STUDY OF REFLECTION COEFFICIENT OF SOME CHEMICAL FOOD PRESERVATIVES

Badhe S. G.
Department of Physics, R. B. Attal College, Georai, Dist. Beed (M. S.)
sgbadhe3@gmail.com

ABSTRACT

A Preservative is a substance or a chemical that is added to food products to prevent decomposition by microbial growth or by undesirable chemical changes. These molecular changes affect the quality of the food. Impedance spectroscopy technique is an important technique to study these molecular changes. In the present work Reflection coefficient (ρ) of food Preservative Citric Acid is studied. A low frequency Time Domain Reflectometry (TDR) technique is developed in the laboratory and used for the study. Various aqueous solutions of different concentration (0.005-0.1) are prepared with freshly collected distilled water and studied at four different temperatures (25^oC, 35^oC, 45^oC and 55^oC). Real (ρ') and Imaginary (ρ'') part of the solutions is studied. It was observed that Reflection Coefficient changes as the concentration and temperature changes. Details are discussed in the text.

Keywords: *Impedance, Reflection Coefficient, Food Preservative, Citric Acid, TDR Technique.*

INTRODUCTION

Food preservatives play an important role in preserved and packed food to maintain quality of food. It is important and interesting to estimate electrical properties of food preservatives. The water is the major constituent of liquid food; we have undertaken the study electrical properties of preservatives in aqueous solution. A Citric Acid chemical food preservative is selected for the study.

Citric Acid (chemical formula $C_6H_8O_7$) is a weak organic acid besides this it is one of the strongest edible acids. It is used as a flavoring and preservative in food and beverages, especially soft drinks and candies [1]. It is denoted by E number **E330.** Citric acid has 247 kcal per 100 g [2].

Exposure to pure citric acid may cause cough, shortness of breath, or sore throat. Over-ingestion may cause abdominal pain and sore throat. Exposure of concentrated solutions to skin and eyes can cause redness and pain [3]. Long-term or repeated consumption may cause erosion of tooth enamel [4, 5].

Spoilage of the food can be detected by measuring molecular change in food stuff. TDR is widely used technique to study the molecular changes of the variety substances. Several researchers used this technique to the study the pathogens or bacteria of the food products [6-9]. Researchers also used ‘E Nose’ based on this technique to study the growth of bacteria or micro organisms before the food get spoiled [10]. A sensory evaluation technique such as descriptive analysis is used to detect the quality of milk [11, 12]. TDR technique is useful in medical field. Researcher used this for the detection of blood sugar [13].

TDR is widely used technique because it uses a small signal and 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 [14].

A low frequency Time Domain Reflectometry (TDR) unit is developed in the laboratory [15, 16] and used for the Impedance analysis. In this technique, a step up pulse is used as an incident pulse which propagated down through the transmission line towards the sample under investigation and reflected back. It reflects the part of the input signal and some part of the input signal is absorbed in it. These signals are monitored by oscilloscope at particular point on line. The resultant signal is analyzed for determination of material properties. In the TDR measurement transmission line, sample cell or probe length plays important role. The calibration of sample cell or probe is important part of TDR measurement.

EXPERIMENTAL

The developed low frequency TDR is of 200 MHz range and 5ns rise time. The whole system consists of a water bath, transmission line, a strip type sample cell of length 5.5cm, Sample holder, temperature controller unit, oscilloscope, storage device etc. chemical grade Acetic Acid is used for the study. Eleven different molar concentrations (0.005, 0.01, 0.02 …….0.1) solutions are prepared with freshly collected distilled water. These solutions were kept at four different temperatures 25^oc, 35^oc, 45^oc and 55^oc. A strip like sample cell i. e. probe

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was immersed in the solution. These solutions were kept in the temperature controlled water bath. A fast rising step up pulse was send through the cable. The pulse strikes the sample and gets reflected back. Reflected pulse carries the information of the sample studied. The nature of the pulse depends upon the properties of the solution. The data was stored in the digital storage oscilloscope i.e. DSO. After every reading probe was thoroughly cleaned with acetone and dried.

RESULTS AND DISCUSSION

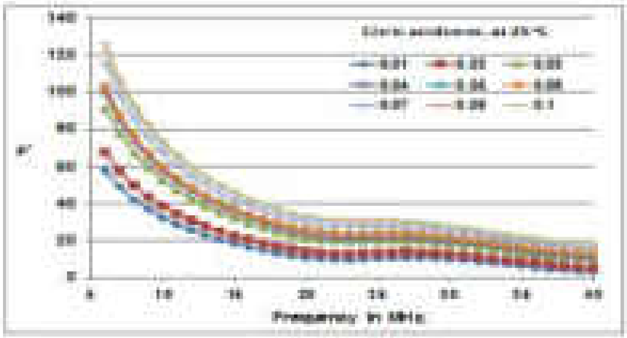
The reflected pulse without sample $r_1(t)$ and with sample $r_x(t)$ is recorded. The FFT (Fast Fourier Transform) of $(r_1(t)-r_x(t))$ and $(r_1(t) + r_x(t))$ is calculated by modifying waveforms with Nicolson's ramp method. The frequency dependent complex reflection coefficient (ρ*) is calculated using equation

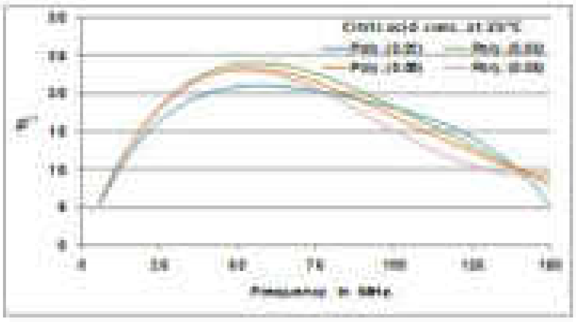
$$\rho^* = \frac{c}{i\omega d} \times \frac{r_1 - r_x}{r_x + r_x}$$

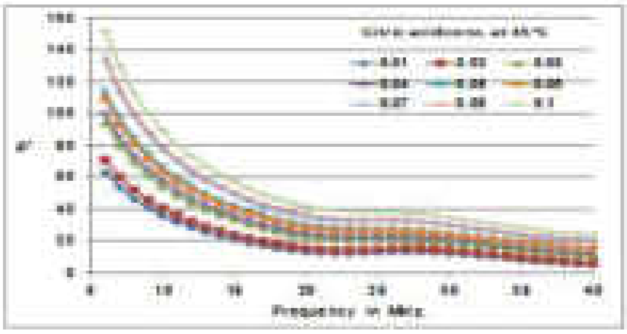
The computed values of real and imaginary part of complex reflection coefficient for aqueous solutions of preservatives are plotted in following figures. The real part is denoted as ρ' and imaginary part as ρ''.

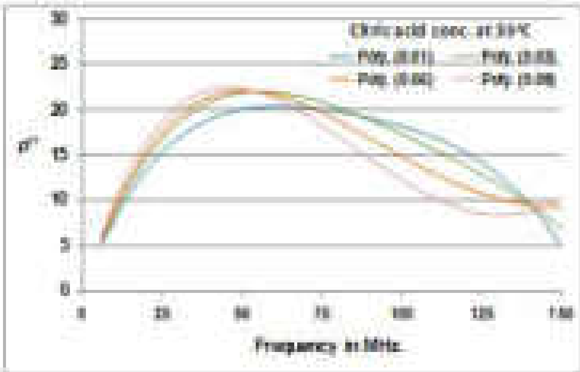
The separate graphs of ρ' and ρ" are plotted below to identify the variation in complex impedance of aqueous solutions of preservatives at different concentrations and at four different temperatures.

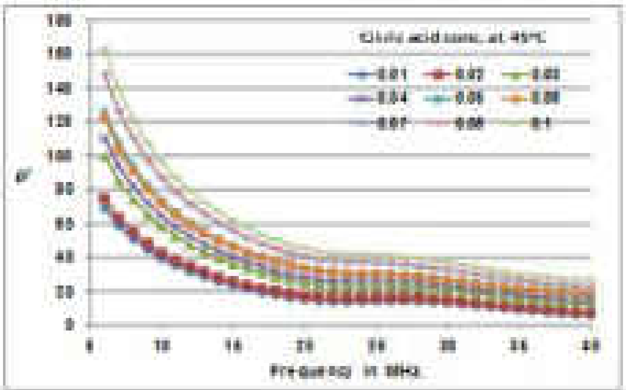
The graphs shows that the real part of Reflection Coefficient (ρ') is higher for lower frequency range. i.e. Reflection Coefficient (ρ') is inversely proportional to frequency. For lower temperature as well as concentration ρ' is low as we goes on increasing the temperature or concentration it increases. Similarly the changes are observed in the imaginary part of Reflection Coefficient (ρ"). Nature of the graph changes as the temperature and concentration changes.

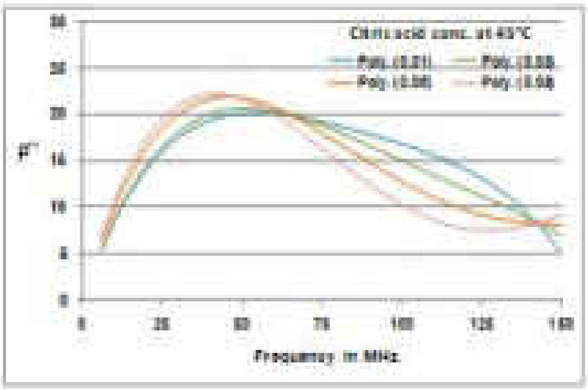


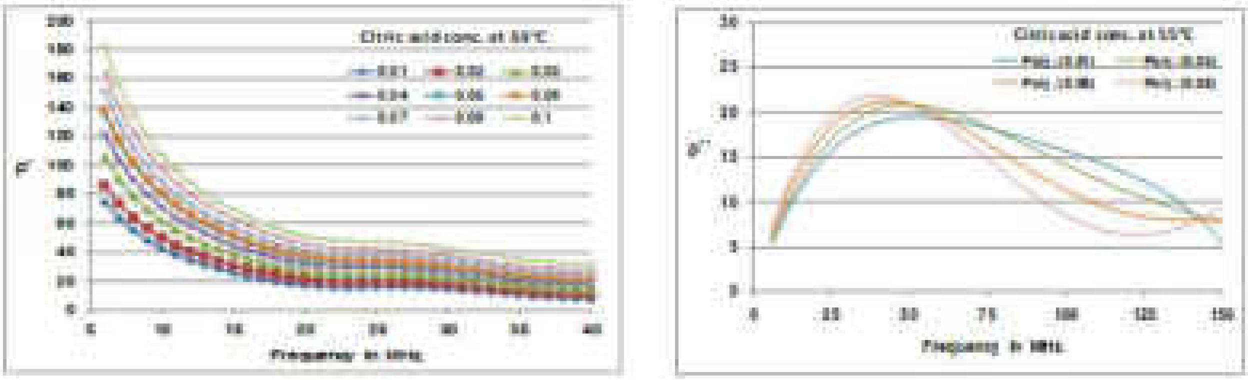












CONCLUSION

After the study of food preservative Citric Acid it was observed that the Reflection Coefficient of Citric Acid changes as the temperature and concentration of aqueous solution changes. This shows that the temperature and excess use of Citric Acid changes the strategy the solution or food stuff.

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