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ANALYSIS OF SOME ELECTRICAL PROPERTIES OF FOOD PRESERVATIVE SODIUM BENZOATE USING TDR

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ABSTRACT:

Preservatives prevent the spoilage of food caused by the certain action of microorganisms or oxidants. Natural as well as synthetic chemicals are used as preservatives. Besides preservation it also affects the quality of the food. So it becomes necessary to study the strategy of the chemical preservatives. The present work is the study of Reflection coefficient (ρ) based on the electrical analysis of food preservative Sodium Benzoate. For the study a low frequency Time Domain Reflectometry (TDR) is developed and used. Ten different molar concentrations (0.001 to 0.1molar) of Sodium Benzoate preservative are prepared with freshly collected distilled water. These solutions are kept in temperature controller unit and maintained at four different temperatures (25^{o}C, 35^{o}C, 45^{o}C and 55^{o}C). The temperature controller unit is controlled and monitored by computer. It was observed that the Reflection coefficient (ρ) of Sodium Benzoate is directly proportional to concentration and temperature.

KEYWORDS: Electrical analysis, Preservative, TDR, Refection coefficient.

1. INTRODUCTION:

Impedance spectroscopy is traditionally used in monitoring corrosion, testing effectiveness of drug preservatives [1, 2] and electro-deposition processes in the coating and characterization assessment of many kinds of sensors and semiconductors [3, 4]. Its application in biotechnology for the characterization of cell cultures [5] has however been notably expanded in the last decade. The impedance has been applied in the field of microbiology as a means of detecting and quantifying pathogenic bacteria [6, 7]. TDR technique is also used in medical field. Blood sugar can be detected with the help of TDR technique. [8]

Impedance spectroscopy is a powerful tool for a fast bio-molecule diagnosis and for analysis in cell cultures [9, 10]. Its superiority over other laboratory techniques lies in that it uses a small signal, thus minimizing the alterations of the properties of the medium, in other words, applied stimulation does not alter the equilibrium conditions of the system. The signal applied to the samples makes it possible to link the properties of the liquid or solid being studied with the variations or changes obtained in its characteristic impedance. This is due to the physical structure of the material, the chemical processes occurring in it, or a combination of both. Consequently, electrochemical impedance spectroscopy is a non-destructive technique providing robust measurements. [10]

A low frequency TDR (Time Domain Reflectometry) unit is developed [11-12] and used for the Impedance analysis. In TDR technique, a voltage step is propagated down through the transmission line towards the sample under investigation and reflected voltage waves are monitored by oscilloscope at particular point on line.

2. EXPRIMENTAL PROCEDURE

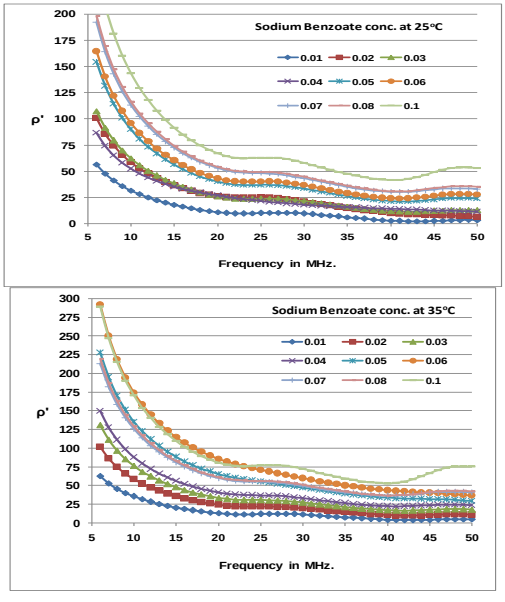
We have developed an instrument for measurement of impedance based on time domain technique. A low frequency TDR of the range 200MHz and 5ns rise time was developed. The

experimental setup consists of sampling oscilloscope DS1000 [25], TDR module, a transmission line, and sample cell. The co-axial transmission line with characteristic impedance of 50 ohm was used for study. The probe is the main sensing part in TDR system. Different types of probes were designed and tested for the accurate measurement. The TDR response of these electrodes is tested with distilled water and standard KCL solution. The TDR unit is used for measurement after warming up for at least 30 minutes.

Ten different molar concentrations (0.001 to 0.1molar) of Sodium Benzoate preservative are prepared with freshly collected distilled water and studied. These different concentrations are kept in water bath at different temperatures 25°C, 35°C, 45°C and 55°C. A probe connected with pulse generator through coaxial cable is immersed in the aqueous solution of Sodium Benzoate. A fast rising pulse is applied through the coaxial transmission line. The rising pulse gets reflected back from the solution under consideration. The nature of the pulse is depends on the properties of the liquid. This pulse is observed and stored in the Digital Storage Oscilloscope i.e. DSO. This data was then collected in an external storage and further calculations were done. Each time the probe was thoroughly cleaned with acetone and dried.

3. RESULTS AND DISCUSSION:

The computed values of real and imaginary part of complex reflection coefficient for aqueous solutions of preservatives sodium benzoate are plotted in following figures.



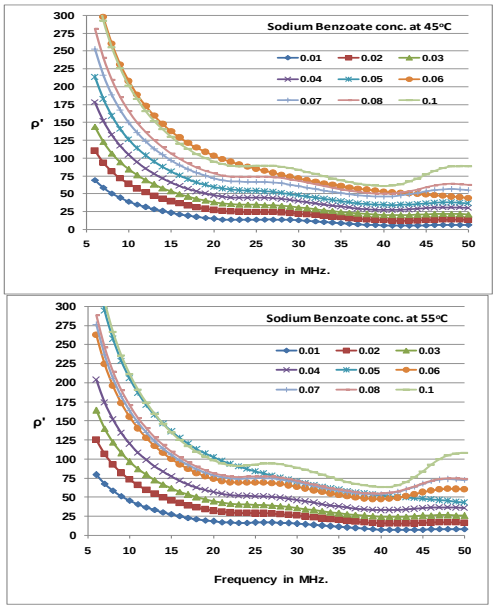


Fig 1. Real part of ρ for Sodium Benzoate solution

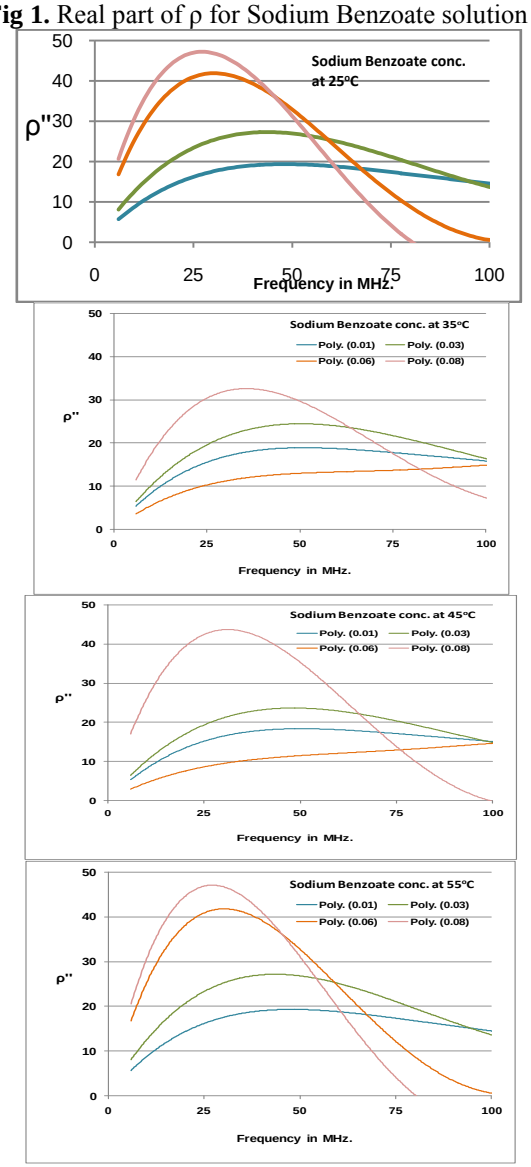


Fig 2. Imaginary part of ρ for Sodium Benzoate solution

From the graphs, we can observe that at higher frequencies the real part of reflection coefficient of aqueous solution decreases. The variation of real part of ρ with frequency is different in aqueous solutions of different frequencies. The frequency response of the solutions is observed at lower frequencies in the range of 50 MHz.

The imaginary part of complex reflection coefficient gives the losses or absorption of energy in the medium. The response of aqueous solutions of preservatives is in the lower frequency range of 150 MHz.

4. CONCLUSION:

The parameter value changes with change in temperature. The change in values of electrical parameter with temperature indicates the change in properties of solution with temperature. This helps to decide the food preservation strategy. The frequency dependent impedance spectrum of aqueous solution of preservative can be used to monitor quality of preserved food or food containing preservative.

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