MODIFIED AIR COOLER WITH SPLIT COOLING UNIT

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ABSTRACT:

Energy consumption all over the world is increasing rapidly and we need to develop ways to conserve energy for futurerequirement for our comfort conditions generally we use an air conditioner, it uses a vapour compression refrigeration system. This refrigeration system consumes very large amount of power (about 1.5 KW), also the cost of this system is high. So the other option for maintaining comfort is evaporative cooler. The cost of evaporative cooler is less than that of AC; also it consumes less power than AC. The main drawback of evaporative cooler is that the air supplied by the cooler contains the large amount of humidity. Due to which when an individual sits in the air of the cooler, he/she feels stickiness on the body which is not comfortable for him/her. This project work involves the manufacturing and design of split cooling unit which will cool air but not increase its humidity. It will maintain the room at comfort conditions by recirculating the air in the room through split unit.

1.INTRODUCTION

The phenomenon of evaporative cooling is a common process in nature, whose applications for cooling air are being used since the ancient years. In fact, it meets this objective with low energy consumption, being compared to the primary energy consumption of other alternatives for cooling, as it is simply based in the phenomenon of reducing the air temperature by evaporating water on it. Due to great consumption of energy in buildings, there are increasing demands to design energy-efficient heating, ventilation, and air-conditioning (HVAC) equipments and systems for buildings. The evaporative cooler was very popular in twentieth century; many of these, made the use of wood wool pads to bring a large volume of water in contact with moving air to allow evaporation to occur. A typical design includes a water reservoir, a pump to circulate water on the pads and a fan to supply air through the pads and into the cooling space. This design and this material remained constant in evaporative coolers in some areas where they are also used to increase humidity. In India, the union ministry of power's research pointed out about 20-25% of total electricity utilized in government buildings gets waste due to non productive design, resulting in an annual energy related financial loss of about RS.1.5 billions. Conventional heating ventilation and air conditioning systems consume approximately 50%of building energy. Conventional vapour compression air conditioning systems consume a large portion of electrical energy which is produced mostly by fossil fuels. This type of air conditioning is therefore neither eco-friendly nor sustainable.

2.MODIFIED DESIGN-SPLIT COOLING UNIT

Welded joints are used for construction of many structures. Welding is a joining or repair process which induces high residual stress field, which combines with stresses resulting from in-service loads, strongly influencing in-service behavior of welded components. When compared with stresses due to service loads, tensile residual stress reduces crack initiation life, accelerates growth rate of pre-existing or service-induced defects, and increases the susceptibility of structure to failure by fracture. Also, welding residual stresses are formed in a structure as a result of differential contractions which occur as the weld metal solidifies and cools to ambient temperature.

Previously some of the methods like heat treatment and peening kind techniques were used for reduction of residual stress. However, those methods need special equipment and are time consuming. In this, we are proposing a new method for reduction of residual stress using vibration during welding. For this Mechanical vibrations will be used as vibration load. In this work, Finite Element Method(FEM) will Split Cooling Unit consist of three heat exchangers. The temperature of water of the Evaporative cooler decreases gradually after starting the cooler. This cooled water is supplied to the Split Cooling Unit. When the air passes through the heat exchanger, it losses its heat and cooled air of 25^{o}C is supplied to the room without increasing its humidity. This unit can be used in non-coastal region.

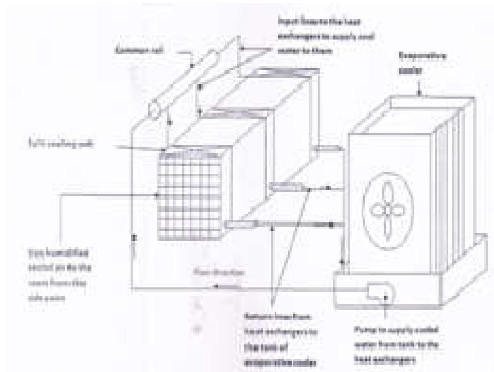

Fig:1.1 Modified Design Spilt Cooling Unit

The split unit has a fan which will supply air to room. The air thus supplied will be cool and non humidified. Only split unit will be keep into the cooling space and the evaporative cooler will not thus the split unit will take air from the and after cooling it the unit will supply air back to the room thus due to this recirculation there will be more cooling effect. The air from evaporative cooler can be use to cool another space where humidity is desired. This system requires very less power (130W) than that of AC. Also the cost of system is very less than that of AC.

2.1 SELECTION OF EVAPORATIVE COOLER

The Cooler buyer finds it difficult to select the right cooler to suit his requirement because of his inadequate knowledge about coolers. At present, the market is flooded with different brands of coolers, each one promising something new with large difference in prices. This further adds the confusion in the minds of buyer .Therefore the purchase is lastly made on the outer finish and manufacturer's recommendations. Except a few, most manufacturers themselves are not aware of the cooler technique and the coolers are manufactured with thumb-rule occupied with minor changes.

2.2DESIGN OF SPLIT COOLING UNIT

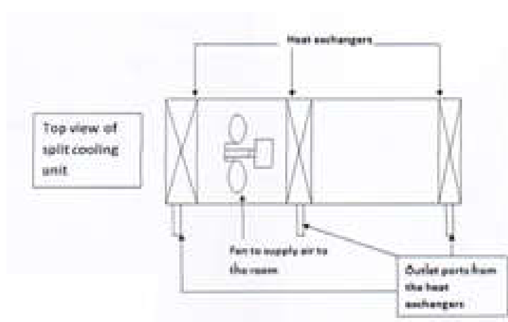

Fig:1.2 Design of Spilt Cooling Unit

The Split cooling unit consist of three heat exchangers equally spaced in which chilled water is supplied from the Evaporative cooler by using a high pressure submersible water pump of 40W. A fan of
18 W is fitted between the first and second heat exchanger, as shown in figure. One common rail is attached at the inlet of split unit which supplies the water to all three heat exchanger at equal pressure while another common rail is attached at the outlet of heat exchanger which collects the water from the heat exchanger and supplies to the water tank of Evaporative cooler

3.THEORETICAL ANALYSIS

Fig:1.3Split Cooling Unit

The cooling efficiency of evaporative air cooling is measured by the saturation effectiveness or the evaporative saturation efficiency (η) (ASHRAE Standard, ANSI/ASHRAE Standard 133–2001). It is determined primarily by the measured temperatures of the air entering and exiting the rigid media using the following equation: $\eta = 100X (T_{d1}-T_{d2}/T_{d1}-T_{wb})$

Where, T_{d1} =inlet dry-bulb temperature (ºC).

T_{d2} =outlet dry-bulb temperature (ºC).

T_{wb} =thermodynamic wet-bulb temperature of the inlet air(ºc).

η =evaporative saturation efficiency (%).

The coefficient of performance of split unit and the evaporative cooler is given by $COP= h_1-h_2/w$

Where, h_1 = heat of air at inlet

h_2 = heat of air at outlet

w = workdone

It should be noted that the above equations consider the water vapour and not the water liquid. The solid media can be considered to simulate a heat exchanger. Consequently the heat or mass transfer coefficient can be calculated with log mean temperature difference ΔT or density difference of water vapour $\Delta\rho_v$ to proxy q and in m_e we obtain. $h=q / As\Delta T$

Where, h = heat transfer coefficient (W/m^2K)

As = total wetted surface area of rigid media (m^2); and ΔT= the log mean temperature difference for a constant water temperature in the heat exchanger, which is assumed to be equal.

4. EXPERIMENTATION

1. The conventional evaporative cooler.

2. A duct consisting of three heat exchangers and a fan to supply air.

The below figure shows the actual set up of evaporative (Desert) cooler used for the testing purpose. All the components used in the assembly of cooler are discussed in the previous point

Fig:1.4Assembly of Desert cooler used for testing

Fig1.5Set up of Desert Cooler used for testing

4.1CALCULATION

Saturation Effectiveness:

η=100X (T_{d1}-T_{d2}/T_{d1}-T_{wb})

Where,T_{d1} = dry bulb temperature(°C) = 42, T_{d2} = outlet temperature (°C)= 25

Twb =thermodynamic wet bulb temperature= 17

η = saturation efficiency

η =100X (42-25/42-17) η =28%

Heat transfer Co-efficient: q=hAs Δ T

Where, h = heat transfer coefficient (W $m^{-2}K^{-1}$);

As = total wetted surface area of rigid media (m^2); and

Δ T is usually taken to be the log mean temperature difference for a constant water temperature in the heat exchanger, which is assumed to equal the wet-bulb temperature.q = W/As (Where, W= Power consumption in watt) q = Heat flux in watt/ m^2

q =131/ 0.025908 = 50.56 w/ m^2 h= q/As Δ T

h= 50.56/(0.025908 x (42-25))= 114.795 (W m-2K-1)

Coefficient of Performance:

COP= Energy supplied/ Energy used

COP= m_s. (h_1 – h_2)/ W

Where, m_s = Mass flow rate of air in Kg/sec

h_1 = Initial Enthalpy of air in Kj/Kg

h_2 = Final Enthalpy of air in Kj/Kg

W= Power consumption in watt

COP = 0.1666 x (105 –50)/ 131= 7,COP = 7

S.No	Dry Bulb Temp.	Wet bulb Temp	Enthalpy	Relative Humidity
	(^{0}C)	(^{0}C)	Kj/Kg	%
1	42	35	105	50
2	25	17	50	50

Table:1From Psychometric chart

5. CONCLUSION

The experimental investigation above confirmed that split unit demonstrated reasonable potential for use as a wetted media in evaporative cooling systems. Consequently, it creates the possibility of new sustainable engineering systems where either cooling or humidifying is required. As the unit maintain the temperature 25°c and it has low cost than AC so it will be good replacement for AC.

For the future modifications, if the density of the split unit is reduced then we can achieve better performance than that achieved. Also we can increase the thickness of the pad to achieve good performance Than That Achieved. This unit a bit bulky; if we work on the design the unit will acquire less space. Also for getting more cooling effect we can increase the thickness of the cooling pads of evaporative coolers. Due to this the incoming air in evaporate will reject more heat in pads; hence the water in the tank of evaporative cooler will become more cool, and if this extra cooled water is circulated in split unit it will definitely give more cooling effect.

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Cladding Mode Absorption Based Optical Fiber Intensity Modulated Sensor for the Measurement of Refractive Index of Optically Transparent Chemical Mixtures

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ABSTRACT: The study of refractive index of liquids play a major role in various applications such as industrial, defence, medical, food processing and consumer applications. In the present paper we report our latest results on a compact and low cost cladding mode absorption based U-shaped intensity modulated fiber optic sensor to sense the refractive indices of Acetone mixed in Benzene and Ethanol mixed in Benzene. The solid U-shaped glass sensor was prepared by bending the radius of a borosilicate glass rod to 1.0cm through a heating process. After which the U-shaped glass rod was connected to a light source of 630nm via the input fiber leg and a Bench mark power meter via the output fiber leg by using suitable adhesives. The experiment was carried out by exposing the U-shaped glass rod to the various concentrations of chemical mixtures. The results obtain through the experiment showed that a linear relationship was formed between refractive index of the different chemical concentrations with the power loss at the sensing zone. A dynamic range of $1.35n_D$ to $1.50n_D$ refractive index was obtained by using this sensor at room temperature.

Keywords: Borosilicate glass rod, Chemical concentrations, Cladding mode absorption, Dynamic range, Sensing zone.

I. INTRODUCTION

Optical fiber refractive index sensors based on cladding mode absorption have been the subject of research for the last few decades. The measurements of refractive index along with other parameters of liquids, oils, waxes, sugar serapes, fragrants, chemicals etc are very useful in many applications [1]. The internal structure or the geometry of the molecule, binary, ternary mixtures of liquids will determine the properties of index of refraction, polarization, density, molar volume, molar refraction, boiling point, melting point and other analytical behavior [2-8]. In the recent years the fiber optic sensors became more popular because they are safety in explosive and hazardous environment, immunity to electromagnetic interference, high sensitivity, remote sensing, distributed sensing and sensing at inaccessible areas etc. Because of many useful features of fiber optic sensors such as low in cost, miniature in size, intrinsic safety and ease of installation make the system ideal for various applications like inline chemical processing, food processing beverages, medical analysis etc. For the determination of ratio of compositions of binary liquids in a mixture an optical sensor was developed by L.M. Bali et al [9]. Sensors for PH measurements, refractive index study, to determine the organic pollutants in the water were developed with various sensor designs and with different sensing method and reported in the literature [10-15]. In the present paper extrinsic intensity modulated fiber optic U-shaped glass probe cladding mode absorption based sensor was developed to determine the refractive index of the chemical concentration of Acetone mixed in Benzene and Ethanol mixed in Benzene.

II. EXPERIMENTAL DETAILS

The experimental setup consists of three basic components. The light source of 630nm wavelength, a suitable Bench mark optical power meter of suitable range and a sensing system consisting of a U-shaped glass probe of thickness 0.2cm, total height of the glass rod 3.0cm, height of the glass rod immersed in the liquid 2.0cm, width between the two prongs 1.5cm and depth of the curvature 1.0cm. One of the ends of the glass rod is connected to the input fiber leg (200/230μm), and the other end of the glass rod is connected to the output fiber leg (200/230μm) by using suitable connecting adhesives. The second end of the input fiber leg is connected to light source of 630nm wavelength. The other end of the output fiber leg is connected to a Bench mark power meter. The experimental setup is shown in Fig.[1].

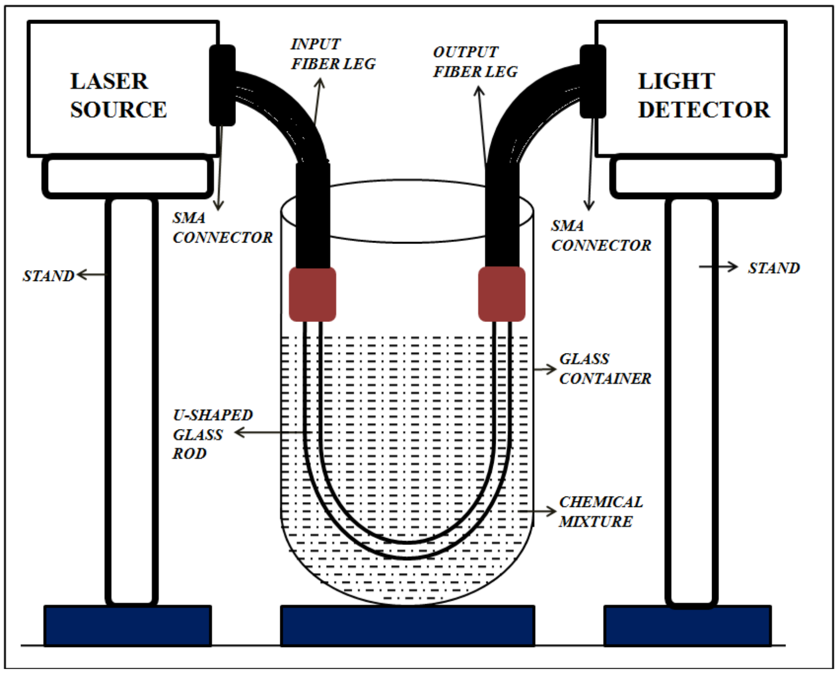

Fig.1: Experimental setup of Cladding Mode Absorption Based Optical Fiber Intensity Modulated Sensor.

Initially a binary mixture of Acetone mixed in Benzene was prepared by taking the known volumes of each liquid with proportional ratios making the total volume of the binary mixture equal to 10ml and preserved in an air tight stopper glass bottles. By using Abbe's refractometer in combination with sodium vapour lamp the refractive indices of all the mixtures were measured with an accuracy of 0.001 units and were recorded.

The U-shaped glass probe connected with light source and a power meter at the both ends by using 200/230μm PCS fibers was immersed in a glass container consist of a particular ratio of binary mixture. Light launched from the source transmits through the input fiber leg and enters into the U-shaped glass rod and couples out into the output fiber leg and enters into the power meter. Power observed in the power meter was recorded. Next the binary mixture with other ratio was exposed to the glass rod and output power was recorded. Finally the output was recorded by immersing U-shaped glass rod in all other binary chemical mixtures with different volume ratios and output power values are tabulated.

By using a specific gravity bottle the densities of all the binary mixtures with different ratios of volumes were measured. By using the suitable mathematical equations the molefraction, molar volume, molar refraction, polarization are determined and tabulated in tabular form 1.

Standard chemical parameter of Acetone and Benzene.

	Benzene	**Acetone**
Molar Mass (g/mole)	78.11	58.08
Refractive Index(n)	1.4957	1.3509
Density (g/ml)	0.8765	0.7846
Molar Volume (c.c./mole)	89.1158	75.1455
Molar Refraction (c.c./mole)	25.6753	16.2070
Polarization ($\varepsilon = n^2$)	2.2371	1.8249

Table-1: Molefraction of Benzene in Benzene + Acetone mixtures, Molefraction of Acetone in Benzene + Acetone mixtures and Refractive Index, Output Power(dBm), Density(g/ml), Molar Volume(c.c./mole), Molar Refraction(c.c./mole) and Polarization ($\varepsilon = n^2$) of Benzene + Acetone chemical mixtures.

S. No.	Volume of the binary mixtures (ml)		Molefraction		Refractive Index	Output Power (dBm)	Density (g/ml)	Molar Volume (c.c./mole)	Molar Refraction (c.c./mole)	Polarization ($\varepsilon = n^2$)
	Benzene	Acetone	Benzene	Acetone						
1	10	0	1.0000	0.0000	1.488	-48.73	0.8765	89.1158	25.6753	2.2141
2	9	1	0.9155	0.0845	1.451	-44.87	0.8673	88.1096	23.7240	2.1054
3	8	2	0.8280	0.1720	1.440	-44.10	0.8581	87.0118	22.9320	2.0736
4	7	3	0.7374	0.2626	1.433	-42.67	0.8489	85.8171	22.3038	2.0535
5	6	4	0.6436	0.3564	1.421	-41.10	0.8397	84.5198	21.4328	2.0192
6	5	5	0.5462	0.4538	1.414	-39.95	0.8305	83.1070	20.7674	1.9994
7	4	6	0.4452	0.5548	1.407	-39.42	0.8213	81.5748	20.0801	1.9796
8	3	7	0.3403	0.6597	1.389	-37.81	0.8121	79.9116	18.8995	1.9293
9	2	8	0.2313	0.7687	1.378	-36.23	0.8029	78.1080	18.0080	1.8989
10	1	9	0.1180	0.8820	1.362	-35.58	0.7937	76.0774	16.8732	1.8550
11	0	10	0.0000	1.0000	1.351	-33.28	0.7845	75.1455	16.2070	1.8252

To conform the values obtained and to ascertain the chemical behaviors of binary mixtures another combination of chemicals; Ethanol and Benzene mixtures were taken and the experimentation was repeated and results are tabulated in tabular form 2.

Standard chemical parameter of Ethanol and Benzene.

	Benzene	**Ethanol**
Molar Mass (g/mole)	78.11	46.07
Refractive index(n)	1.4957	1.3602
Density (g/ml)	0.8765	0.7895
Molar Volume (c.c./mole)	89.1158	58.6729
Molar Refraction (c.c./mole)	25.6753	12.9558
Polarization ($\varepsilon = n^2$)	2.2371	1.8501

Table-2: Molefraction of Benzene in Benzene + Ethanol mixtures, : Molefraction of Ethanol in Benzene + Ethanol mixtures and Refractive Index, Output Power(dBm), Density(g/ml), Molar Volume (c.c./mole), Molar Refraction(c.c./mole) and Polarization ($\varepsilon = n^2$) of Benzene + Ethanol chemical mixtures.

S. No.	Volume of the binary mixtures (ml)		Molefraction		Refractive Index	Output Power (dBm)	Density (g/ml)	Molar Volume (c.c./mole)	Molar Refraction (c.c./mole)	Polarization ($\varepsilon = n^2$)
	Benzene	Ethanol	Benzene	Ethanol						
1	10	0	1.0000	0.0000	1.488	-48.73	0.8765	89.1158	25.6753	2.2141
2	9	1	0.9322	0.0678	1.460	-46.10	0.8678	87.5060	25.2108	2.1316
3	8	2	0.8593	0.1407	1.451	-45.25	0.8591	85.6733	23.4650	2.1054
4	7	3	0.7808	0.2192	1.443	-44.36	0.8503	83.6021	22.1631	2.0822
5	6	4	0.6961	0.3039	1.430	-42.30	0.8416	81.2417	20.9868	2.0449
6	5	5	0.6042	0.3958	1.422	-41.14	0.8329	78.5551	19.9625	2.0221
7	4	6	0.5044	0.4956	1.409	-39.53	0.8242	75.5047	18.6680	1.9853
8	3	7	0.3955	0.6045	1.396	-38.46	0.8155	72.0317	17.3074	1.9488
9	2	8	0.2762	0.7238	1.382	-36.47	0.8067	68.0791	15.8432	1.9099
10	1	9	0.1450	0.8550	1.370	-34.68	0.7980	63.5536	14.3749	1.8769
11	0	10	0.0000	1.0000	1.360	-34.12	0.7893	58.6729	12.9558	1.8496

III. RESULTS AND DISCUSSIONS

The tabulated experimental details of Acetone mixed in Benzene especially the variation of output power with refractive index shows a linear relationship. This relationship indicates as the refractive index of the binary mixture surrounding the U-shaped glass rod decreases the output power increases and vice-versa, which has been shown in Fig.[2].

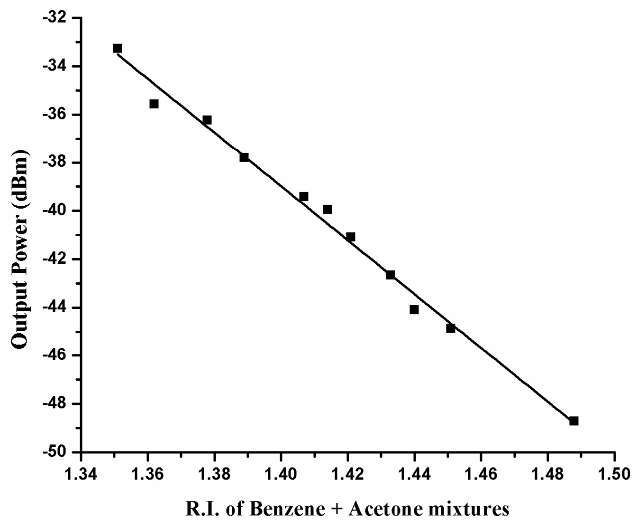

Fig-2: Relation between Refractive Index of Benzene + Acetone mixtures Vs Output Power (dBm)

In addition to variation of output power with refractive index of binary mixtures the other relations i.e. output power Vs density, output power Vs molefraction, output power Vs polarization, output power Vs molar volume and output power Vs molar refraction were determined and results are plotted in graphs [Fig.3-7].

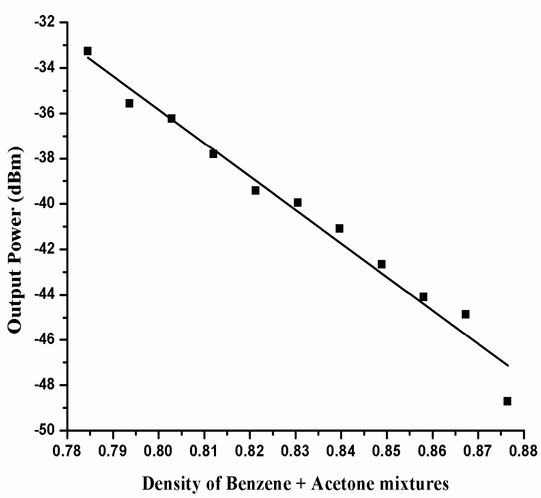

Fig-3: Relation between Density (g/ml) of Benzene + Acetone mixtures Vs Output Power (dBm).

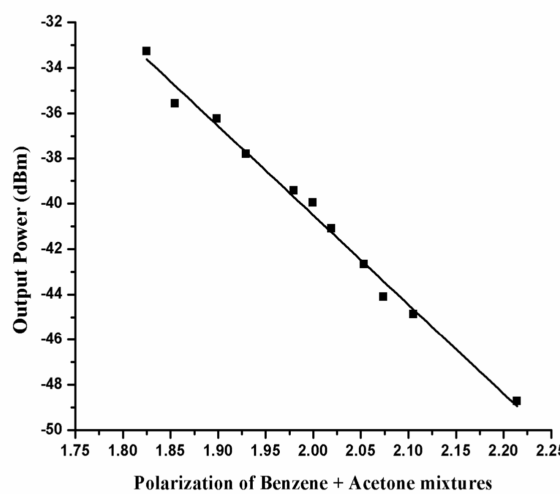

Fig-4: Relation between Polarization of Benzene + Acetone mixtures Vs Output Power (dBm).

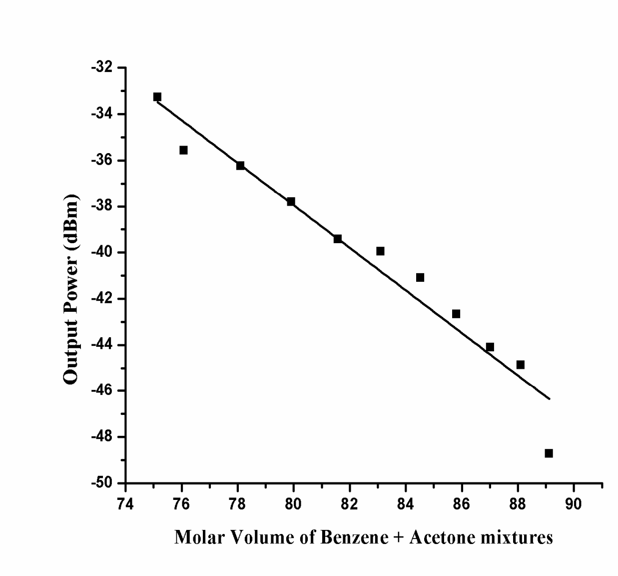

Fig-5: Relation between Molar Volume (c.c./mole) of Benzene + Acetone mixtures Vs Output Power (dBm).

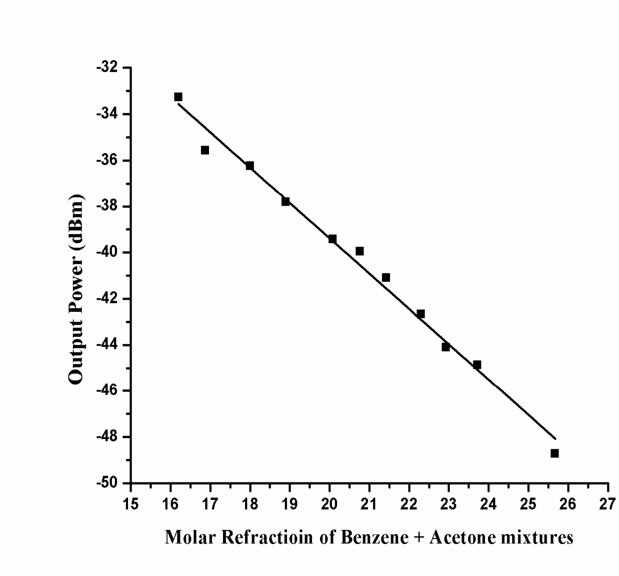

Fig-6: Relation between Molar Refraction of Benzene + Acetone mixtures Vs Output Power (dBm).

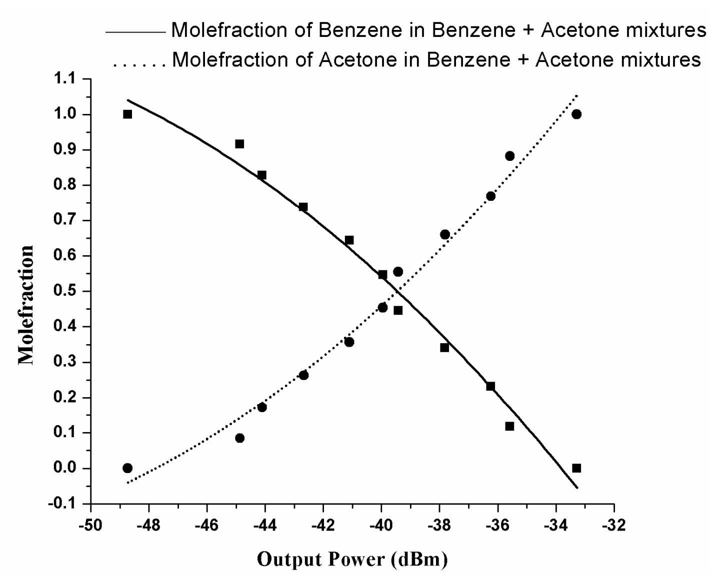

Fig-7: Relation between Molefraction of Benzene & Acetone in Benzene + Acetone mixtures Vs Output Power (dBm)

In conformation to the variation of output power with refractive index as tabulated in tabular form 2 the variation in the values of output power with refractive index of binary mixture of Ethanol mixed in Benzene forms a linear relationship and the results are plotted in graph [Fig.8].

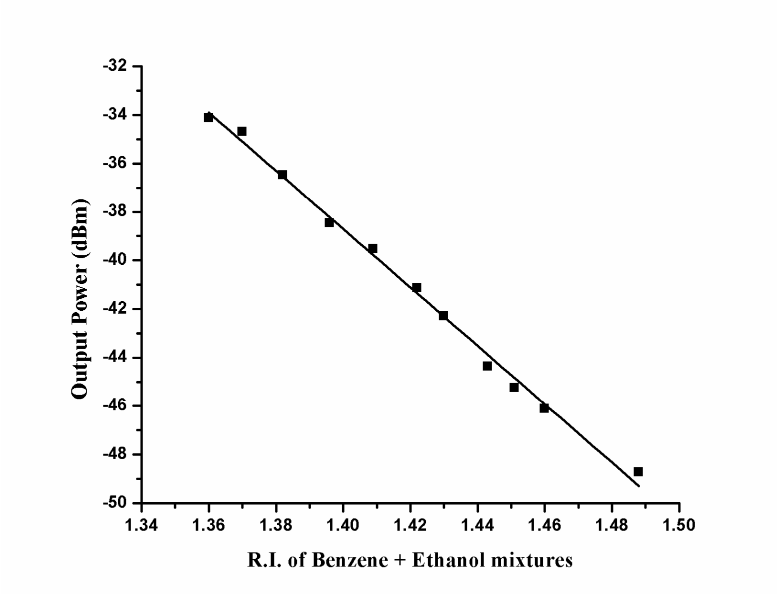

Fig-8: Relation between Refractive Index of Benzene + Ethanol mixtures Vs Output Power (dBm)

In addition to variation of output power with refractive index of binary mixtures the other relations i.e. output power Vs density, output power Vs molefraction, output power Vs polarization, output power Vs molar volume and output power Vs molar refraction were determined and results are plotted in graphs [Fig.9-13].

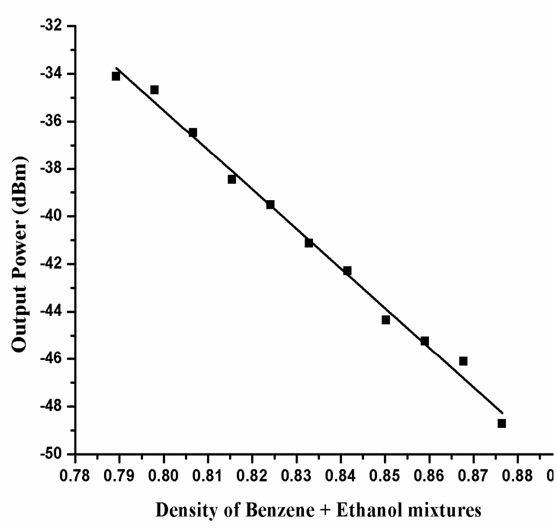

Fig-9: Relation between Density (g/ml) of Benzene + Ethanol mixtures Vs Output Power (dBm).

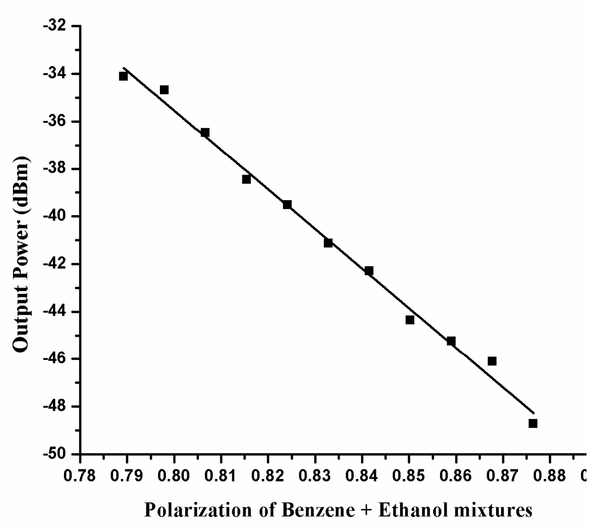

Fig-10: Relation between Polarization of Benzene + Ethanol mixtures Vs Output Power (dBm).

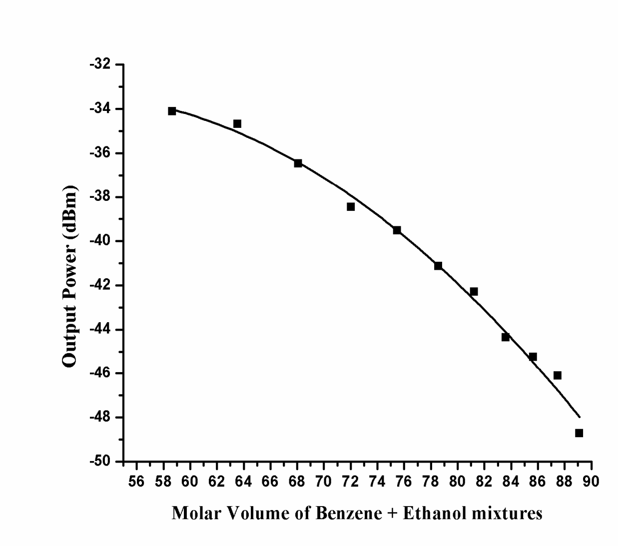

Fig-11: Relation between Molar Volume (c.c./mole) of Benzene + Ethanol mixtures Vs Output Power (dBm).

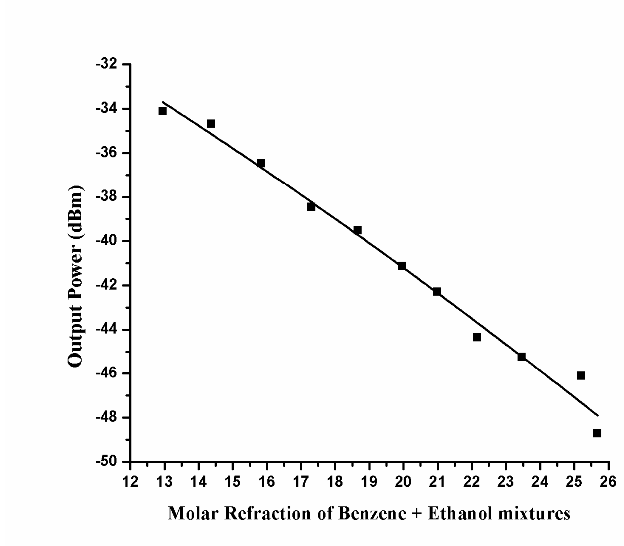

Fig-12: Relation between Molar Refraction of Benzene + Ethanol mixtures Vs Output Power (dBm).

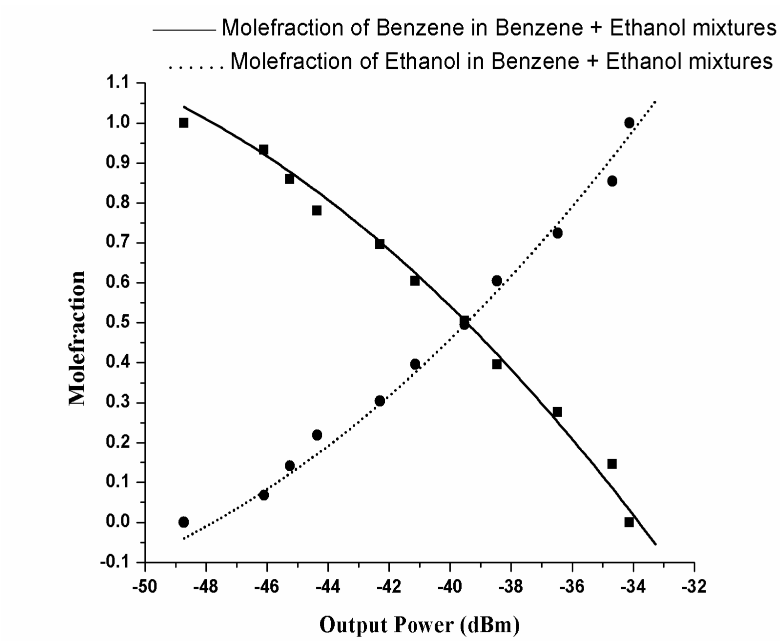

Fig-13: Relation between Molefraction of Benzene & Ethanol in Benzene + Ethanol mixtures Vs Output Power (dBm)

IV. CONCULSIONS

The refractive index of binary chemical mixtures of transparent liquids were determine with the help of existing Abbe's refractometer, corresponding powers are noted down and with the help of both these values (Refractive index & Output power) graphs (Fig. 2&8) are drown which can be used to measure the refractive index of unknown liquids in the dynamic range of 1.35n_D to 1.50n_D in the case of Acetone mixed in Benzene and 1.36n_D to 1.50n_D in the case of Ethanol mixed in Benzene at room temperature. This work also can be extended to design a refractive index sensor to record the refractive indices of both transparent and dark liquids at various temperatures.

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