USE OF IMPEDANCE SPECTROSCOPY TECHNIQUE FOR THE STUDY OF RESISTIVITY OF FOOD PRESERVATIVE SODIUM BENZOATE

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Abstract

Food preservative plays a very important role in food industry. Sodium Benzoate is one of the most frequently used chemical food preservative. The present work deals with the study of Resistivity (R_L) of Sodium Benzoate. A low frequency Time Domain Reflectometry (TDR) unit was developed and used for the study. In the present work aqueous solution of preservative is prepared with freshly collected distilled water. Eleven different molar solution were kept at four different (25ºC, 35ºC, 45ºC and 55ºC) temperature. Computer controlled water bath unit was used to maintain the temperature. It had been found that Resistivity (R_L) of Sodium Benzoate is inversely proportional to the temperature as well as molar concentration.

Key words: Sodium Benzoate, Preservative, Resistivity, Time Domain Reflectometry (TDR).

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1. Introduction

Sodium Benzoate is a very commonly used preservative with E number E-211. It is white or colorless, crystalline, odorless powder. Its chemical formula is C_6H_5COONa. It is most widely used in acidic foods such as salad dressings, carbonated drinks, jams and fruit juices, pickles, condiments. It is also used as a preservative in medicines and cosmetics [1, 2].

The impedance and conductance of the system are the main parameters for electrochemical signal analysis. Scientific community has chosen Impedance Spectroscopy (IS) to characterize a large number of electrochemical systems [3, 4, 5, 6]. Impedance spectroscopy (IS) is traditionally used in monitoring corrosion [7] and electro-deposition processes in the coating and characterization assessment of many kinds of sensors and semiconductors [8, 9]. Its application in biotechnology for the characterization of cell cultures [10] 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 [11, 12]. Impedance Spectroscopy (IS) is a powerful tool for a fast bio-molecule diagnosis and for analysis in cell cultures [13, 14]. Its uses a small signal and 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 because of the chemical processes occurring in it or the physical structure of the material. Consequently, electrochemical Impedance Spectroscopy (IS) is a nondestructive technique providing robust measurements. [15] Impedance Spectroscopy (IS) have been made in the biological area, such as studies of polarization across cell membrane and of animal and plant tissues [16, 17]. The analysis techniques of IS are not limited to electrical immittance but apply as well to measurements of mechanical [18] and acoustic [19] immittance.

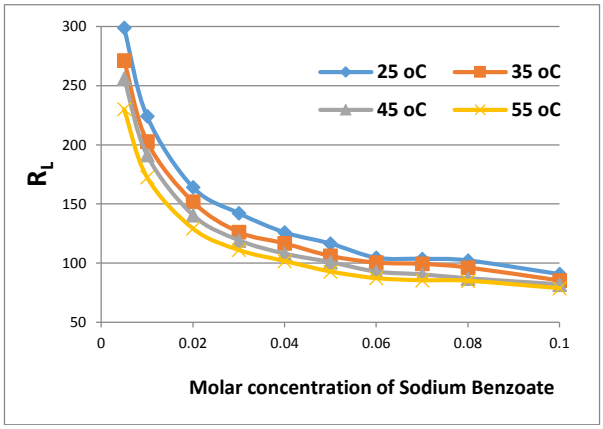
2. Materials and Methods

An instrument for measurement of impedance based on time domain Reflectometry technique was developed in the laboratory and used for the study. A low frequency TDR of the Bandwidth 25MHz to 200MHz. Maximum real time sampling rate is 200MHz to 1GHz and 5ns rise time was developed. 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. Different types of probes (sample cell) were designed and tested for the accurate measurement. Various samples of different molar concentrations with freshly collected distilled water and Sodium benzoate were prepared. These samples were kept at four different temperature. Temperature of the sample was controlled and monitored by computer. Resistivity (R_L) of Sodium Benzoate were calculated with the help of TDR.

3. Results and Discussion

The Resistivity (R_L) values for sodium benzoate exponentially decreases with increase in concentration of sodium benzoate in water. It was observed that the resistivity of the solution decreases nearly 50% from 0.005 molar to 0.02 molar concentration. After 0.02 molar till 0.1 molar solution, very slow fall was observed. The decrease in R_L value is from 300 ohm to 91 ohm at 25ºC. The R_L values decrease uniformly with temperature for all concentrations. i. e. initially sudden fall and then slowly decrease in the rate of R_L values. About 70% decrease in R_L is observed for all temperatures whereas decrease in R_L at lower concentration with temperature is from 23 % to 11%. i.e. at higher concentration change in R_L with temperature is small compared with lower concentration.

Molar Conc.	**Values of R_L**			
	25ºC	**35ºC**	**45ºC**	**55ºC**
0.005	299	271	256	230
0.01	224	203	191	173
0.02	164	152	141	129
0.03	142	126	119	111
0.04	126	117	108	102
0.05	117	106	101	93
0.06	105	101	93	87
0.07	104	99	90	85
0.08	102	96	87	85
0.1	91	85	82	79



Variations of R_L for aqueous solution sodium benzoate

4. Conclusion

The Resistivity (R_L) value for aqueous solution sodium benzoate changes with change in temperature as well as concentration of the solution. The change in values of this electrical parameter with temperature and concentration indicates the change in properties of solution. This helps to decide the food preservation strategy. Thus 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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