Design of Dielectric Resonator Liquid Yagi-Uda Antenna

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***Abstract*—This paper presents on modified the dielectric properties of liquid with varying salinity, that was based on yagi-uda structure. Dielectric resonator antennas (DRAs) can be made with a wide range of materials and allow many excitation methods [1]. Pure water does not work at high frequency (> 1 GHz), but increases the salinity of water that modifies the dielectric properties of water. The resonator column height determined the operating frequency [2]. These antenna shows that the salinity increases the antenna was resonated at different frequency.**

***Index Terms*—Molar (M), resonant frequency, liquid dielectric, liquid yagi-uda antenna**

I Introduction

The dielectric resonator antenna (DRAs) was first study in1983 [3]. It has been shown that electrically conducting liquids and some biological fluids can operate as antennas at microwave frequencies [4]. The advantage of liquid dielectric is that permitted improvements in electromagnetic coupling between dielectric and antenna because there is no air gap. H. Fayad and P. Record used a Salt (S< 6ppt**)** was added to decrease the dielectric response (real and imaginary) of pure water at (2< GHz) [2].

II Antenna Design

The liquid yagi-uda antenna constructed from the PVC (polyvinyl chloride) hollow tube. A liquid yagi- uda antenna of p.v.c tube of diameter 1 cm and as shown in Fig. 1. The resonant frequency for this proposed antenna was 1.509 GHz in L-band (1-2 GHz). The yagi-uda antenna is basically an arrangement of dipoles in such a way that the whole system provides a directional antenna beam in desired direction. That's why some times it is called a directional antenna system. The yagi antenna's overall basic design consists of a "resonant" fed dipole [5] (the fed dipole is the driven element).

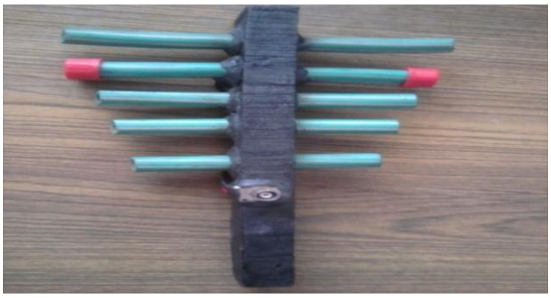

Figure 1. Photograph of liquid yagi-uda antenna

A. *The Elements of Yagi*

The driven element**-** The driven element of a yagi is the feed point where the feed line is attached from the transmitter to the yagi to perform the transfer the power from the transmitter to the antenna. A dipole driven element will be "resonant" when its electrical length is ½ of the wavelength of the frequency applied to its feed point [6]. The feed point is on the center of the driven element.

The directors-The directors are the shortest of the parasitic element and this end of the yagi is aimed at the receiving station. It is resonant slightly higher in frequency than the driven element, and its length will be about 5% shorter, progressively than the driven element. The length of directors can vary depending upon the director spacing. The numbers of directors that can (length) of the supporting boom needed by the used are determined by the physical size design. The directors are used to provide the antenna directional pattern with gain. The amount of gain is directly proportional to the length

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of the antenna array not by the number of directors used. The spacing of the directors can range from 0.1 to 0.5wavelengths or more and will depend largely up on the design specification of the antenna [7].

The reflector- The reflector is the element that is placed at the rear of the driven element (The dipole). Its resonant frequency is lower, and its length is approximately 5% longer than the driven element. Its length will vary depending on the spacing and the element diameter. The spacing of the reflector will be between 0.1 wavelengths and 0.25 wavelengths [8]. Its spacing will depend upon the gain, bandwidth forward/backward ratio, and side lobe pattern requirements of the final antenna design. The length and spacing between the elements which we are taken to design the antenna are shown in the Table I.

TABLE I. THE LENGTH AND SPACING BETWEEN THE ELEMENTS IN TERMS OF WAVELENGTH

Element	Length	Separation
Reflector	0.55λ	0.1λ
Driven	0.50λ or λ/2	0.1λ
Directors	0.45λ,0.40λ, 0.35λ	0.1λ

The gain of yagi antenna is depend on the number of dipoles used in the antenna system and for high gain there should be more number of elements is used and kept low separation between the element For this research, pvc hollow tube of 10 mm diameter is used as antenna element and by using the formula λ=c/f the length of the dipoles is calculated and create the separation between the dipoles is 0.1λ which is equals to 1.98cm. All the physical design consideration at 1.509 GHz are shown in the Fig. 1.

III THE EXPERIMENTS

Figure 2. Experimental set up

The return loss of the liquid yagi-uda antenna was measured with FS315 spectrum analyzer connected by SWR (50 Ω) bridge as shown in Fig. 2. Spectrum analyzer operated at minimum hold position for all measured value. Fig. 3 shows resonant frequency 1.509 GHz of liquid yagi -uda antenna without liquid.

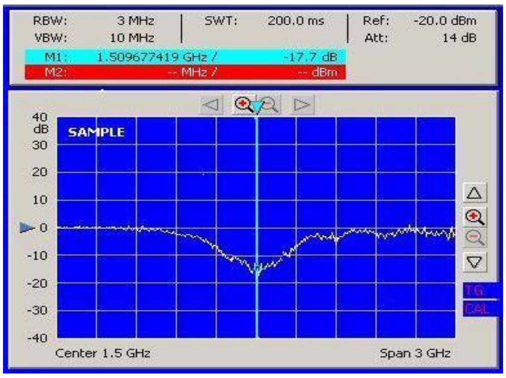

Figure 3. Resonant frequency of liquid yagi-uda antenna with(Distilled water) liquid

The test saline antennas were 50 ml pipet container filled with 25ml distilled water shown in Fig. 4 The height of liquid was calculated from the volume of liquid in container. We will made different molar salinity with the help of this pipet and filled different molar solution in driven element of the liquid yagi-uda antenna. By varying the salinity of distilled water from 0.5-2 M (Molar) range, the frequency of liquid yagi-uda antenna was resonated at 1.606 GHz as shown in Fig. 5 because it is reduces a dielectric response of water. The salinity continues to increase up to 2 M with 0.5 M difference. The antenna resonant frequency further varies 1.635 GHz, 1.664 GHz, and 1.674 GHz (shown as in Fig. 6-8) respectively.

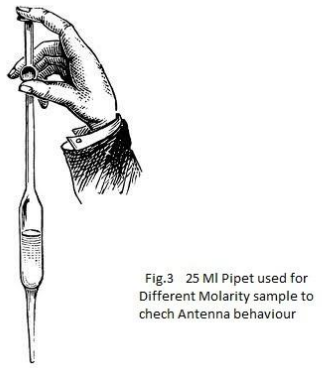

Figure 4. Photograph of pipet container filled with 25 ml distilled water

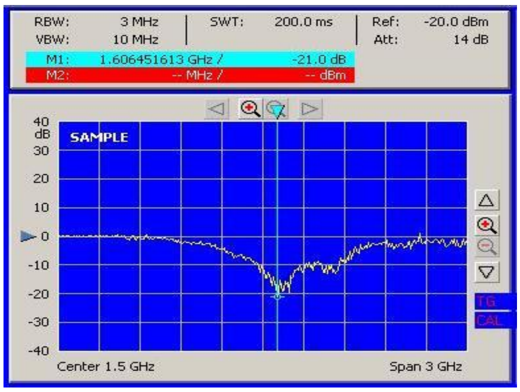

Figure 5. Resonant frequency of liquid liquid yagi-uda antenna at specified salinity (0.5 M).

Figure 6. Resonant frequency of liquid liquid yagi-uda antenna at specified salinity (1M)

Figure 7. Resonant frequency of liquid liquid yagi-uda antenna at specified salinity (1.5 M)

Figure 8. Resonant frequency of liquid liquid yagi-uda antenna at specified salinity (2 M).

IV RESULT AND DISCUSSION

The whole procedure of dielectric resonator liquid antenna was moving around the difference of resonant frequency of liquid yagi-uda antenna. It was normally operated at 1.509 GHz without liquid. Pure water becomes lossy dielectric at high frequency (> 1 GHz). If adding the salt in distilled water (specific molarities) to reduce the dielectric response (real and imaginary), it was analysis that salt does not impact antenna conductivity, but only alters the dielectric properties. It was observed that the return loss and resonant frequency decreases by increasing the salinity in the 0.5-2 M (Molar) range as shown in Fig. 9.

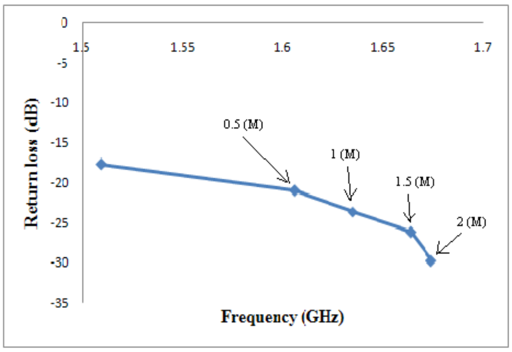

Figure 9. Return loss (dB) vs. Frequency (GHz) for different concentrations 0.5- 2 M rage

V CONCLUSION

This paper presents the experimental analysis of liquid dielectric antenna that was effective microwave radiator because the liquid antenna has reconfigurable properties. The simple liquid yagi-uda antenna was tuned at different resonant frequency with sufficient return loss more than -10 dB level through with different salinity of distilled water, that employ in many applications, medical and dielectric resonator liquid antenna. However, the primary restriction in water based antenna was not work at high frequency up to 1GHz because water becomes lossy. The obtain result are compared with available published data and good agreements find.

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