# HUMIDITY MONITORING SENSOR

Hathi A.L.A.
*Department of Electrical and Electronic Engineering*
*University of Peradeniya*
Sri Lanka
e20132@eng.pdn.ac.lk

Hussain M.Z.Z.
*Department of Electrical and Electronic Engineering*
*University of Peradeniya*
Sri Lanka
e20152@eng.pdn.ac.lk

Riyaldeen F.Z.M.
*Department of Electrical and Electronic Engineering*
*University of Peradeniya*
Sri Lanka
e20340@eng.pdn.ac.lk

***Abstract*— This project is designed to develop a sensor to measure the humidity in the surrounding air. It can measure humidity in a wide range of humidity levels in the air. The mechanism used here is measuring the current between the metal plates which carries salt in between the plates.**

***Keywords—sensor, humidity***

## I. INTRODUCTION

Humidity, defined as the amount of water vapor in the air, is commonly expressed as "relative humidity" (RH), taking into account the temperature. Over time, various methods were developed to measure relative humidity. Early hygrometers, utilizing materials like animal hair and paper coils to absorb water vapor, proved inaccurate with limited range and maintenance issues. Alternative methods like the sling psychrometer and chilled mirror hygrometer utilized evaporation and condensation for indirect humidity measurement but had limitations. The demand for more accurate and comprehensive relative humidity measurements in weather and research led to the development of electrical humidity sensors after the invention of the transistor. These sensors measured resistance changes in materials absorbing water vapor but faced issues like poor stability, limited accuracy, and hysteresis in responding to decreasing humidity levels. The quest for an accurate and low-maintenance solution persisted.

This project aims to design and build a simple humidity monitoring sensor without relying on a microcontroller. This approach avoids the need for programming and complex circuitry, making it suitable for beginners or situations where resources are limited.

## II. INITIAL SPECIFICATIONS

### *A. Measurement quality*

This sensor can be used in normal air conditions with acceptable environmental temperature changes

### *B. Range*

In normal air conditions, the humidity varies between 50% to 80% commonly. But we can reduce the humidity further. So, the desired humidity range is 20% - 90%.

The temperature range is normally $25℃ - 40℃$.

The Operating Voltage range 3.7 V – 9.0V (DC)

Error - ± 7%

## III. METHOD

### *A. Principle of operation*

Dry salt is placed between two metal plates. A 9V battery is used to send a current between the plates. As humidity changes, dry salt absorbs moisture. Then the resistance between the two plates also changes, thereby altering the current. We measure the current to calibrate our sensor.

Materials needed:

1. Salt (table salt or any other type of salt)
2. Two electrical wires
3. Two metal plates or foil strips
4. Battery (1.5V AA battery)
5. Multimeter

### *B. Sensor module*

The sensor module includes two metal plates that carry some amount of salt between the plates. A $9V$ battery is connected between the plates by using wires. By changing the humidity level near the conductors, the current is measured for various humidity values. By using a multimeter, the current is measured.

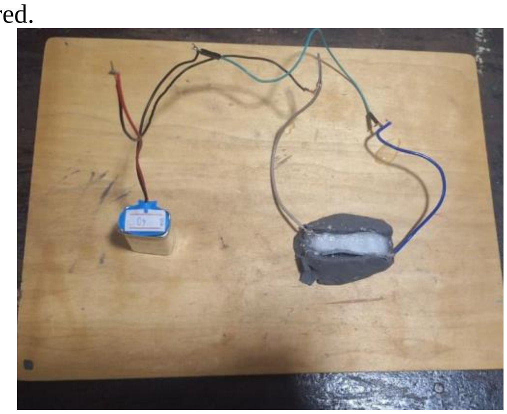

*Figure 1 – Sensor Setup*

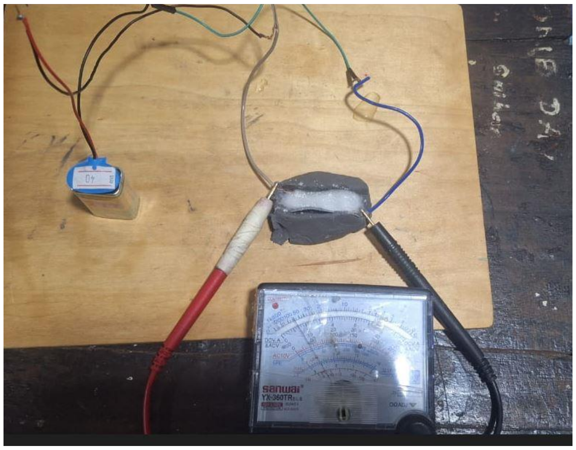


*Figure 2 - Current Measurement*

## IV. RESULT

Three sets of measurements were taken for a single humidity value of air at various times. At this time the temperature of the environment was almost constant.

### A. *Observations*

TABLE I. VARIATIONARIATION OF OUTPUT CURRENT WITH HUMIDITY

| **Humidity (%)** | **Current measurement(mA)** | | |
|---|---|---|---|
| | ***Set1*** | ***Set2*** | ***Set3*** |
| 20 | 1.5 | 1.4 | 1.4 |
| 30 | 1.2 | 1.1 | 1.3 |
| 40 | 1.1 | 1.2 | 1.1 |
| 50 | 1.0 | 1.0 | 1.1 |
| 60 | 0.9 | 1.0 | 0.9 |
| 70 | 0.8 | 0.7 | 0.6 |
| 80 | 0.7 | 0.8 | 0.7 |
| 90 | 0.6 | 0.7 | 0.6 |

### B. *Statistical Analysis*

Finding average and standard deviation values of the measurements.

Average = Sum of readings / No. of readings

σ − Standard deviation

$x_i$ − Voltage reading

$\bar{x}$ − Average

n − No. of readings

$$Standard\ Deviation(\sigma) = \frac{\sqrt{\sum(x_i - \bar{x})^2}}{n}$$

TABLE II. VARIATIONARIATION OF AVERAGE OUTPUT CURRENT WITH HUMIDITY

| Humidity | Average | Standard deviation |
|---|---|---|
| 20 | 1.43 | 0.047 |
| 30 | 1.2 | 0.081 |
| 40 | 1.13 | 0.047 |
| 50 | 1.03 | 0.047 |
| 60 | 0.93 | 0.047 |
| 70 | 0.70 | 0.081 |
| 80 | 0.73 | 0.047 |
| 90 | 0.63 | 0.047 |

### C. *Input-output characteristic graph*

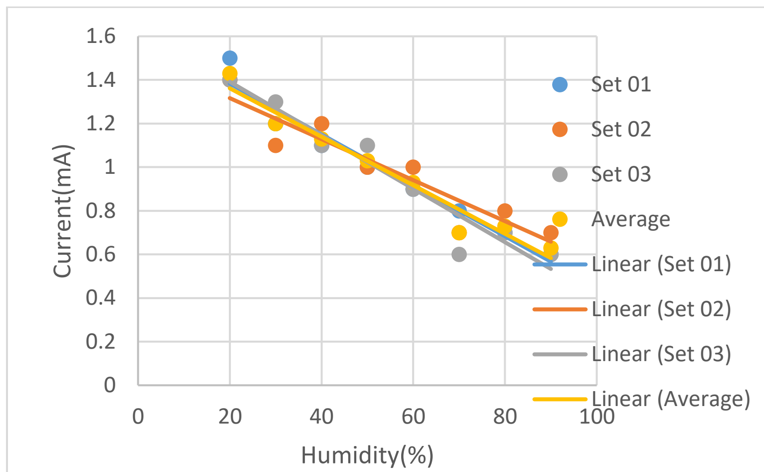


*Figure 3 – Variation of output current vs Humidity*

In common the above input output characteristic variation is linear. But we can actually see an exponential variation between the relative humidity and average current.

The corresponding relation between Current and Humidity is below.

$$y = 1.78e^{-0.012x}$$

$$x = \frac{-1}{0.012}\ln\left(\frac{y}{1.78}\right)$$

$$RH = \frac{-1}{0.012}\ln\left(\frac{I}{1.78}\right)$$

$RH$ - Relative Humidity (%)
$I$ – Average Current ($mA$)

The corresponding variation has shown below.

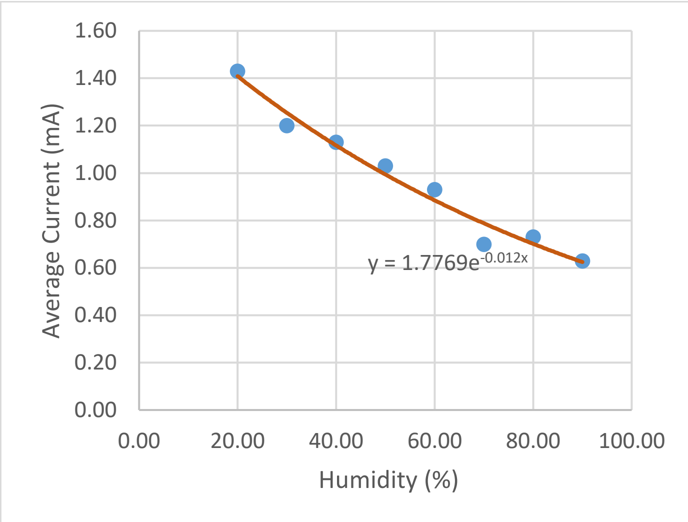


*Figure 4 – Variation of average current vs Humidity*

## V. DISCUSSION

### A. Difficulties

#### 1) Change Humidity

It was difficult to change the humidity level and record the corresponding true humidity level. To overcome this, we used some fixed humidity environments, such as inside a fridge or a container with a saturated salt solution.

#### 2) Measure Current

The change in current with humidity is relatively small, making it difficult to record exact current measurements.

#### 3). Lack of precision:

Homemade sensors may not offer the same level of precision as commercially available sensors, leading to less precise humidity measurements.

### B. Strengths

#### 1. Cheap

The components we used to build this sensor are very cheap and easy to find.

#### 2. Customizability

This sensor offers the flexibility to customize the design and materials based on specific requirements or environmental conditions

### C. Weaknesses

#### 1. Limited Accuracy

This is not as accurate as commercially available sensors.

#### 2. Sensitivity to environmental factors

This sensor can be more susceptible to interference from external factors such as temperature changes or airflow, affecting the accuracy of humidity readings.

### D. Comparison

This humidity sensor offers an extensive range, a straightforward installation process, and a user-friendly operating system in comparison to alternative sensor products. Additionally, upgrading to the latest version is so simple which can be achieved by simply replacing the metal plates and sensing material(salt) of the sensor without altering the sensing module. Users can easily gauge humidity levels by observing the current value in the multimeter. However, unlike some other humidity sensors, this product does not provide a direct numerical output. We have to manipulate from the corresponding equation given above.

## VI. CONCLUSION

The humidity sensor is useful electrical device that measures the humidity for various applications. Here we have used salt as the sensing material which is sensible to the air humidity level. In our simple sensor model, we just measure the current through the circuit and calculate the humidity using the formula we found.

Maintaining an optimal humidity level is crucial in numerous industries, including agriculture, manufacturing, and healthcare, where precise environmental conditions are paramount. There should be an error in our measurement, so it is better to implement humidity range rather than giving direct numerical output for the real-world applications.

This project aims to provide experience in understanding the functionality of real-time applications, exploring communication protocols among electronic devices and their outputs, and mastering the integration of diverse components. Finally, by completion of this project our ability as an engineer is improved.

## ACKNOWLEDGMENT

We are grateful to Dr. K.R.M.N. Ratnayake and Dr. Ruwan Ranaweera for their valuable guidance and help. We would also like to show our gratitude to the senior students and our batchmates for their unbelievable support. Any mistakes or errors are solely our responsibility and should not cast a shadow on the esteemed individuals involved

## References

1. Technical Information Library. (2019). *How do I calibrate the Relative Humidity Sensor?* [online] Available at: https://www.vernier.com/til/4337.

2. Räsänen, O. (2023). *How to Calibrate a Hygrometer or Air Humidity Sensor?* [online] Ruuvi. Available at: https://ruuvi.com/how-to-calibrate-a-hygrometer-or-air-humidity-sensor/#:~:text=By%20placing%20salt%20in%20a.