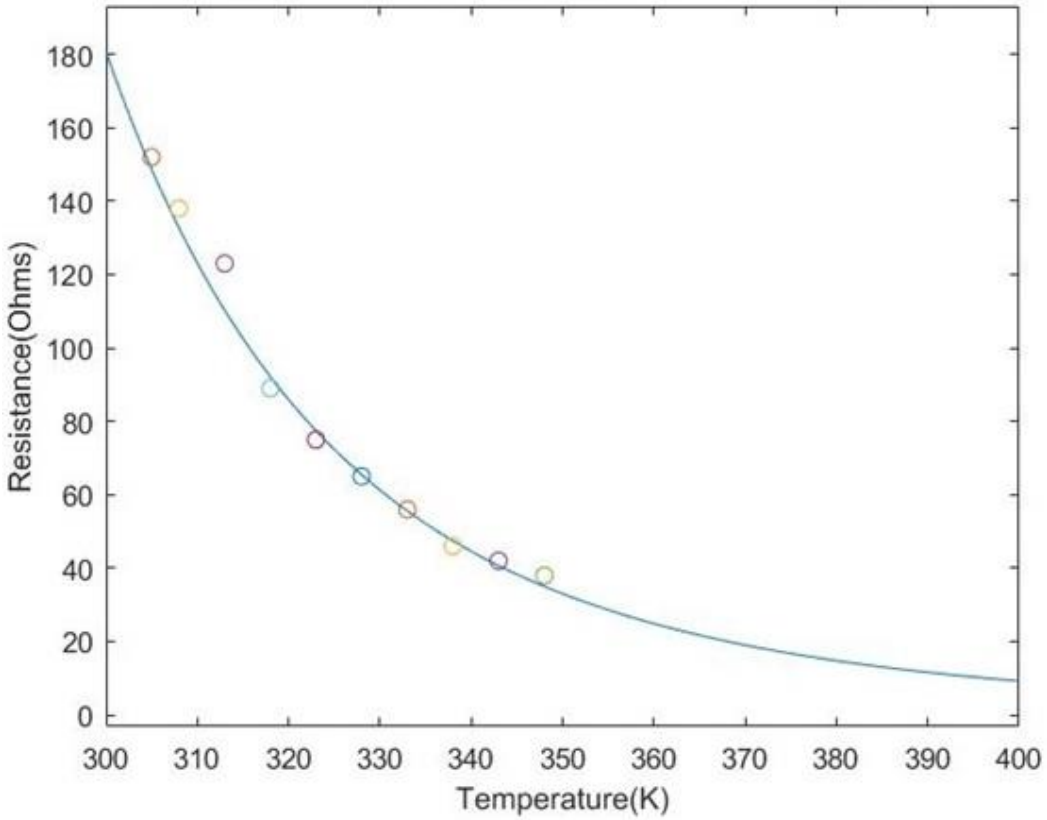
GP108 :: MINI PROJECT

DESIGN A FLOW RATE SENSOR

CALIBRATION OF THE THERMISTOR

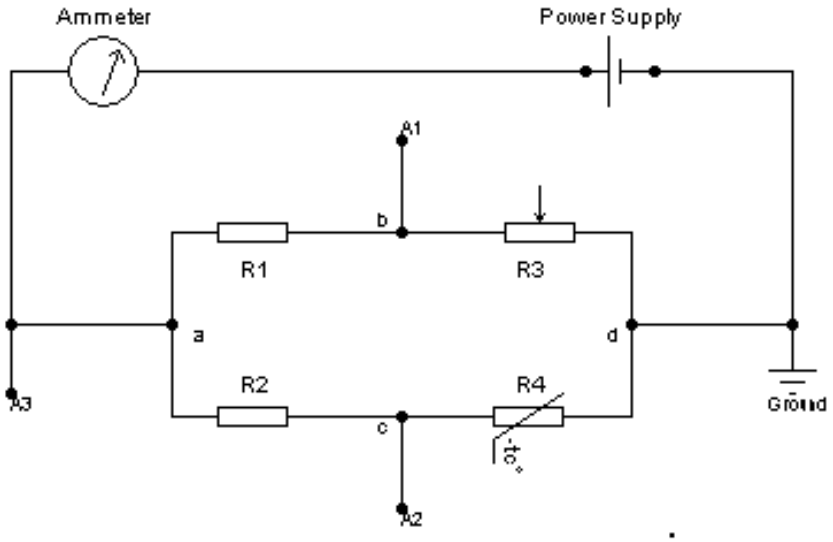
The equation for the used thermistor for the sensor,

$$R=180.73e^{3569.1(1/T-1/300)}$$



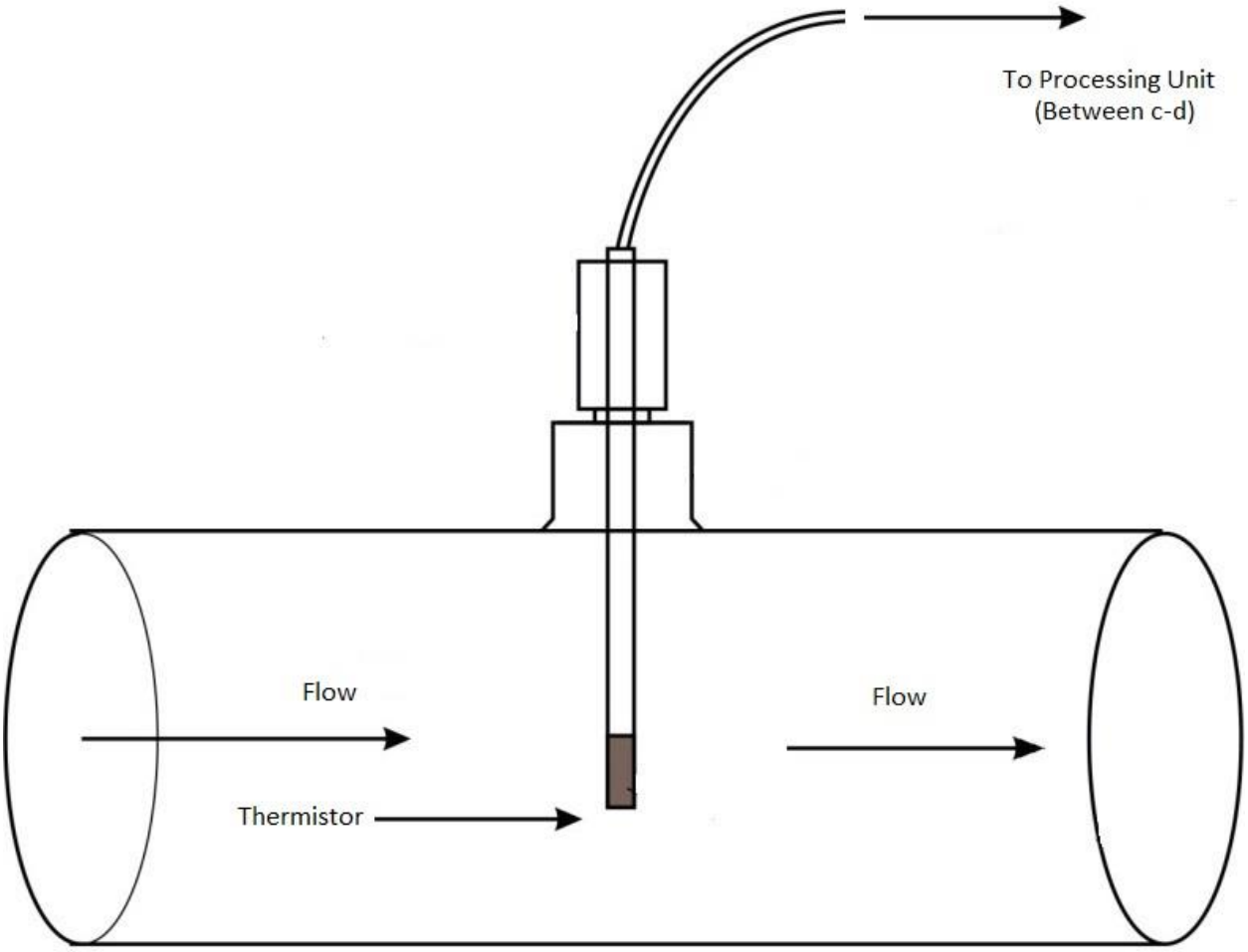
Flow Rate Sensor

Circuit Diagram



- R1,R2 - Resistors
- R3 - Variable Resistor
- R4 - Thermistor
- A1,A2,A3 - Analog pins of arduino board

Apparatus



This is the main part of our flow rate sensor and we are able to take readings for the resistance of thermistor in different temperature values of the flow by using this item.

How to measure the flow rate of a given flow using our gadget

- First we should know the density and the specific heat capacity at constant pressure of the given flow.
- Our calculating process is done by using MATLAB with the help of ARDUINO.
- Our first script is used to find the reference temperature for our calculations.
- That script finds necessary voltage, current and resistance with the help of arduino and calculates the wanted values and returns the reference temperature.
- Then, the next script is used to calculate the flow rate of the given flow.
- When that script is run, it asks for the reference temperature, density and specific heat capacity at constant pressure of the flow from us. After we give that, it finds necessary voltage, current, resistance and temperatures and calculate the flow rate and returns the value.

How to run the MATLAB scripts

- First, install the Arduino-MATLAB support package and get the connect between MATLAB and Arduino by using the following command in command window in MATLAB.

  "**a=arduino ('COM4');**"

- Then, run the "**Flow_Rate.m**" script.

The working principle of our sensor

- The thermistor is heated by its own supply current.
- In the case of negative (NTC) thermistor, the higher is the temperature, the lower is the resistance and thus the voltage drop on the element.
- When exposed to the flowing water, the temperature of the thermistor decreases as it cools down. For higher water flow, the thermistor is cooled more efficiently.
- First, we calculate the reference temperature when the flow pipe is empty.
- Then, we calculate the temperature while the fluid is flowing through the pipe.
- Here we make some assumptions,
  - The heating effect of the thermistor is fully equal to the absorbed heat by the water which contacts with the thermistor at a considered moment.
  - The density and the specific heat capacity at constant pressure of the flow remain at theoretical values the moment of the flow.
- By using these assumptions, we are able to calculate the flow rate of the flow at a considered moment.

MATLAB Scripts

Calculate the reference temperature

```
%This is the script for calculate the reference temperature for the process
I=0;
while I==0
    V1=analogRead(a,1);
    V2=analogRead(a,2);
    V3=analogRead(a,3);
    Vbd=(V1*5)/1024;
    Vcd=(V2*5)/1024;
    Vab=((V3-V1)*5)/1024;
    Vac=((V3-V2)*5)/1024;
    V=V1-V2;
    if V==0
        I=Vac/330;
        [y,Fs]=audioread('Beep.wav');
        sound(y,Fs);
    else
        disp('Calibrate the variable resistor well');
        I=0;
    end
end
R4=Vcd/I;
R=R4;
T1=35691/(10*(log(R) + 926192819086730809/140737488355328000));
fprintf('The reference temperature is %.3f K.\n',T1);
```

Calculate the flow rate

```
%This is the script for calculate the flow rate at a considered moment
run Reference_Temperature
T1=input('Enter the reference temperature(K) : ');
p=input('Enter the density of flow(kg/m^3) : ');
c=input('Enter the specific heat capacity at constant pressure of flow(kJ/kgK) : ');
I=0;
while I==0
    V1=analogRead(a,1);
    V2=analogRead(a,2);
    V3=analogRead(a,3);
    Vbd=(V1*5)/1024;
    Vcd=(V2*5)/1024;
    Vab=((V3-V1)*5)/1024;
    Vac=((V3-V2)*5)/1024;
    V=V1-V2;
    if V==0
        I=Vac/330;
        [y,Fs]=audioread('Beep.wav');
        sound(y,Fs);
    else
        disp('Calibrate the variable resistor well.');
        I=0;
    end
end
R4=Vcd/I;
R=R4;
T=35691/(10*(log(R) + 926192819086730809/140737488355328000));
fprintf('The temperature is %.3f K.\n',T);
q=(Vcd*I)/(p*c*(T-T1));
fprintf('The flow rate is %d m^3/s.\n',q);
```

Example

Consider the liquid as water

```
Calibrate the variable resistor well
Calibrate the variable resistor well
The reference temperature is 200.356 K.
Enter the reference temperature(K) : 200.356
Enter the density of flow(kg/m^3) : 1000
Enter the specific heat capacity at constant pressure of flow(kJ/kgK) : 4.2
Calibrate the variable resistor well.
Calibrate the variable resistor well.
The temperature is 263.243 K.
The flow rate is 1.766448e-08 m^3/s.
```

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