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A Microcontroller based Hygrometer for Moisture Level Measurement

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Abstract- ***A hygrometer is a device used to measure the moisture content in the atmosphere. Modern electronic devices use temperature of condensation or change in electrical capacitance or resistance to measure humidity difference. In this work a microcontroller based digital hygrometer ranges from 1.8 – 100ppm will be designed and implemented. A capacitive type moisture sensor consisting of nano porous thin film of alumina coated in between two parallel gold electrode onto an alumina substrate will be used. And we are also introducing temperature sensor to determine the moisture level according to temperature variation. Hence finally we can get a result about the healthy environmental condition whether it is proper for breathing or not. Develop an electronic circuit capable of converting change in capacitance into frequency and signal processing is done by a microcontroller and moisture level display in terms of ppm.***

Keywords- ***capacitive sensor, gold electrode, hygrometer, temperature sensor, LCD***

I. INTRODUCTION

Hygrometer is an instrument used in metrological science to measure the humidity, or amount of water vapor in the air. Humidity sensor plays an important role in industries. Humidity sensors are also used in cement industries, automobile industries, building and laundries. Humidity sensors are used for chemical gas purification, health monitoring of transformer oil, paper mill and textile production. There are endless applications where moisture measurement is needed. The types of humidity sensors are required depend on measurement range and application. A low cost microcontroller based hygrometer has been developed to measure the moisture level of the atmosphere of the air by converting analog data to digital data using analog to digital converter. In earlier case signal is in analog form then the accuracy of the measurement may be degraded now use the such a smart sensor with the circuit by high sensitivity, low response and recovery time, low cost, and linear response is always desirable and different material can be used to fabricate the humidity sensor such as organic polymer, porous ceramic, porous silicon etc.

In the present work, efforts have been made to develop a microcontroller based hygrometer to measure the moisture from 1.8 – 100 %RH using the capacitive type humidity sensor. We are also introducing temperature sensor to measure the exact moisture level according to temperature variation. The response has been modeled to develop a circuit to convert capacitance change in digital form. The digital output can be easily interfaced with microcontroller. The fabricated output in terms of ppm and %RH is displayed with the help of LCD.

II. FABRICATION OF MOISTURE SENSOR

Humidity is the presence of water in the air. The amount of water vapor in the air can affect human comfort as well as many manufacturing processes in the industries. Here we have develop a capacitive moisture sensor which is fabricated on an alumina substrate of dimension 2cmx2cm. Then, by using manual screen printing equipment, a gold electrode of dimension 1.6cmx1.4cm was screen printed onto an alumina substrate and fired at 400° c for one hour. γ-Al_2O_3 deposited on the electrode with the help of dip coated by dipping the substrate 6 times in the sol gel solution. To ensure uniform thickness of film, the film was deposited by using PC controlled automatic dip coater. Deposited thin film of 6 µm thickness on electrode is the dried slowly at room temperature for several hours and another gold electrode of dimension 1.3 cm x 1.2cm was screen printed on thin film. An optimal thickness of the film is desired because if the thickness is small the two electrodes may easily short and if the thickness is large the sensitivity of the device will reduce. Also the gold is made porous with average pore dimension 1.7µm large then the pore dimension is thin film (10A°). Larger pores in electrode will allow water molecules to penetrate then absorbed by the porous γ-Al_2O_3 film with very large specific area. Finally the film was sintered in a programmable furnace by firing it initially at 400° c for one hour and then subsequently at 900 degree c for another one hour for curing the top gold electrode. Electrical connection to the sensor is made by two silver wire soldered on both electrodes. The fabrication of sensor in the form of thin film is highly desirable to response to the micro and nanotechnology demand. The sensor based on film technology will be very fast, highly reproducible, very low hysteresis. Among different types of materials ceramic sensor offers excellent physical and chemical stability. There are many types of humidity sensor but capacitive sensor in the form of parallel plate where sensing film in between the electrodes are very few. The parallel electrode structure is important for detecting humidity in lower range. The efforts are being made to make the sensor output as linear as possible for easy fabrication, low cost and simple.

III. ELECTRICAL CHARACTERISTICS OF THE SENSOR

The humidity sensor consists of a polymide capacitor fabricated on silicon substrate. The use of a silicon as substrate offers the possibility of integrating the signal processing circuit and thus developing smart sensor. All the electrical measurement of the sensor was measured and sensor was tested at different percentage of relative humidity. The sensor was tested at a fixed ac voltage of 1V (rms) and signal frequency of 1 KHz. The low frequency has been selected because most of the humidity sensors show maximum sensitivity at low signal frequency. Experiments have been performed to determine the response, repeatability, capacitive response, and hysteresis effect of the sensor. The capacitive response of the sensor shows that as capacitance increases humidity level also increases. Similarly for decrease in humidity, the capacitance value decreases. The change in capacitance value for increase and decrease in humidity is almost identical.

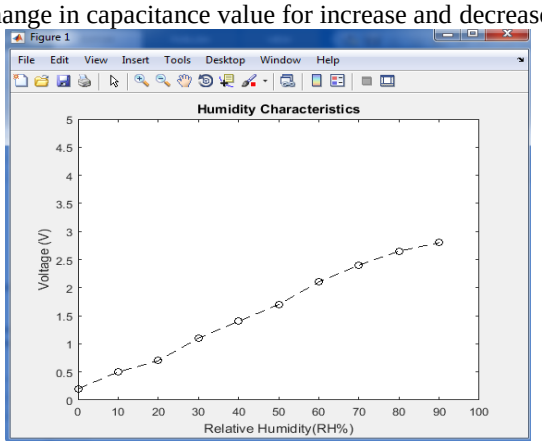

Fig. 1. Electrical Characteristics of Humidity Sensor

Figure 2 showing electrical characteristics of temperature sensor which is inbuilt in humidity sensor.

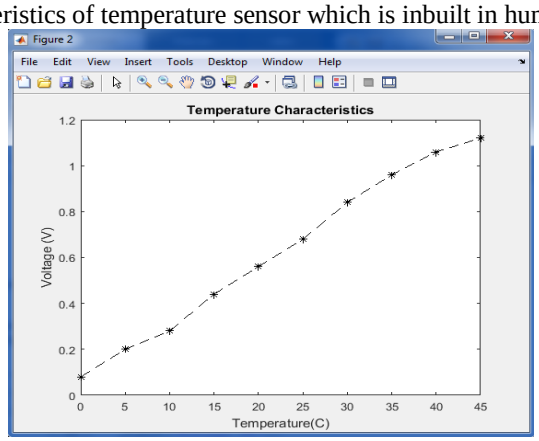

Fig. 2. Electrical Characteristics of Temperature Sensor

IV. SIGNAL CONDITIONING FOR MOISTURE DISPLAY

Block diagram of the complete system is shown in figure 3. For detection and signal processing an 8 bit microcontroller was used. Since the output of the sensor is in digital form it can be interfaced directly to the microcontroller. This is the complete block diagram of a digital hygrometer which consist of capacitive type humidity sensor and LM-35 temperature sensor, output of the sensor is analog form and converted to digital value by analog to digital converter and signal processing is done by microcontroller and moisture level display on 2x16 alphanumeric LCD in terms of parts per million (PPM). The characteristics of the hygrometer examined for 1.8 to 100ppm moisture content in air of environment or dry gas.

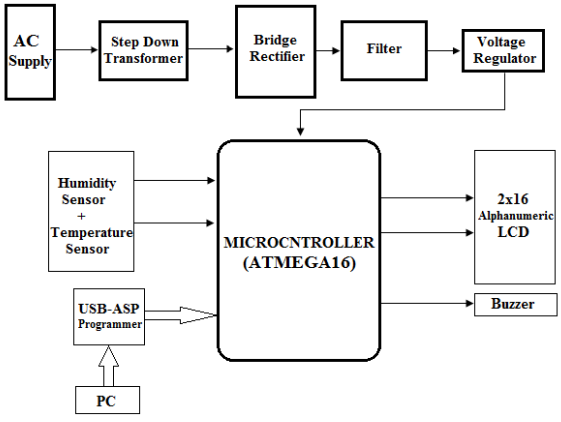

Fig. 3. Block Diagram of Microcontroller based Hygrometer

V. CONCLUSION

In this work a microcontroller based digital hygrometer ranges from 1.8 to 100 ppm will be designed and implemented. The circuit is simple to operate and assembled few components for its hardware implementation. And in this project we are also introducing a temperature based monitoring system so that we can get a result about environmental condition whether it is proper breathing or not. The main objective is to develop an electronic circuit capable of converting change in capacitance into frequency and signal processing is done by a microcontroller and moisture level display on 2x16 alphanumeric LCD and two connecting points to show waveform on an oscilloscope. The moisture level displays will be in terms of PPM.

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