



Research Paper

BLOOD FLOW RATE MEASUREMENT BY USING NANO-PIEZOELECTRIC SENSOR

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This study was to Design a setup used to measure the flow using piezoelectric sensor for medical purposes using the property of piezoelectricity. The piezoelectric disc used is shown below. Two/four piezoelectric discs were placed in line, inclined or parallel on a flexi tube (ACLYRIC) and the outputs observed for various waveforms and levels of water to measure the direction of Fluid.

Keywords: Blood flow rate, nano-piezoelectric, Medical purpose

INTRODUCTION

The main objective of this project was to develop a blood Flow meter to measure the velocity and direction of blood flow in veins which is crucial information for a doctor during any surgery. This blood flow meter would use piezoelectric sensors of the smallest size available to perform the operation.

PIEZOELECTRICITY

In 1880, Jacques and Pierre Curie discovered an unusual characteristic of certain materials: when subjected to a mechanical force, the crystals became electrically polarized. Tension and compression generated voltages of opposite polarity, and in proportion to the applied force. Subsequently, the converse of this relationship was confirmed: if one of these

voltage-generating crystals was exposed to an electric field it lengthened or shortened according to the polarity of the field, and in proportion to the strength of the field.

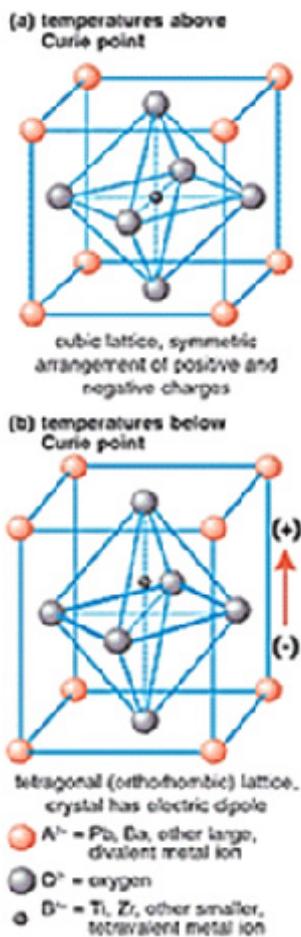


These behaviors were labeled the piezoelectric effect and the inverse piezoelectric effect, respectively, from the Greek word piezein, meaning to press or squeeze.

It is the property of certain crystalline substances to generate electrical charges on the application of mechanical stress.

Conversely, if the crystal is placed in an electric field, it will experience a mechanical strain.

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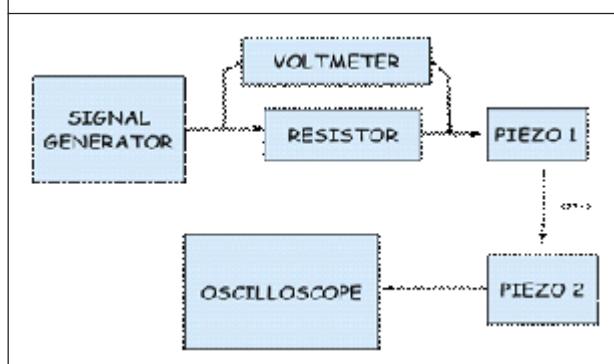
Figure 1: Crystal Structure of a Piezoelectric Ceramic

Quartz is a well-known single crystal material depicting such piezoelectric property.

Figure 2: Medical Piezoceramic Discs

METHODOLOGY

The project is focused on the development of a blood flow meter. The basic experiment to test the working of piezoelectric sensor used in the flow meter consists of 2 piezoelectric discs. This disc on one end is connected to a resistor (1 Kilo Ohm) which in turn is connected to a signal generator. A voltmeter is connected in parallel to the resistor. The other piezoelectric disc is connected to an oscilloscope.

Figure 3: Block Diagram of the Setup

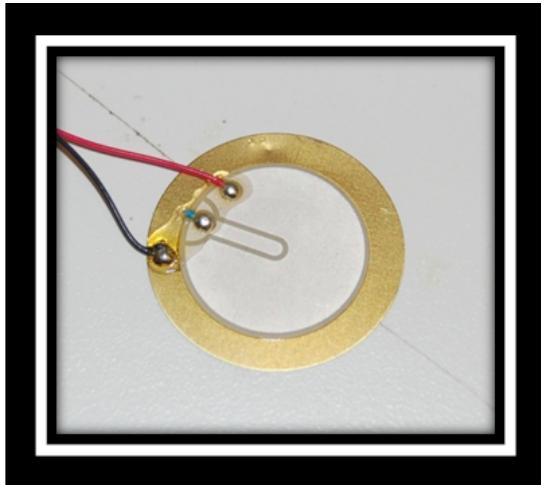
PIEZOELECTRIC DISCS

This project consists of a piezoelectric disc that generates electrical charges on application of mechanical stress. Conversely if it is placed in an electric field it will experience mechanical strain. Such elements are useful transducer elements which transduce electrical energy into mechanical energy and vice versa. When an AC voltage is applied, it will cause it to vibrate and thus generate mechanical waves at the same frequency of the input AC field. Similarly, it would sense the input mechanical vibrations and produce the proportional charge at the matching frequency of the mechanical input.

They are available in various shapes and sizes. For the experiment performed we used

the piezoelectric discs shown below. For the actual application we are going to use 3 mm size piezoelectric sensor of square shape which has been ordered and will be delivered in a couple of weeks.

Figure 4: Medical Piezoceramic Discs



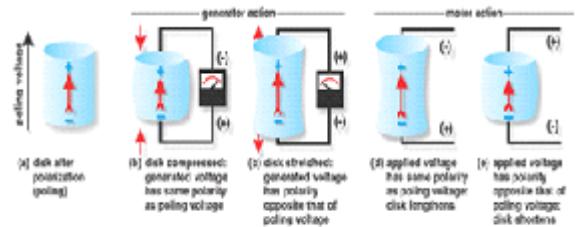
GENERATOR AND MOTOR ACTIONS OF PIEZOELECTRIC ELEMENTS

Why Do We Use Piezoelectric Sensor?

- Small size
- Broad frequency range

- Light-weight 2-wire operation (IEPE)
- Ultra low noise
- Wide dynamic range
- Wide temperature range
- Simple signal conditioning
- Cost effective test implementation

Figure 5: Generator and Motor Actions of a Piezoelectric Ceramic



* Generator action is used in fuel-igniting devices, solid state batteries, and other products; motor action is adapted to piezoelectric motors, sound or ultrasound generating devices, and many other products.

APPLICATIONS

These materials are available in a variety of shapes and sizes such as disks, plates, bars, rings, rods, tubes, etc.

Some of the typical applications are:

- High Voltage Generators for gas lighters
- Fuses for explosives
- Ultrasonic cleaner
- Ultrasonic welders
- Ultrasonic atomizer's
- Nebulizers
- Strain and excitation gauges
- Accelerometers
- Flow meters
- NDT transducers
- Dynamic force and pressure measurement

- SONAR
- Deep water hydrophones
- Piezoelectric actuators/translators

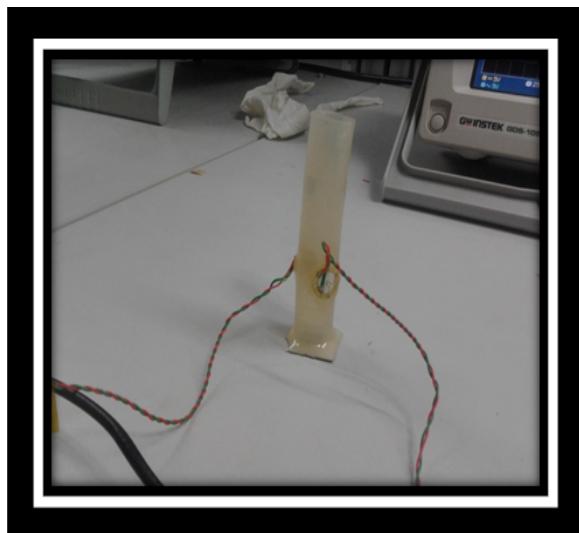
THE DIFFERENT TYPES OF PIEZO TESTING MODULE FOR FLOW MEASUREMENT

Setup-1

This setup was made by taking a flexi tube of 9 cm length and we cut out two circular portions of the tube in line with each other with a blade. Take two piezoelectric discs we fit them in the circular holes and stuck the edges using fevicol quick adhesive and an adhesive called araldite which is water resistant. Taking a small square piece of aluminum we closed one end of the flexi tube again using the araldite adhesive.

We connected each piezoelectric to a channel of the oscilloscope one at a time after it was placed firmly in the flexi tube. We tapped the center of the piezoelectric discs with the maximum force and the waveforms verify that the piezoelectric discs were working properly.

Figure 6: Piezo Testing Module for Flow Measurement

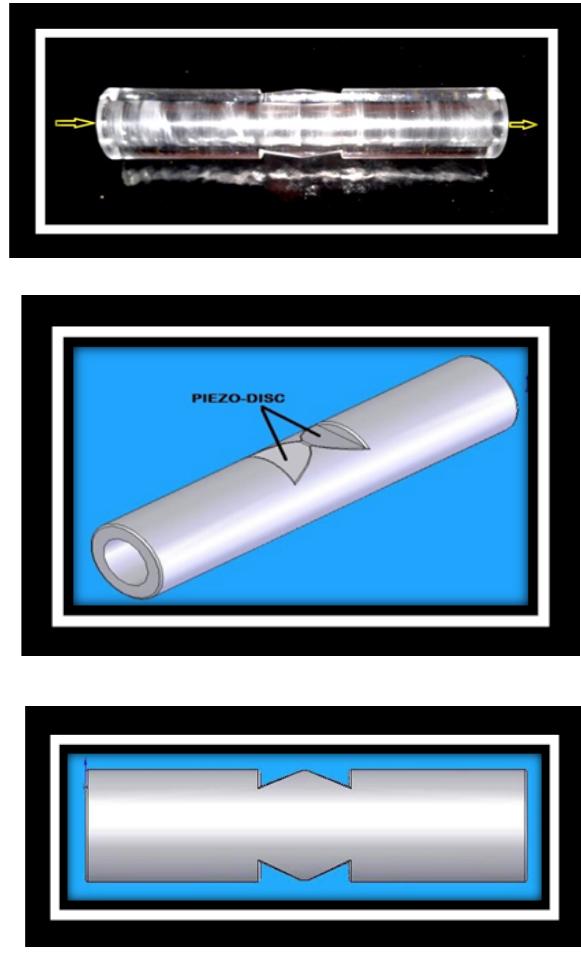
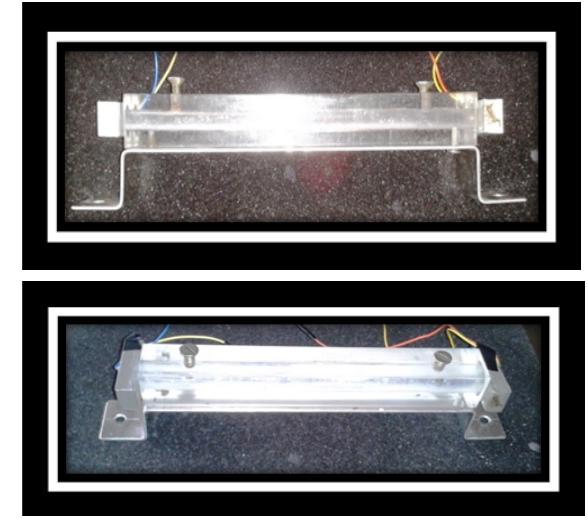


PROJECT EXECUTION

- Two piezoelectric discs are attached to a flexi tube opposite to each other at the same level from ground.
- One piezoelectric disc is connected to a 1 Kilo Ohms resistor which in turn is connected to the signal generator.
- A voltmeter is connected in parallel with the resistor which measures the voltage across the resistor. When this voltage is divided by the resistance we obtain the current flow in the circuit.
- The two ends of the piezoelectric disc 1 is also connected to the channel 1 of the oscilloscope.
- The other piezoelectric disc is connected to the channel 2 of the oscilloscope which shows the output.
- Water is filled into the flexi tube.
- The input and output waveforms are noticed simultaneously on the CRO and the output voltage, resistor voltage and hence the current are noted down for different frequencies, input voltage and waveforms.

Setup-2

This setup was made by taking a Acrylic Rod of 10cm length, 2cm Diameter. First we drill a hole of diameter 0.8cm And after that we Make a triangular Cut of 1cm Height,0.2cm Base as shown in fig. In those Cut off , we goanna place the .3cm Diameter Piezeo electric sensor facing parallel to each other .We will place 4 Piezeo out of which 2 will act as a receiver and 2 as a transmitter. All these piezeosignal goanna intersect at one point which will tell us the Direction of flow of fluid.

Figure 7: Actual Front View of Setup**Figure 8: Actual Front View of Setup**

CONCLUSION AND FUTURE WORK

We hope to use this piezoelectric disc of 3 mm or smaller size in a blood flow meter where it shall detect the velocity and direction of blood flow. Also we hope to prepare a compact design to provide the proper signal to the piezoelectric disc of 1 MHz frequency with options for tuning the same. On delivery of the required piezoelectric sensors another experiment shall be conducted in a similar fashion as the real model of blood flow meter. ☺

Setup-3

This setup was made by taking a Acrylic Cuboid of Dimension 20cm length And 6cm .A hole has been drilled through it and having diameter 1cm and two piezeo is fixed in it , on both side and for water filling and discharge two opening are there at top .This setup is being fabricated at NAL Workshop ,Bangalore under the guidance of a Ph.D. scholar Ajay

This graph depicts an almost linear rise in current with increase in level of water. However it may vary slightly with various trials.

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