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Research Papers

Measurement of change in Capacitance with Temperature, using unprocessed Indian Bee wax and its use as a Temperature sensor with IC 555 timer circuit.

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ABSTRACT

Beeswax is naturally found material used by bees to built bee nest. It is made up of mixture of esters of fatty acids and fatty alcohols, paraffinic hydrocarbons and free fatty acids. It also shows change in resistivity due to change in temperature and having melting point of 62-63 degree Celsius. In this research paper beeswax is used as medium between two parallel plates forming the system of capacitor. This capacitor is used in IC 555 timer Astable- Multivibrator circuit. The output is Square wave having period proportional to Capacitance if resistance of resistors is kept constant.

It was observed that period of output square wave was directly proportional to temperature and the response is almost linear up to 55 degree Celsius but there after increases rapidly as temperature approaches to 62 degree Celsius. It was worth noting that if experiment is repeated the values are found to be same, which indicates that there is repeatability observed.

OBJECTIVES:

Following are the objectives:

1)Measurement of change in capacitance with temperature with unprocessed Indian beeswax as medium.

2)Use of it as a temperature sensor by getting calibration curve of temperature with output period.

3)To obtain extent of linearity of response and repeatability of measured values.

METHODOLOGY AND TOOLS USED:

The sample can be selected from the lump of beeswax from bees nest. One clean it with fresh water and allow it to dry in open air. This step can be repeated for many time till the color of sample turns from dark red to pale brown, which ensures removal of honey, and other dead parts of insects. This sample can be placed in between two parallel plates and area and distance of separation was measured using travelling microscope.

This capacitor is then placed in RC network of astable multivibrator with IC 555 timer. IC 555 circuits produces sharp rising square wave. The period of output waveforms can be measured with cathode ray oscilloscope (CRO).

The capacitor is placed in the tube containing paraffin oil, which was then placed in the water bath. The temperature can now vary from 50C to 600C. it was observed that period of output waveform increases with temperature. These observations formed calibration curve.

The circuit of IC 555 timer circuit is as shown:

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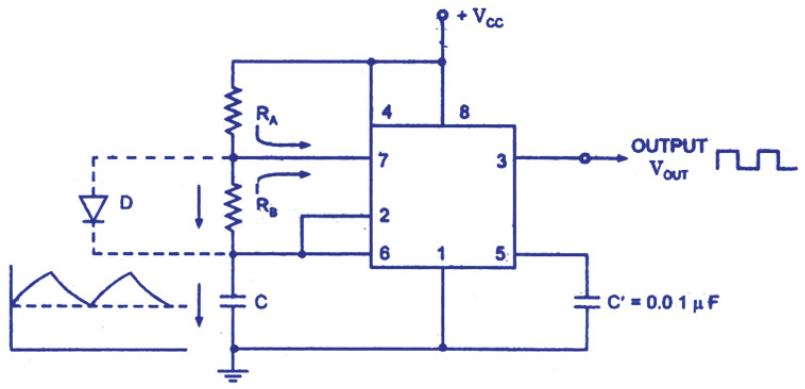

Circuit of The Timer 555 as an Astable Multivibrator

The output period T= 0.693(RA+2 RB) C. The capacity of capacitor depends on the material used between the parallel plates. It was found that the resistivity of beeswax is temperature dependent quantity. Hence it was observed that the capacity of capacitor increased with Temperature. Since there was increase in capacitance there was increase in output period T of timer circuit. Thus this circuit can be used as temperature sensor.

OBSERVATION TABLES AND GRAPHS:

Note that output period T was measured in Microseconds. The capacity of capacitor was measured in Pico Farads. The temperature was measured in degree Celsius.

Set 1 and Set 2 represents reading taken after some time gap to check repeatability of response.

Set 1			Set 2		
Temp(^{0}C)	C(pF)	Period(T)	Temp(^{0}C)	C(pF)	Period(T)
5	84.48	4.4	5	84.48	4.4
10	88.32	4.6	10	92.16	4.8
15	96	5	15	96	5
20	97.92	5.1	20	97.92	5.1
25	99.84	5.2	25	103.68	5.4
30	103.68	5.4	30	107.52	5.6
35	113.28	5.9	35	115.2	6
40	119.04	6.2	40	119.04	6.2
45	122.88	6.4	45	122.88	6.4
50	126.72	6.6	50	130.56	6.8
55	138.24	7.2	55	153.6	8
60	192	10	60	230.4	12
62	288	15	62	307.2	16

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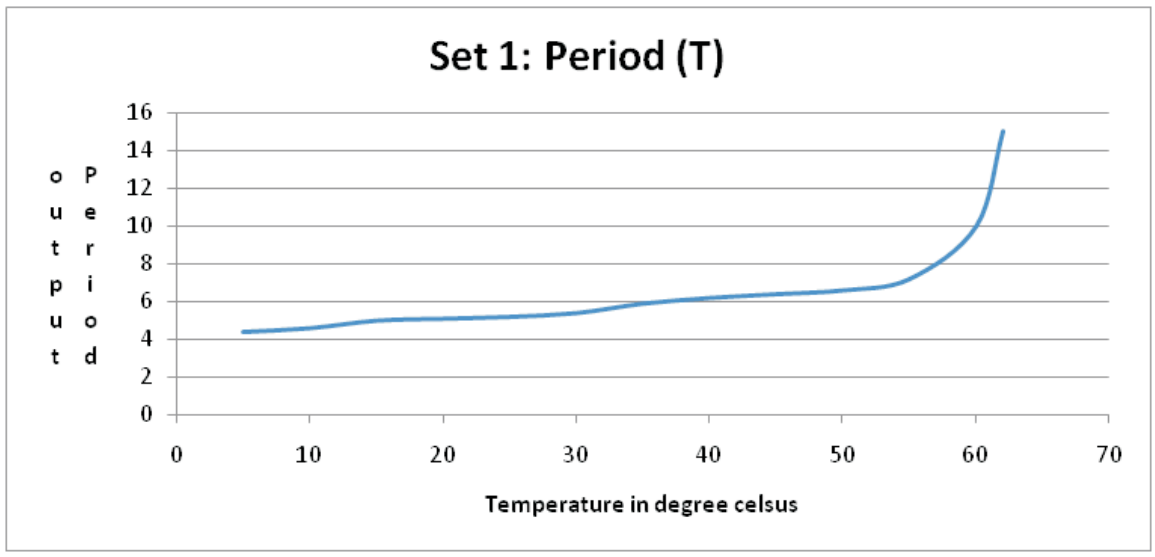

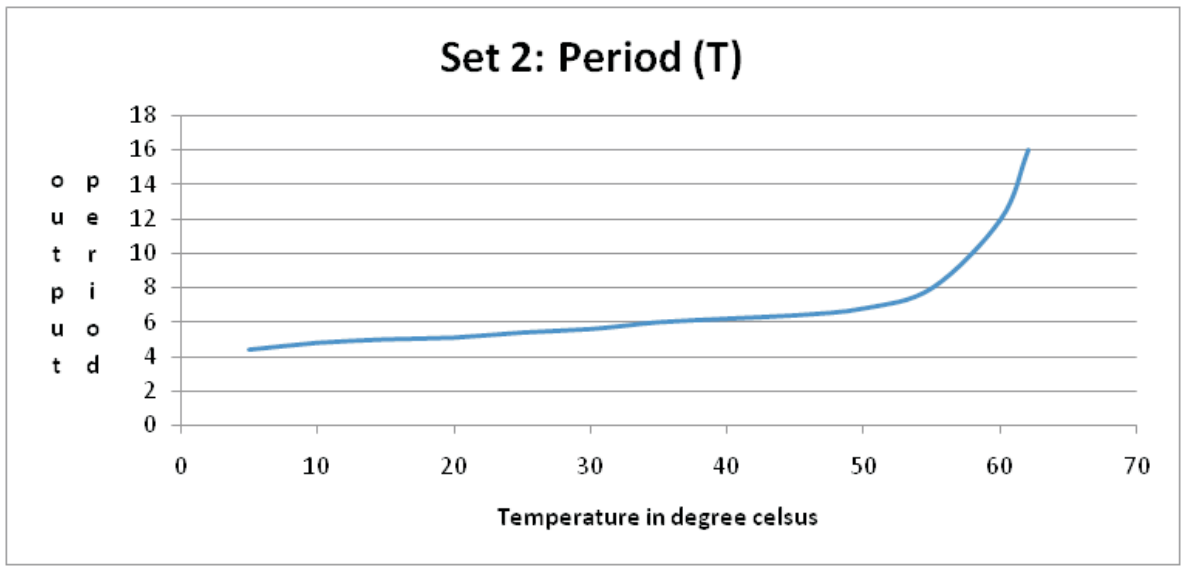

ANALYSIS OF RESPONSE:

The material was placed between two parallel plates and this system of capacitor was placed in oil bath. The temperature was allowed to change from 50C to 600C.the output period was measured on CRO. It was found that the response showed direct proportionality with temperature and period. Between the temperatures 50C to 580C the response was gradual and somewhat linear. But after 580C the output period rapidly increases which showed that the medium was turning in to conductor. As a temperature of sample reaches to melting point which is 620Cto 630C, due to phase transition there must be rapid fall of resistivity due to which the period abruptly increases. After 620C there was no signal as beeswax was shorting the terminals of capacitor.

The experiment was repeated after cooling and it was found that we could got the similar response, which indicates the repeatability of response.

MAIN FINDINGS:

Following are the findings of response:

1)With the help of IC 555 timer circuit it is possible to measure change in capacitance of capacitor made up of beeswax as a medium.

2)The capacitance and hence output period was directly proportional to temperature of sample.

3)The response was linear up to 580C and thereafter there was abrupt increase in period.

4)After 580C the sample becomes conductor and near 630C it was not possible to measure the period due

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to phase transition.
5)The response showed definite repeatability, thus unprocessed Indian beeswax can be used as a temperature sensor. The characteristics graph of output period versus temperature can be treated as a calibration curve.

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