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ANALYSIS OF REFLECTION COEFFICIENT OF FOOD PRESERVATIVE UREA AND POTASSIUM META-BISULPHITE (KMS) USING IMPEDANCE SPECTROSCOPY

Badhe S. G., Prajapati T. A. and Helambe S. N.
R. B. Attal College, Georai, District Beed
P. G. and Research Center, Department of Electronics, Deogiri College, Aurangabad

ABSTRACT
Preservatives play a vital role in food industry. Preservatives stop the microbial action in the food stuffs. Besides this it also changes in molecular properties of the food which affects the quality of the food. These molecular changes can be observed through the Impedance Spectroscopy technique. Reflection coefficient (ρ) of food Preservative Urea and Potassium Meta – Bisulphite (KMS) is studied in the present work. A low frequency Time Domain Reflectometry (TDR) technique is developed and used to study this parameter. Various molar concentration (0.005 – 0.1) with freshly collected distilled water are prepared and studied at four different temperature (25°C, 35°C, 45°C and 55°C). It was observed that Reflection coefficient changes as the concentration and temperature changes. Urea does not show any remarkable changes in Reflection coefficient. In case of Reflection coefficient of KMS it decreases as the concentration as well as temperature increases.

Keywords: Impedance, Reflection coefficient, Urea, Potassium Meta-Bisulphite, TDR Technique

INTRODUCTION
Food preservatives play an important role in our fast and busy life. Various types of preservatives chemical as well as natural preservatives are used. Urea and Potassium Meta- Bisulphite are the chemical preservatives which are used to extend the life of food stuff. The Potassium Meta-Bisulphite preservative is an additive that is commonly used in households for wine-making; the winemaking industry uses Potassium Meta-Bisulphite as an additive during the bottling process [1]. It also used for preserving all kinds of vegetables and fruit. Dry urea salt is used to denature or retard the activity of enzymes of the meat in order to extend the shelf life of meat by preventing spoilage [2].

The TDR technique is widely used technique in impedance spectroscopy. This technique is used for study of electrical impedance, conductivity, permittivity of medium etc. The impedance spectroscopy technique is used for variety of systems i.e. conducting, non- conducting, liquids, solids, powder and in various biological systems, food industry, agricultural products and soils for measurement of various electrical properties. Several researchers have used this to detect various pathogens and bacteria in every kind of substance especially in food [3-6]. Many research projects concentrate on the development of so-called 'electronic noses'. Volatile compounds, produced by microorganisms during their growth, can rapidly be detected using these devices [7]. A sensory evaluation technique such as descriptive analysis is used to detect the quality of milk [8, 9]. TDR technique is useful in medical field. Researcher used this for the detection of blood sugar [10].

TDR technique is superior 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 [11].

A low frequency TDR (Time Domain Reflectometry) unit is developed in the laboratory [12, 13] 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
A low frequency TDR of the Bandwidth 25MHz to 200MHz and 5ns rise time was developed in the laboratory. The experimental setup consists of sampling oscilloscope DS1000, TDR module, a transmission line, and sample cell. The co-axial transmission line with characteristic impedance of 50 ohm was used for study.

Ten solutions of various molar concentrations (0.005 – 0.1) were prepared with freshly collected distilled water. These solutions were kept at four different temperatures (25°C, 35°C, 45°C and 55°C). A water bath was developed to maintain the temperature. The water bath was controlled by computer. Different types of probes (sample cell) were designed and tested for the accurate measurement. The TDR unit is used for measurement after warming up for at least 30 minutes. A fast rising voltage pulse was propagated through a coaxial line. The strip line probe connected at the end of a coaxial transmission line was immersed in the sample placed in the glass test tube. The reflected waveform was observed carefully. The probe was cleaned thoroughly every time with acetone and dried with drier.

The computed values of real and imaginary part of complex reflection coefficient for aqueous solutions of preservatives Urea and Potassium Meta – Bisulphite (KMS) are plotted in the figures. The real part is denoted as ρ' and imaginary part as ρ''. Separate graphs of ρ' and ρ'' are plotted to identify the variation in complex impedance of aqueous solutions of preservatives at different concentrations and at four different temperatures.

RESULTS AND DISCUSSION

From the graphs, it can be concluded that at higher frequencies the real part of impedance of aqueous solution of Potassium Meta – Bisulphite decreases. The variation of ρ' with frequency is different in aqueous solutions of different frequencies. The frequency response of Potassium Meta – Bisulphite solutions is observed at lower frequencies. The imaginary part of complex impedance 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. The aqueous solution of urea doesn't show any desirable changes in real and imaginary part of reflection coefficient.

Fig 1: Real part of ρ for Potassium Meta-Bisulphite Solution*

Fig.2: Imaginary part of ρ for Potassium Meta-Bisulphite Solution.*

Fig.3: Real part of ρ for Urea Solution.*

Fig.4: Imaginary part of ρ for Urea*

CONCLUSION

The designed low frequency TDR unit successfully detected the variations in the Reflection coefficient of Potassium Meta-Bisulphite. The variations in the value of Reflection coefficient were observed according to the change in concentration as well as temperature. This strategy of change in Reflection Coeficcient affects the food quality. TDR unit failed to detect the changes in Urea. Further research is required.

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