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RESEARCH AND DEVELOPMENT OF CAPACITIVE TRANSDUCER FOR MEASURING DISPLACEMENT OF BIMETALLIC STRIP

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Abstract: In the report is presented a method for implementation of capacitive transducer for measuring displacement of bimetallic strip. A set of studies have been made on the developed transducer.

Key words: capacitance, electrode, capacitive, bimetallic strip

1. Introduction

Capacitive transducers are widely used in everyday life. Those transducers are small sized, have good sensitivity and frequency response, high input impedance and low power consumption. The capacitive transducers can be also used for measuring of linear and angular displacement, force, pressure, humidity, volume, density and weight.

The principle of capacitive transducers is based on the change of its capacity under stimulus from physical system. The capacitance is described through , where C is the capacitance of the capacitor (F), A – area of the electrodes, d – distance between capacitor electrodes and ε - permittivity of the material between the electrodes.

In the report the steps for developing capacitive transducer for measuring displacement of bimetallic strip, as well as conducted research of the transducer are described.

2. Development of capacitive transducer

The specific use of capacitive transducers requires the following preconditions to be met:

- The transducer should have high sensitivity due to the relatively little displacement of the bimetallic strip
- The transducer should have very low weight of the floating electrode, so it doesn't interfere with the displacement of the bimetallic strip

2.1. Testing the possibility of creating a capacitive transducer with floating electrode – a pin, and a fixed electrode – aluminium foil.

Considering the listed conditions mentioned above, the capacitive transducer consists of floating electrode – a pin, and fixed electrode – aluminium foil.

Before the actual transducer was developed, series of test were conducted to test the sensitivity of the pin and the aluminium foil. The aluminium foil is with triangular form and is scaled in a specific way so every displacement of the pin will cover different area between the pin and the foil.

On figure 1. the experimental setup is presented. The setup consists of specialised module NI ELVIS II and two wires – the first is attached to the pin and the second is soldered on the aluminium foil. The loose ends of the wires are connected to the build-in impedance meter of the NI ELVIS II device. NI ELVIS II is connected to a computer with installed program environment LabVIEW (figure 2.) where the results are collected and displayed.

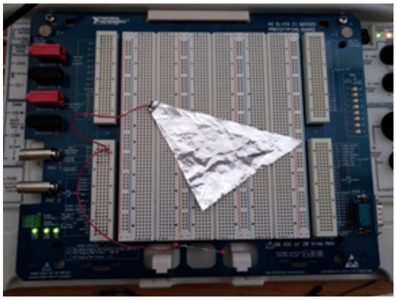

Fig.1. Setup

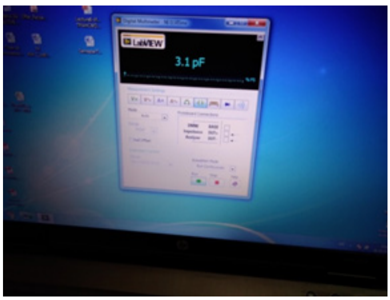

Fig.2. Display of the results

The first test is conducted with one pin. The results are presented in table 1.

Table 1. Results of conducted test with one floating electrode – a pin.

Displacement, mm	Capacitance, pF
0	3.1
50	3.6
100	3.7
150	3.8
200	3.9
250	4.0

The results show slight variation of the capacitance, which leads to low resolution. To improve the resolution, a second test is conducted increasing the area of the floating electrode adding a second pin. The results are presented in table 2.

Table 2. Results of conducted test with floating electrode – two pins.

Displacement, mm	Capacitance, pF
0	3.1
50	3.7
100	3.8
150	4.0
200	4.1
250	4.5

The results show almost double increasing of the resolution.

From the conducted tests it can be concluded that the capacitive transducer with floating pin and fixed electrode from aluminium foil is plausible.

2.2. Development and testing of capacitive transducer and application

Following the results of conducted tests, a capacitive transducer with a specific implementation is developed (figure 3.). A pin is soldered to a bimetallic strip. Under the area of movement of the pin is glued aluminium foil, so the movement of the pin, due to change of the environmental temperature and the deformation of the bimetallic strip, covers different area between the two electrodes.

Two wires are soldered to the pin and the aluminium foil and are connected to impedance meter of NI ELVIS II. The results of test are almost equal to the results in table 1, which are not satisfactory for practical purposes. Therefore, actions for increasing the resolution must be taken.

Fig.3. Capacitive transducer with floating electrode one pin.

A second test is made with increasing the area of the floating electrode with rectangular shaped aluminium foil. (figure 4).

The results of the test are presented in table 3.

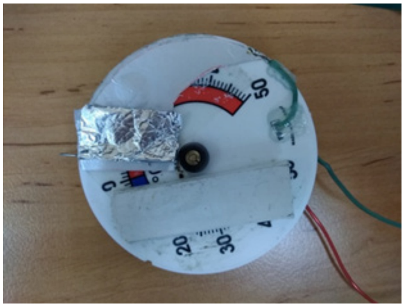

Fig.4. Capacitive floating electrode a pin and rectangular shaped aluminium foil.

Table 3. Results of conducted test with floating electrode a pin and rectangular shaped aluminium foil

Angle, °	Capacitance, pF
0	7.3
30	6.8
60	6.0
90	4.8

The results show a significant increase of the capacity, which leads to better resolution. The developed transducer can be used for practical purposes.

3. Conclusions

Due to the capacitance of the wires connecting the transducer with the impedance meter, a permanent component of 3,1 pF is observed. A part of the observed nonlinearity is from bumps in the stationary electrode (aluminium foil).

The obtained results with the increased area of the floating electrode with aluminium foil increases the area of overlap are significantly better than using one and two pins. In future, these results can be used for developing of virtual instrument for measuring temperature with bimetallic strip as a primary transducer.

Reference:

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