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An Opto-electronic Honey Adulteration Measuring System

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Abstract: **A simple, low cost, & robust fiber optic technique is developed for the near as well as remote measurement of the honey adulteration. It employs the pressure applied by the sample over the sensor. A diaphragm containing optical fiber in helical geometry with maximum diameter of 5 cm, attached at the base of cylindrical housing, type basic sensor is used. It converts the developed pressure into deflection of the diaphragm which modulates the light falling on it because of bending losses of optical fiber cable. The modulated optical signal, containing information about the sample travels through the optical fiber up-to the station where it is converted into electrical signal by the detector, and then is calibrated into adulteration level. This system can be mounted in all the big and small containers of honey, and adulteration can be checked by plain power meters or digital multimeters Introduction.**

1. INTRODUCTION

Honey adulteration is a complex problem which currently has a significant economic impact and undeniable nutritional and organoleptic consequences Honey is one of the very important natural product because of its wide usage in food and medicines all over the world. It contains on average 20% water, 75% monosaccharide (fructose and glucose), 3-10% disaccharides (sucrose), complex sugars and other materials eg. protein, minerals, vitamins, enzymes, antioxidants etc. Since Honey types differ from one country to another and in different regions in same country due to floral origin, soil composition and other factors, hence quality criterion differs. Also most of the honeys are traded without quality sign or reference to the origins, [3,1] and this may lead to honey adulteration.

Honey adulteration has evolved from basic addition of cane sugar and water to specially produced syrups. Therefore, there is a need, for the development of more sophisticated methods to detect honey adulteration. .

For highly precise measurement of adulteration, pollen analysis, Capacitive, Isotopic analysis, Microscopic detection etc. techniques have been used [6, 7, 8]. In some cases, chromatographic method is also used for measuring the adulteration. Electrical conductivity is one of the international standards for honey control. [9]

In the past two decades, Fiber Optic Sensors have been developed from the experimental stage to practical applications. It has happened due to multi dimensional advantages of Fiber optic sensors such as wide band width, freedom from interference and electromagnetic couplings, nearly zero leakage currents, low cost, robust structure and may be used in highly injurious environments. [1].

In present paper we can compare the sample of honey with quality standards depending upon the type of honey, without contaminating the sample, by calibrating our instrument accordingly.

The gauge pressure P at depth below the surface of the liquid open to atmosphere is greater than atmospheric pressure by an amount ρgh, where ρ is the density of liquid, g is the acceleration due to gravity and h is the level of the liquid above the object.

2. PRINCIPLE OF OPERATION

The proposed electronic technique is based on light intensity variation at the output, due to variation in pressure exerted on designed sensor.

Honey, the only sweetening material that can be stored and used exactly as produced in nature. No refining or processing is necessary before enjoying this. Honey is the sweet, viscous substance elaborated by the honeybee from the nectar of plants [2] whereas Golden syrup is a thick, amber colored inverted sugar syrup and has an appearance similar to Honey.

When an object is dipped in the liquid, a static pressure is applied by the liquid on the object which may be given by following expression:

$$P = \rho g h + \mathrm{p} \tag{1}$$

Where P is the gauge pressure, ρ is the density of liquid, g is the acceleration due to gravity and h is the level of the liquid above the object.[5].

Optical Fibers suffer radiation losses at bends or curve on their path, The loss can generally be represented by a radiation attenuation coefficient (A) which has the form where R is the radius of curvature and C_1 &C_2 are constants independent of R [1],i.e as R changes attenuation changes exponentially.

$$A=C_1 \exp(-C_2R) \tag{2}$$

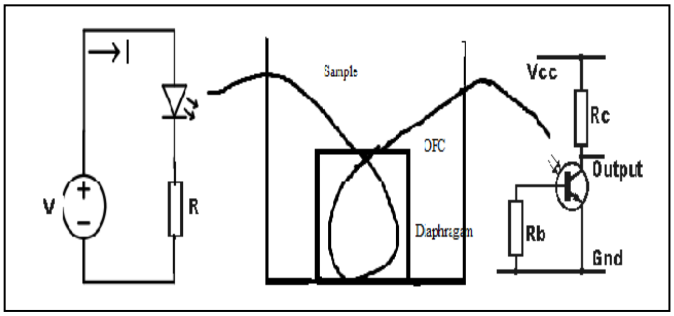

Fig.1 Experimental setup

Here we propose a system to measure adulteration of honey with the help of Fiber optic sensor and a diaphragm. The diaphragm can be used in the measurement of absolute, gauge and differential pressures. However, measurement of unknown pressure as gauge pressure is considered in this particular case. The change in gauge pressure on diaphragm containing optical fiber changes radius of curvature (R) and hence attenuation changes, and intensity of light is modulated which then is converted to voltage at detector. With change in R, A changes exponentially hence, sensitivity of this system is very high.

When pressure varies with sample the output voltage varies, confirming the above stated relations.

Relationship between output voltage of the receiver and the deflection of the diaphragm may be given by following expression:

$$V_o = V_F - k\Delta D_F \tag{3}$$

Where V_o is the output voltage of the light detector, V_F is the output voltage at the starting point (only atmospheric pressure),k is proportionality constant, D_F is the height of the diaphragm from the base, and ΔD_F is the deflection of the diaphragm. As pressure increases output voltage decreases.

Since deflection is created by pressure, hence

$$\rho gh \ \alpha \ \Delta D_F \tag{4}$$

Comparing equations 3 & 4,
Output voltage varies with the variation in pressure.

3. EXPERIMENTAL METHODS AND RESULTS

An optical fiber based honey adulteration measuring system is designed, fabricated and tested for percentage adulteration of 10% and more (50%). Experimental setup is shown in Fig.1. It consists of a well calibrated glass cylinder, a **high ductile** Low-density polyethylene (LDPE) as diaphragm, containing optical fiber in helical geometry, attached at the base of cylindrical housing. The output circuit includes a detector circuit and digital multimeter. This basic sensor is used to convert the developed pressure into deflection of the diaphragm and

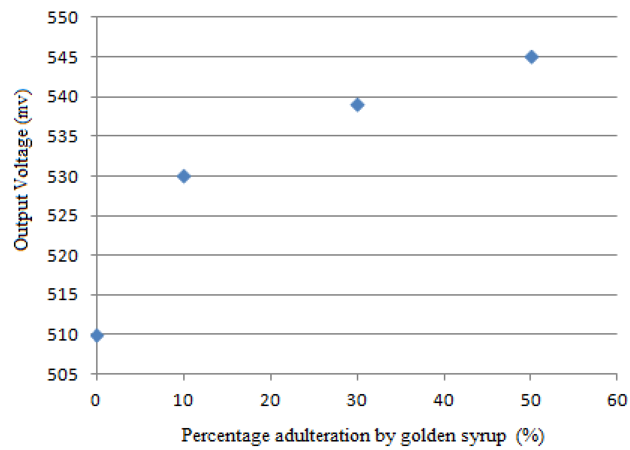

Fig. 2. Output voltage with percentage adulteration of Honey by golden syrup

deflection is used to modulate the light falling on it because of bending losses of optical fiber cable, so the output voltage changes, depending upon the sample. The bending losses were 2.3dbm for 660nm wavelength, without any sample, as measured by power meter. Plastic Optical fibers are used in the fabrication of the probe as they are cheap, robust and easy to handle. The variation of output voltage with percentage contamination by golden syrup is shown in Fig.2. The loss factor due to pressure on fiber decreases and hence output voltage increases with increasing syrup content. For each sample measurement, the sensor is washed and dried to avoid any impurity and to achieve better accuracy. The results are in close conformation to above developed theory.

4. CONCLUSION

We have developed a cheap, simple, convenient and rapid purity meter for honey, which has near as well as remote application. With golden syrup, as impurity, the results are appreciable linear. The loss factor due to pressure on fiber decreases with increasing syrup content. The adulteration level is easily calibrated in terms of output voltage.

All information will be transferred through optical fiber from sample to any station, at high speed, as well as without much attenuation. Over all energy consumption of the proposed method is so low that any type of power pack may be used for long term operation. Also the calibration can be done with impurities like addition of cane sugar and water, as it changes the density of the sample.

The proto type has been fabricated with plastic fiber and worked nicely up to 0.5m. However for long distance operation glass fiber can be used for better performance.

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