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IoT Based Coriolis Mass Flowmeter

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Abstract: According to a study, The Coriolis flow meter market has been one of the fastest growing flow meter markets over the past five years. Many users find Coriolis Effect flow meters a good investment, despite their higher initial purchase price when considering total cost of ownership. As such, many process plants are increasingly selecting Coriolis meters to replace differential-pressure devices, and their use is also growing in the oil & gas industry. One of the most important features of Coriolis effect flow meters is that they measure mass flow. While volumetric flow measurement is sufficient in many cases, mass flow measurement provides certain advantages. For example, many products are sold by weight rather than by volume, and in these cases it is often desirable to measure mass flow. Chemical reactions are often based on mass rather than volume, so mass flow measurement is also often required in the chemical industry. This paper aims to introduce measurement of pressure along with mass flow measurements of the liquid put into use. The pressure sensor (BMP 180) is used to measure the pressure of the liquid present inside the tube. Thus, the entire Coriolis Effect for Mass flow measurement has been executed with an additional feature of pressure measurement at a very minimal price than those available in the markets these days with a very high accuracy of 0.1percent along with technical incorporation of Internet of Things (IoT) to reduce manual interaction and also to access the data from remote sites.

Keywords: Differential Pressure Devices, Wifi- Module, Pressure Sensors, Accuracy, IoT

I. INTRODUCTION

Over the past two decades, flow meters based on the Coriolis principle have become one of the most important areas of development of flow measurement. The significant development of Coriolis flow measurement technology has covered several technical aspects and is due to advances in the critical modelling, signal processing, computing power, and testing facilities, and most importantly due to the acceptance by various industries. Our project focuses upon a methodology which will enable us to employ IoT- Internet of Things to the Coriolis mass flow meter with an additional feature of pressure measurement. We have opted U tube shape flow path for the Coriolis mass flow meter. Flow will be regulated using a Hydraulic workbench. The flow, pressure and temperature sensors are fitted inside the flow tube to have a track of the flow and pressure measurements along with temperature measurement of the flowing process liquid. The sensors used are BMP180 to measure the Pressure, Temperature related information's are obtained using DHT 11 sensor, and a Robokart Water Flow sensor. The sensors are placed at the inlet and outlet sections as necessary. Microcontrollers are widely used in embedded systems and make devices work according to our needs and requirements. One such MCU that we prefer is Arduino UNO Board that provides ease of use as well as programming in our work. The data received from the sensors are processed and offered to the Wi-Fi module (ESP8266).

We have shortlisted three IoT platforms which includes Google cloud, Microsoft Azure and IBM Watson. Since they provide a better and more secure IoT platform for the student community exclusively. Our first choice of cloud services is the IoT ThinkSpeak Server. They are providing a FREE base for students IoT projects alongside the security of data and easy modification of the devices connected to it. Our project offers the output in Three different forms: Through LCD (16x2 Liquid Crystal Display), as Waveforms through CRO (Cathode Ray Oscilloscope) and also for access from anywhere on the planet, through IoT ThinkSpeak server.

II. EXISTING SYSTEM

In the existing system there are many types of Humidity and Temperature monitoring system but none of them are using IOT, Digital technology and Computer technology. In this paper, we are going to implement Humidity and Temperature monitoring system by using IOT. All the Flow meters, already in use are too expensive with comparatively less accuracy. As there is a very high growing demand for the Flow meters in the industries, it has now become a major need to improve their accuracy. We have added Pressure monitoring system in order to increase the overall accuracy of the Flow meter along with the Coriolis Flow Effect.

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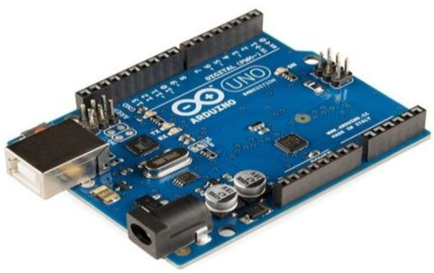
III. PROPOSED SYSTEM

In this Project we have sensors to obtain the required measurements of flow, pressure and temperature. And these are then interfaced with the Arduino UNO. The DHT 11 sensor provides precise measurements of the temperature of the liquid inside the U-Shaped flow tube. Similarly, the corresponding sensors placed to measure pressure and flow rate provide the monitored values to the Arduino. From the UNO board, the estimated values are transferred to the Cloud at regular intervals of time through ESP8266 WIFI module. From the Cloud, flow, pressure and temperature values can be seen on the (16x2) LCD, CRO and also graphically on ThinkSpeak IoT platform from anywhere in the world. With the help of WIFI module we can able to access the data.

IV. HARDWARE INTERFACE

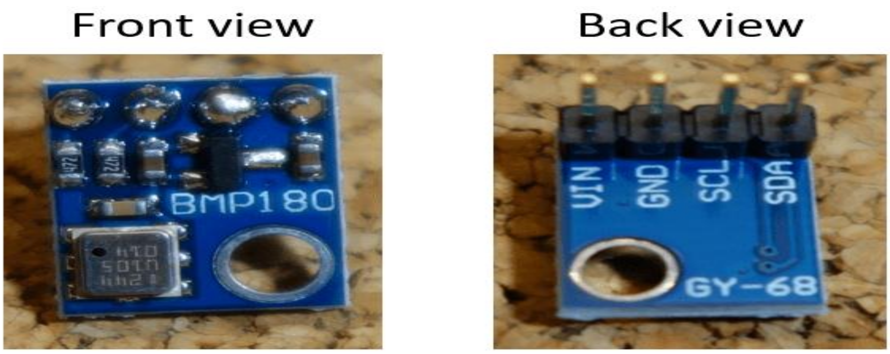
A. Arduino Uno Board

Arduino Uno may be a very valuable addition within the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also guides serial communication using Tx and Rx pins. It is an open-source platform, means the boards and software are available and anyone can modify and optimize the boards for better functionality. The software used for Arduino devices is named IDE (Integrated Development Environment) which is liberal to use and required some basic skills to find out it.



B. BMP 180

It is a barometric pressure sensor. It measures absolutely the pressure of the air around it. It has a measuring range from 300 to 1100hPa with an accuracy right down to 0.02 hPa. It can also measure altitude and temperature. The BMP180 barometric sensor communicates via I2C interface. This means that it communicates with the Arduino using just 2 pins. Operating Voltage is 5 V Supply Current is 6 mA Pressure Type Absolute Operating Pressure Min 15kPa Operating Pressure Max 115kPa Sensitivity 45.9mV/kPa



C. DHT 11

DHT11 is a temperature and a humidity sensor with a calibrated digital signal output. It uses a capacitive humidity sensor and a thermistor to scale the surrounding air and separates digital signal on the data pin. It is simple to use but requires careful timing to grasp data. In this instrument the DHT 11 is used to measure the temperature and humidity and this sensor is of ultra-low cost and hence helps in reducing the cost of the instrument.

D. FLOW SENSOR

Water flow sensor composed of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its accelerate changes with different rate of flow. The hall-effect sensor results the corresponding pulse signal. They are compact, easy to install and has high sealing Performance it consists of a high Quality Hall

Effect Sensor. Its specifications include Flow Rate Range: 1~30L/min, Mini. Working Voltage: DC 4.5V,Max. Working Current: 15mA (DC 5V) and Working Voltage: DC 5V~24V

*E. **WIFI – MODULE :***

NodeMCU is a IoT Module based on ESP8266 wifi Module. NodeMCU uses Lua Scripting language and is an open source Internet of Things (IoT) platform. This modules has CH340g USB to TTL IC.

Specification of Node-MCU IoT Module :-

- It is based on ESP8266, integates GPIO, PWM, IIC, 1-Wire and ADC all in one board.
- Power your developement in the fastest way combinating with NodeMCU Firmware!
- USB-TTL included, plug&play
- 10 GPIO, every GPIO can be PWM, I2C, 1-wire

V. WORKING

Working of then Coriolis Mass Flow Meter can be split into three stages:

i) a parallel shaped flow tube
ii) a sensor assembly
iii) an electronics unit

In this meter unit, the liquid passes through a parallel shaped tube which vibrates in an angular harmonic oscillation. Coriolis forces will then deform the tube and a further vibration component gets added to the already oscillating tube. This added vibration element results in a phase shift or twist in few parts of the tubes.

For example, when the tube is moving upward during the first half of a cycle, the fluid flowing into the meter resists being forced up by pushing down on the tube. On the opposite side, the liquid flowing out of the meter.

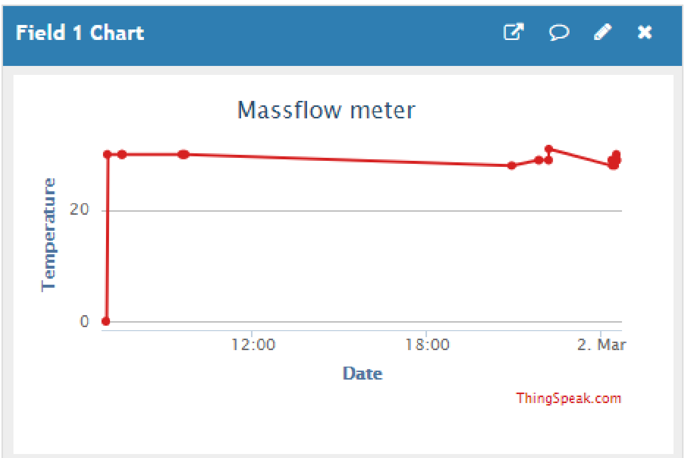


Fig. 1 Temperature output

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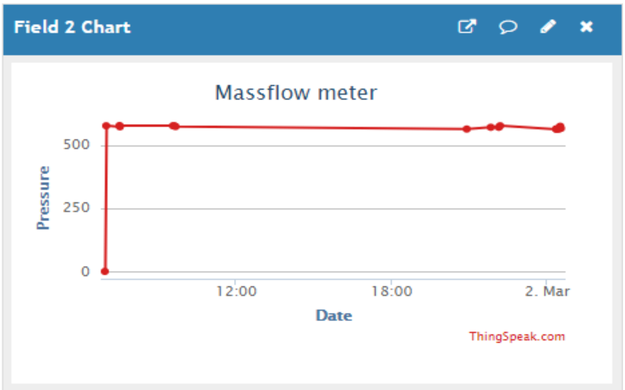


Fig.2 Pressure output

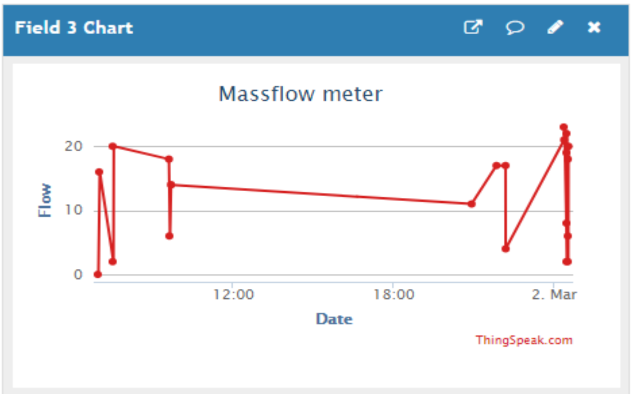
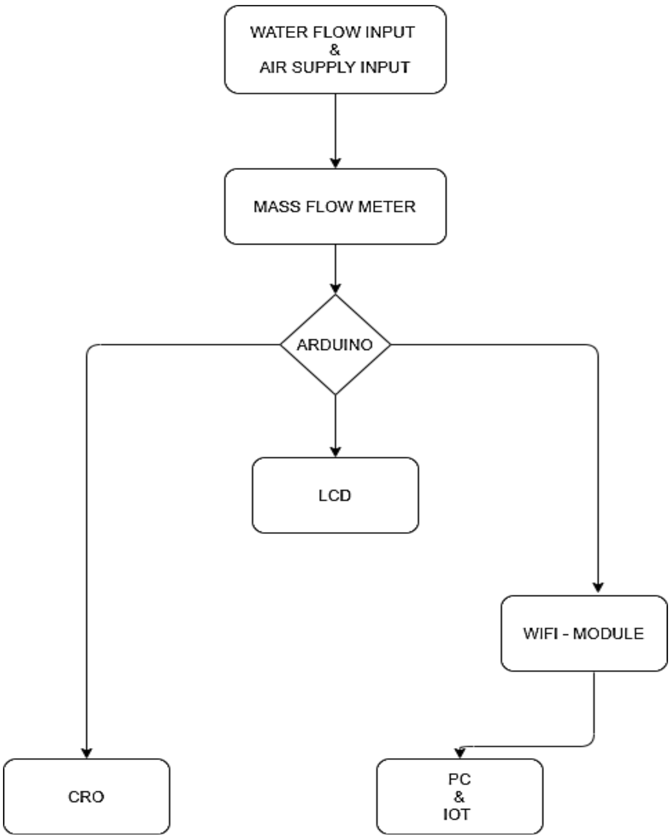


Fig.3 Flow output

A. **FLOW CHART:**



VI. ALGORITHM

1. Start.
2. The principle of the project is to measure the flow of liquids and gases using the Coriolis mass flow meter phenomenon.
3. The flow of gases is measured using a temperature-pressure detector and the flow of liquids is measured using a flow sensor.
4. The sensor measurements are processes using an Arduino microcontroller for further proceedings.
5. The flow of liquids and gases using the Coriolis mass flow meter data is transferred to an IoT system using a wifi module.
6. The sensor readings are used to produce a graphical representation of the flow using an IoT system.
7. The waveform representation of the sensor values are obtained using a CRO device.
8. Stop.

VII. CONCLUSION

The current system of mass flow measurement is typically slow and requires complex formulations for the signal acquirement. But the proposed system gives a significant way for the mass flow measurement in an accurate and quicker response. It must be stressed that the significantly reduced errors in mass flowrate measurement from the Coriolis mass flow meters and gas volume fraction prediction are achieved by using the existing data from the Coriolis flow meters and a simple DP transducer without the use of any other devices.

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