International Journal of Advance Research in Science and Engineering
Volume No.06, Special Issue No.(01), December 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

# A Comparative Study of Determination of Refractive Index of Human Urine using Glass refractometer and Abbe's refractometer

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## ABSTRACT

*Urine is one of the important fluids that present in the human body. Most of the ailments in the human body will be reflected in the blood and urine pictures. In the present paper an attempt is made to study the refractive index of human urine using a glass refractometer and Abbe's refractometer. A U-shaped solid glass rod having certain physical parameters is used as a sensing element which is connected between two multimode plastic (PCS) fibers with 200/230 μm dia. The input fiber end is connected light source operating at a wavelength of 633 nm, and the output fiber is connected to a bench mark power meter. The light launched into the input fiber will be coupled to the output fiber via the U-shaped glass rod and emerges as power output in the power meter. The sensor is calibrated using methanol and benzene mixtures taken at different proportions in the dynamic range of* $1.3n_D$ *to* $1.5n_D$*. Using the calibrated graph, the refractive index of human urine samples of 25 persons in the age group between 20 years and 60 years are determined. The refractive indices obtained are further compared with that determined using Abbe's refractometer. The comparison yielded good results, which are in perfect agreement with the literature values. Such studies play a crucial role in deciding the whole body picture of the human body, as most of the other parameters of the urine are dependent on refractive index studies.*

***Keywords: Glass refractometer, Abbe's refractometer, U-shaped solid glass rod, calibrated graph, human urine***

## I.INTRODUCTION

The blood and urine pictures provide the information about most of the ailment in the human body. Many important parameters such as sugar content, salt content, specific gravity, salinity, and density etc. determined through the study and analysis of human urine. The refractive index profile of both human blood and urine is very important for pathologists and practicing doctors in the study and treatment of people suffering with various diseases[1 – 5]. In the present work, the results of study of refractive index of urine are presented. For elimination of toxic wastes, most animals have excretory systems. The soluble wastes are excreted primarily by the urinary systems, removed by perspiration in humans. The excretory system consists of one bladder, twp kidneys, two ureters and one urethra. With metabolic activity, and with dietary intake of food and water, the composition of urine can vary [6 – 9]. The principal composition of urine consists of sodium chloride, urea, ammonia, sulfates, creatine, uric acid, and phosphates. The properties of urine and clinical examination of urine provide overall assessment of our body's health. Urine must be collected in a container for the examination of physical and chemical analysis. For sunlight, the color of the urine is usually light yellow. The yellow color of the urine is due to the presence of a pigment called urochrome in the urine. Depending upon the amount of dissolved substances (salts, minerals, etc.) that may be present. Urine will always have a specific gravity value greater than 1.000 depending upon the amount of dissolved substances. Specific gravity can be determined by either of two methods using a refractometer or a urinometer. Measurement of specific gravity parallels the measurement of refractive index of the liquid [10 - 12].

Refractive index: the measurement of refractive index was made with Bausch and Lomb refractometer calibrated for sodium yellow light with respect to air. Using pipette, 1-2 drops of urine into the hole provided in the Abbe's refractometer. By physical observations the refractive index can be determined. The refractive index has a straight line (linear relationship) correlation with solute weight fraction for binary solutions.

## II.EXPERIMENTAL ARRANGEMENT

The architecture of the experimental arrangement consists of two multimode plastic (PCS) fibers of 200/230 diameter, in between which a U-shaped glass rod of specific physical diameters connected by using a suitable index matching glue by using proper sleeves. The other end of the input fiber is connected the light source by using a SMA connector and the second end of the output fiber is connected to the power meter by using another SMA connector. Thus the sensor acts as a extrinsic as the light modulation expected to takes place outside (within the U-shaped glass rod) the two fibers used, the sensor works as an extrinsic fiber optic sensor in which two fibers simply act as light conduits to take and send the light to and from the sensor head. And also as the light intensity is measured is the power in the power meter, the sensor is operates as intensity modulated sensor. The sensor so prepared is placed inside a glass jar and fixed in it.

Now to calibrate the sensor, two chemicals such as methanol and benzene were selected and their mixtures each time were taken in the required proportion to maintain around the externally connected U-shaped glass rod placed inside the glass jar. With each mixture poured into the glass jar, and at the same time, the light launched into the input fiber transmits through U-shaped glass rod interacting with the liquid mixture and couples to output fiber and emerges as output power that enter the power meter. Simultaneously, the refractive index of each (liquid mixture) sample were noted against the power reaching power meter is and tabulated. Then the graph plotted taking refractive index on the X- axis and the power output on the Y- axis will becomes the standard graph between output power vs. refractive index which forms the linear relationship between power output and the refractive index in the dynamic range of 1.3methanol) to 1.5 (benzene). Using this graph, the refractive index of unknown liquid either transparent or dark, cab determined by maintaining the liquid surrounding U-shaped probe and by simply knowing the power value in the power meter. This mechanism is used to determine the refractive index of human urine selecting fixed age group of people and for 25 persons in number.

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www.ijarse.com
IJARSE
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In the present experiment, samples of human urine of 25 persons were collected whose age group ranges between 20 years and 60 years. Each time taking the urine sample of person and pouring into the glass jar, the light is launched into the sensor and corresponding power output is noted. By using the standard calibrated graph, the refractive index corresponding to the power is noted. Thus the refractive index of the unknown liquid either transparent of dark can be determined using the sensor developed. This process is repeated for the rest i.e. for the other 24 urine samples collected from different persons. The results are plotted in the form of graphs and explained the mechanism behind the sensor developed.

## III.RESULTS AND DISCUSSION

To calibrate sensor, the refractive index of each mixture is determined using Abbe's refractometer using sodium D line and noted down. The mole fractions of methanol in benzene is calculated and tabulated. And with each mixture, the output power is noted down. The graph between the mole fraction of Methanol in benzene and the power output shows the exponential increase in power with increasing the mole fraction of methanol in benzene as methanol reduces the concentration of benzene (Fig. 1). A graph between mole fractions vs. refractive index indicates the reduction in concentration with adding more methanol into benzene (Fig. 2). Finally a graph is plotted between refractive index of methanol and benzene mixtures and the output power noted (Fig. 3). This graph represents the decrease in output power with increase in r. i. values, as r. i. values increases the concentration of mixture also increases.

The increase in power values with decrease in mole fraction of methanol in benzene attributed to the reduction of absorption spectra due to decreased concentration of the mixtures. Thus by adding the different quantities of methanol (R. I. = 1.326) in benzene, the concentration of benzene (1.488) is reduced. It is also known that the concentration of the liquid surrounding the glass rod is more; the depth of absorption of light is more and the light collected at the output end is accordingly less in quantity. Thus, when methanol and benzene mixtures used, the dynamic range of the sensor lies between 1.326 and 1.488 at room temperature. The dynamic range of the sensor can be increased by selecting two other liquids whose R. I. values may lie between 1.326 for first liquid and the R. I. of second liquid may have R. I. value around 1.7 or may be more.

The refractive index of a liquid is temperature dependent, in the present work the temperature of the liquid mixtures are maintained as fixed at room temperature. Thus by using the sensor so developed and calibrated the refractive index of any liquid whose R. I. values lie between 1.326 and 1.488, can be determined by simply exposing the liquid to the extrinsic glass probe.

**Table 1: Change in power with refractive index and mole fraction of benzene and methanol Mixtures using U shaped 0.5 mm dia glass rod (Free space power output -45.0dBm)**

| SL. No. | $C_6H_6$ (ml) | $CH_3OH$(ml) | R. I. of Mixture | Power output(dBm) | Mole fraction of $CH_3OH$ |
|---|---|---|---|---|---|
| 1 | 0 | 10 | 1.326 | -46.5 | 1.0000 |

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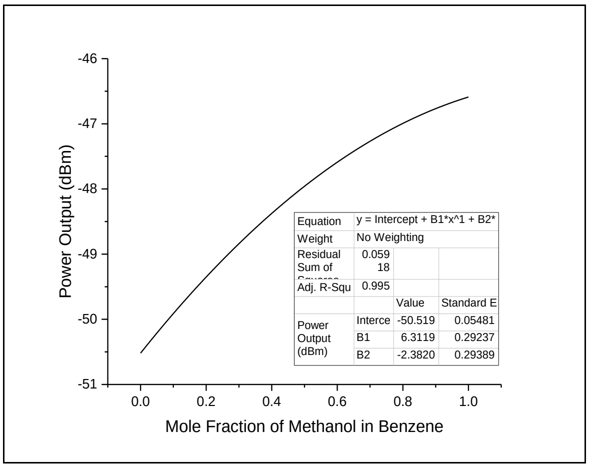
| | | | | | |
|---|---|---|---|---|---|
| 2 | 1 | 9 | 1.339 | -47.1 | 0.8039 |
| 3 | 2 | 8 | 1.353 | -47.5 | 0.6457 |
| 4 | 3 | 7 | 1.370 | -47.9 | 0.5153 |
| 5 | 4 | 6 | 1.389 | -48.3 | 0.4060 |
| 6 | 5 | 5 | 1.405 | -48.8 | 0.3130 |
| 7 | 6 | 4 | 1.421 | -49.1 | 0.2330 |
| 8 | 7 | 3 | 1.437 | -49.5 | 0.1634 |
| 9 | 8 | 2 | 1.453 | -49.8 | 0.1026 |
| 10 | 9 | 1 | 1.471 | -50.3 | 0.0482 |
| 11 | 10 | 0 | 1.488 | -50.6 | 0.0000 |



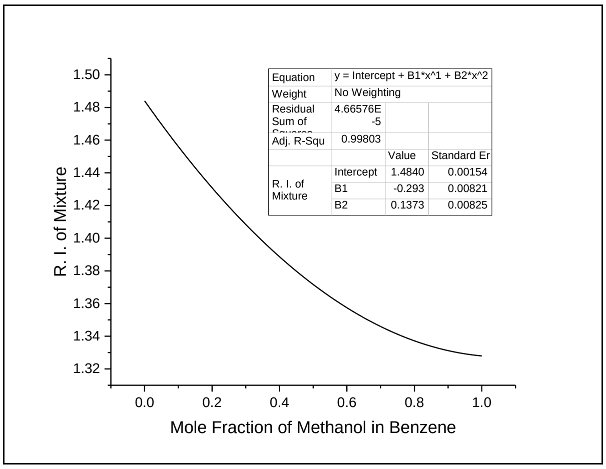




Fig. 1: Relation between Mole fraction and R.I. Power of benzene and methanol mixtures using U shaped 0.5 mm dia rod

Fig. 2: Relation between Mole fraction and of benzene and Methanol mixtures using U shaped 0.5 mm dia glass rod

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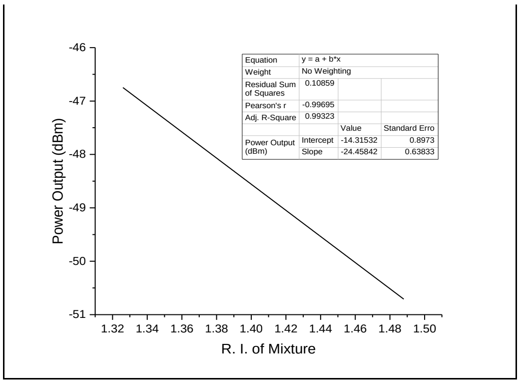


**Fig. 3: Relation between R.I. and Power Output of benzene and methanol mixtures using U shaped 0.5 mm dia glass rod**

Now the graphs are plotted between the refractive index of human urine using glass refractometer and the output power, and the refractive index of the human urine determined by Abbe's refractometer and the output power (figures 4 & 5) are shown evident, that there is a close agreement between the values of refractive index obtained from the present experiment and the values determined by Abbe's refractometer. The experiment is carried out in the laboratory of the physics department, is simple, easy to construct, can be repeated any number of times, and overall cost effective and the results can be sensed from a remote place.

**Table 2: Data on refractive index of human urine collected from 25 persons within the age group of 20 and 60**

| S. No. | Subject Code | Age Group | Power Output (dBm) | R. I. using Glass Refractometer ($\mu_1$) | R. I. using Abbe's Refractometer ($\mu_2$) | $(\mu_1 \mu_2)/\mu_2 \%$ |
|---|---|---|---|---|---|---|
| 1 | GA01 | 52 | -48.0 | 1.325 | 1.323 | 0.151 |
| 2 | AV02 | 60 | -48.3 | 1.330 | 1.329 | 0.075 |
| 3 | SK03 | 41 | -48.5 | 1.330 | 1.329 | 0.075 |
| 4 | PR04 | 33 | -48.3 | 1.330 | 1.329 | 0.075 |
| 5 | AS05 | 23 | -48.2 | 1.330 | 1.329 | 0.075 |
| 6 | MZ06 | 21 | -48.5 | 1.330 | 1.329 | 0.075 |
| 7 | BA07 | 41 | -49.1 | 1.339 | 1.338 | 0.075 |
| 8 | PR08 | 43 | -49.2 | 1.339 | 1.338 | 0.075 |
| 9 | SU09 | 45 | -49.0 | 1.339 | 1.338 | 0.075 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | GA10 | 39 | -49.2 | 1.339 | 1.338 | 0.075 |
| 11 | PE11 | 29 | -49.1 | 1.339 | 1.338 | 0.075 |
| 12 | PR12 | 55 | -49.6 | 1.344 | 1.342 | 0.149 |
| 13 | SK13 | 24 | -49.5 | 1.344 | 1.342 | 0.149 |
| 14 | AA14 | 21 | -49.6 | 1.344 | 1.342 | 0.149 |
| 15 | RA15 | 48 | -50.0 | 1.348 | 1.346 | 0.223 |
| 16 | AM16 | 27 | -50.1 | 1.348 | 1.346 | 0.223 |
| 17 | MS17 | 20 | -50.1 | 1.348 | 1.346 | 0.223 |
| 18 | VR18 | 19 | -50.0 | 1.348 | 1.346 | 0.223 |
| 19 | KS19 | 53 | -50.2 | 1.348 | 1.346 | 0.223 |
| 20 | KR20 | 37 | -50.1 | 1.348 | 1.346 | 0.223 |
| 21 | JA21 | 48 | -50.4 | 1.353 | 1.351 | 0.148 |
| 22 | SR22 | 22 | -50.4 | 1.353 | 1.351 | 0.148 |
| 23 | KA23 | 33 | -50.7 | 1.357 | 1.355 | 0.221 |
| 24 | HA24 | 31 | -50.8 | 1.357 | 1.355 | 0.221 |
| 25 | SN25 | 50 | -50.7 | 1.357 | 1.355 | 0.221 |

$\mu_1$ : Refractive Index of urine using glass refractometer

$\mu_2$ : Refractive index of urine using Abbe's refractometer

With slight increment in the refractive index values measured with glass refractometer comparing with Abbe's refractometer as shown in figures 4 & 5 the values are in close relationship with one another, which proves the measuring capabilities of the present developed glass sensor. Hence this sensor can be used to sense refractive index of many other liquids both transparent and dark in the dynamic range of 1.3nD to 1.5nD at room temperature. The operational range of the FO glass sensor can be enhance by properly selecting two liquids one with low index of refraction and the other with high index of refraction and by verifying their miscibility maintaining at room temperature. The sensor also can be expected to be used in the various temperature ranges by studying its functionality at different temperatures. The sensitivity of the sensor can be increased by properly designing by selecting reduced diameters of the glass rod and also reducing the bending radius of the U- Shaped glass rod.

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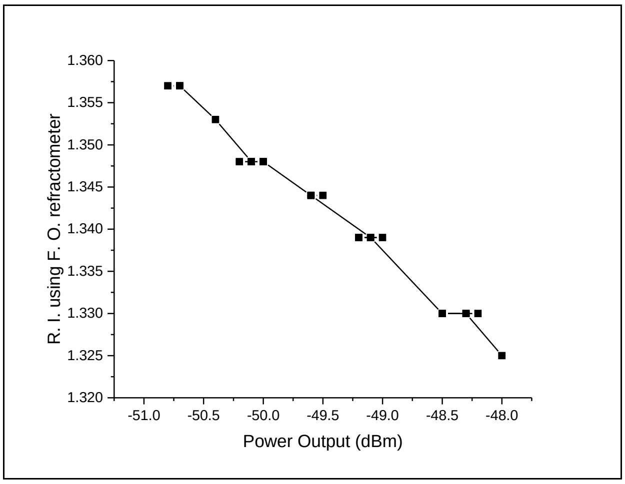


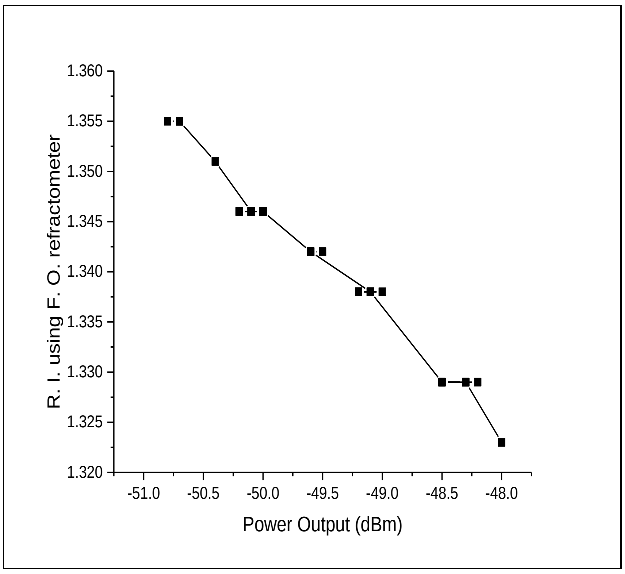


**Fig. 4: Using Glass refractometer** **Fig. 5: Using Abbe's refractometer**

## V.CONCLUSIONS

The present method of determination of refractive index of urine is very much useful for diagnostic purposes medical professionals. The sensor is expected to play major role in future industrial, medical, military, food processing, petrochemical industry, fragrant, unoni, cosmetic, food flavors and many other consumer applications where the need of measuring the refractive index of liquids arise. It also can be used to measure the pollutants in the water bodies, contaminated liquids like contamination of milk and contamination of honey by measuring the refractive refractive indices of contaminated agents, etc. the contaminations can be measured at high degree of accuracy and with higher degree of sensitivity. This sensor also can be used to measure the chemical industry for the measurement of various chemical activities as it is inert to many chemical reactions.

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