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An Electronic tongue for core taste identification based on conductometry

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Abstract

This paper presents a method for identification of basic tastes, i.e. sweet, sour, bitter and salty with the help of electronic tongue. The electronic tongue works on the basis of conductometric technique and having two electrodes. This technique determines the concentration of ions in solutions in terms of current flow as a function of voltage when polarization of ions occurs around the electrode. This measured current is a function of different chemical composition and hence can be used for the identification of different taste, as different taste having different chemical composition. The main objective of the present work is to test samples from four different tastes with the help of electronic tongue and analyzing the output current obtained from different solution in time domain.

Keywords — *Electronic Tongue, Basic Test, Conductometry, Electrode.*

I. INTRODUCTION

Electronic tongue is also called as artificial tongue, taste sensor. Electronic taste instruments have been developed and optimized to answer some of these issues: reduces human sensory test panels, precise measurement of taste, requires small sample volume, decreased measurement time, small size of sensor, reproducibility, easily operated by unskilled personnel. An electronic tongue is a sensor that works on the liquid samples. The responses of the sensor are not specific. The collective response of the tongue sensor varies from solution to solution due to the presence of different compounds and ions. Electronic tongue sensor, in general, makes use of this collective response, and various electrochemical methods have been exploited for such analysis. Potentiometry, Voltammetry, and conductometry are some of the measurement techniques that have been used successfully in electronic tongues for different applications, such as classification of wine, assessment of fat content of milk, quality evaluation of several beverages like tea, beer, and juice, water quality [1], and other food stuffs like tomatoes [2]. This can also be used in pharmaceuticals to identify the taste of medicine [3].

The electro analytical technique called the conductometry, which is one of the oldest and in many ways simplest among the other electro analytical techniques. This technique is based on the measurement of electrolytic conductance. An application of electrical potential across the solution of an electrolyte involves the transfer of mass and charge from one part of the solution to the other. A transport property of great significance, which can be easily measured, is the conductance. Since an electrolytic solution consists of ions and the nature of interaction existing in the medium could be better understood in terms of the conducting power of these ions, it is more convenient to speak of conductance rather than resistance. The conducting ability of electrolytic solutions provides a direct prove of the existence of ions in solutions. The experimental determinations of the conducting properties of electrolytic solutions are very important.

The main objective of the present work is to test samples from four different tastes with the help of electronic tongue and analyzing the output current obtained from different solution in time domain. It can also be used for water quality and food quality assessment. The procedure when running measurements with the electronic tongue set up seen from the user's viewpoint is often straightforward. Take a sample of the requested liquid, put it in contact with the electronic tongue sensor and receive the response. Behind this simplified process are both the operational principles of the electronic tongue and the data acquisition.

II. ELECTRONIC TONGUE SET UP

The sensor consists of two copper electrodes. A potential is applied at one electrode and the resulting current through the sample is measured. When a voltage is applied, an electrochemical redox reaction occurs at the electrodes surface and gives rise to the measured current. All particles in the measured sample that are redox reactive below the applied voltage will contribute to the response. The method used is pulse conductometry which indicates that the input waveform is formed by pulses of some amplitude. By using pulses of different amplitude the sensitivity can be increased and the discrimination

between samples will be improved. Depending on the sample's chemical content, the amount of particles contributing to the current will differ. The functional block diagram of the present system is as follows:

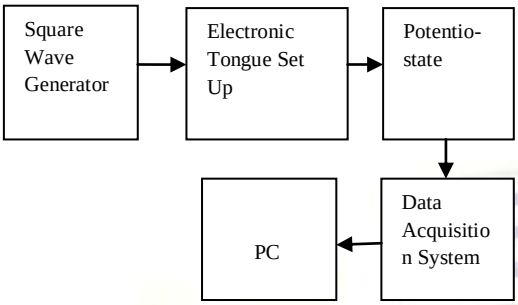

Fig 1 Functional block diagram of the electronic tongue

The 555 timer connected as astable multivibrator can be used to produce a square wave output. The electronic tongue system consists of two electrodes as sensor. Here, two copper plates are used to make an electrochemical cell. This set up is put in contact with the requested liquid. A potentiostate measures the potential difference between the two electrodes. The basic potentiostate consists of two parts, I/E Converter and DC Level Offset [4]. The data acquisition system establishes the communication between the sensor and data processing system. The configuration of the Data Acquisition System was implemented MATLAB environment. The sensor system used for the experiments is a so called electronic tongue. Note, that it is not identical to the functionality of the human tongue [5].

III.SAMPLES DETAIL AND PREPARATION

Four different tasted samples such as Bitter, Salt, Sour and Sweet have been taken for this study. Kitchen salt (NaCl) is used as salty sample. Similarly, lemon juice is used as sour, Sugar is used for sweet taste and bitter juice from some food stuffs is used for bitter taste. For preparing the salty sample, 5gm of salt is dissolved in 20 ml distilled water. Sweet sample is made by dissolving 5 gm of sugar in 20 ml distilled water. Same way sour and bitter samples are prepared by mixing lemon juice and juice of bitter food stuff. Here the input is taken as voltage and output is as current. By giving the same input for each sample, the responses from the sensor are observed.

IV. RESULTS AND DISCUSSION

Experimental data collected from the setup is plotted as the response of the electronic tongue for the different sample as mentioned above. Response of the system for all different samples is quite same. But their amplitudes are different. It is observed that the time domain response of the above mentioned different sample is different, i.e. the maximum and minimum peak values of the different responses are different (Table 1). So with the response of the electronic tongue setup for different sample may possible to distinguish them from each other.

Table 1: Maximum and minimum peak values of different samples

Sr. No.	Taste	Exp. No.	Current	
			Maximum value	Minimum value
1	Salty	1	2.9693	-0.7084
		2	2.8729	-0.7890
2	Sweet	1	0.0846	-5.9314e-04
		2	0.0926	-7.2208e-04
3	Sour	1	2.3405	-0.1398
		2	2.4169	-0.1460
4	Bitter	1	1.2822	-7.3915e-04
		2	1.2164	-7.3851e-04

From table-1, it is observed that the response for the salty sample has the highest peak value, and sweet sample has the lowest.

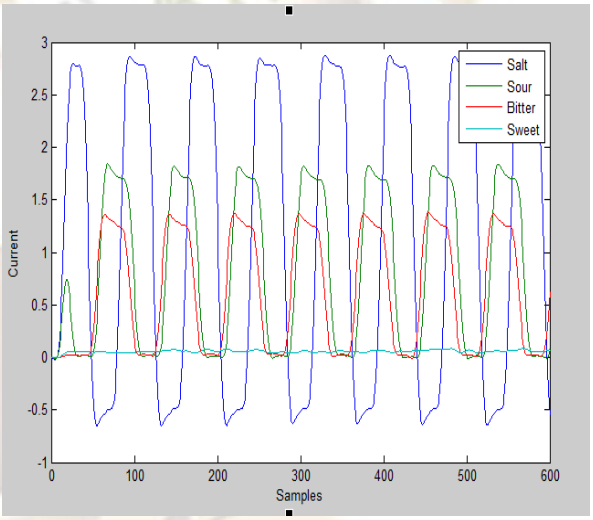

Fig 2 Correlation of responses of different taste samples

V. CONCLUSION

In this paper, an electronic tongue system based on conductometry for taste evaluation has been presented the best results has been obtained by taking the value of each response by set-up for different samples. This can be concluded that different samples have different current carrying capacities. This is because of current carrying ions present in the solution to be tested. The salty sample is found with a highest current and sweet sample with lowest current through the liquid during the experiments. Hence, this electronic

tongue approach is helpful in test identification of core tastes.

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