(a): The air and room humidity for the three samples which was measured in the Jazeera state.

Time	Sample 1		Sample2		Sample3	
Hour	Air humidity%	Room humidity%	Air humidity%	Room humidity%	Air humidity%	Room humidity%
1	45	70	50	75	47	73
2	42	69	46	74	45	72
3	40	67	42	70	41	70
4	38	58	39	62	39	61
5	35	41	36	51	37	50
6	33	39	35	42	36	41
7	32	39	35	38	35	39
8	32	39	35	38	35	38
9	33	40	35	38	35	38
10	34	40	35	39	36	40
11	36	41	36	40	38	41
12	38	43	37	42	39	45
13	41	45	39	46	42	47
14	44	47	42	48	45	50
15	46	50	45	55	48	54
16	46	58	50	65	50	63

Table 1(b): The air and room humidity for the three samples which was measured in the Khartoum state.

Time	Sample 1		Sample2		Sample3	
Hour	Air humidity%	Room humidity%	Air humidity%	Room humidity%	Air humidity%	Room humidity%
1	38	55	42	60	40	58
2	36	54	39	59	38	57
3	35	50	38	58	37	54

4	34	48	36	42	36	46
5	33	45	34	40	34	42
6	32	42	33	39	33	40
7	31	40	32	38	32	39
8	31	38	32	38	31	38
9	31	37	31	37	31	37
10	31	37	31	37	31	37
11	32	37	33	40	31	37
12	33	38	35	42	33	39
13	36	40	37	45	35	42
14	39	43	38	50	38	44
15	42	46	40	55	41	49
16	45	50	43	65	44	56

The following chart illustrates the relationship between the humidity in percentage against the time in hour for the three samples, RH air humidity, RH1 Room humidity of sample 1, RH2 Room humidity of sample 2, and RH3 Room humidity of sample 3, as in Fig.5 (a) and 5(b).

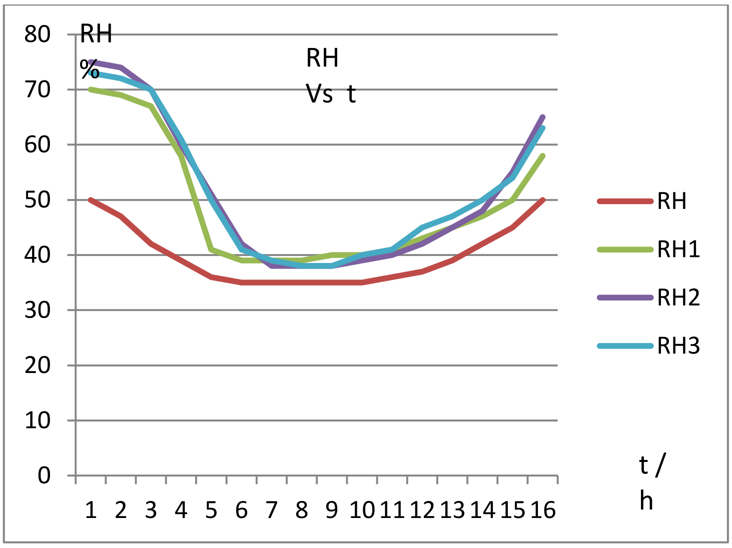

Figure 5(a): The relation between humidity versus times for the three samples measured in the Jazeera State.

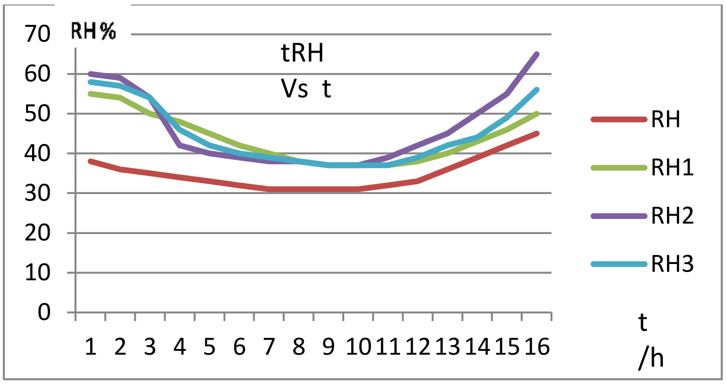

Figure 5(b): The relation between humidity versus times for the three samples measured in the Khartoum State.

The following table shows the values of humidity for the three samples of bricks, these values were calculated from the drawing in fig.5. The results are shown in table below.

Table 2 (a): Compared to air and room humidity for the three samples measured in the Jazeera.

The best sample	Sample1		Sample3		Sample2	
	Air humidity%	Room humidity%	Air humidity%	Room humidity%	Air humidity%	Room humidity%
At morning	45	70	45	72	45	73
At evening	39	44	39	45	39	46
At evening	42	46	42	47	42	48

In the above table 2(a), the three samples measured in the Jazeera state were compared, and the best sample of humidity was found to be the first sample consisting of (75% garirh, 25% kaolin). The reason was because the humidity was very low compared to other samples. This sample is followed by the sample which consists of (80% garirh, 20% kaolin), and finally the sample which consists of (70% garirh, 30% kaolin).

Table 2 (b): Compared to air and room humidity for the three samples measured in the Khartoum state.

The best sample	Sample1		Sample3		Sample2	
	Air humidity%	Room humidity%	Air humidity%	Room humidity%	Air humidity%	Room humidity%
At morning	38	55	38	57	38	58
At evening	33	38	33	39	33	40
At evening	38	42	38	44	38	50

In the above table 2(b), the three samples measured in the Khartoum state were compared, and the best sample of humidity was found to be the first sample consisting of (75% garirh, 25% kaolin). The reason was because the humidity was very low compared to other samples. This sample is followed by the sample which consists of (80% garirh, 20% kaolin), and finally the sample which consists of (70% garirh, 30% kaolin).

Discussion

The humidity measurements were performed for all the previously prepared brick samples. Fig. 5 represents the results and shows that the humidity was high in the morning and very low at noon, then rises and become very high in the evening, readings were performed each hour.

The researchers concluded that the best sample of the refractory brick samples was the first sample consisting of (75% garirh, 25% kaolin), because its humidity was very low compared to the other samples. This sample is followed by the sample which consists of (80% garirh, 20% kaolin), and finally the sample which consists of (70% garirh, 30% kaolin) for both the Jazeera and Khartoum states, see Fig. 5.

Conclusion

After measuring the humidity using the three samples of refractory bricks, it was noticed that the best sample was sample 1 which consists of 75% garirh and 25% kaolin. The reason, the sample was the best, was because the measured humidity was the lowest of the three samples. Where as if we consider the thermal conductivity of the three samples (Mohamed. I. Mustafa. H. and Huda M. Kamal, Taj A. Taj (2016) The Effect of Increasing Ratio of Garirh to Kaolin on the Thermal Conductivity of Refractory brick, sustech.edu/, e_ISSN:1858 – 618, vol. 17 (2)) we conclude that the best sample of thermal conductivity was the third sample consisting of (80% garirh, 20% kaolin).

The study recommends that the best refractory brick in humidity is the one composed of 75% garirh and 25% kaolin, and areas with high thermal conductivity brick type of the third sample, which consists of (80% garirh, 20% kaolin) should be used.

Acknowledgement

The author would like to thank Dr. Tajedin A. Baker, for assembling the electronic device for humidity measurement performed in the electronic laboratory of

the Department of electronic University of Bahri.

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