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Simulation of E-Tongue using Coventorware 2010 tool for Differentwater Samples

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Abstract: **A study for identification of three water samples, i.e. SEAWATER, DI WATER, and WATER is done using coventorware 2010. The Design works on the basics of voltammetry technique and having two electrodes and a conductive liquid channel connects them. In this context the resistivity and resistance of these electrolytes has been obtained through the simulation. The difference between resistivity is evident from the result as calculated in the tool. The result shows that SEA WATER resistivity is less because it contains more ions as compared to other samples hence the conductivity for sea water is maximum. The effect of gap between two electrodes and electrode length on current density has also been studied different values of gap are 2.5µm, 5µm, 7.5µm.**

1. E-TONGUE

A tool that has recently become available is the "electronic tongue"is an electronic instrument that can mimic the human tongue that is great in demand in the various field. The electronic tongue can be considered as a promising device in quantitative and qualitative analysis of multispecies solutions. Electronic Tongue is an instrument which comprises of electrochemical cell, sensor array and pattern recognition system, capable of recognizing simples. The advantages of this approach include its speed, relatively low cost, and lack of risk [1].

2. WORKING PRINCIPLE

Electro analytical techniques are concerned with the interplay between electricity & chemistry, namely the measurement of electrical quantities such as current, potential or charge and their relationship to chemical parameters such as concentration, current density, current etc. The use of electrical measurements for analytical purposes has found large range of applications including environmental monitoring, industrial quality control & biomedical analysis[4]. 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].

In voltammetrytechniques, the electrode potential is used to drive an electron transfer reaction, and the resulting current is measured. The size of the electrode potential determines whether the target molecules loss or gain electrons. Voltammetric methods can thus measure any chemical species that is electro active (that is, capable of electron transfer). Voltametric methods provide high sensitivity, a wide linear range, and simple instrumentation.The use of voltammetry in electronic tongues has many advantages; the technique is commonly used in analytical chemistry because of features such as very high sensitivity, versatility, simplicity, and robustness [5].

3. DEVICE DIMENSIONS

Various Dimensions of the device and its individual parts are described in the table 1.

Table 1. Device specifications

Name	Dimension		Units
Electrode	Length	45	µm
	Width	6	
	Height	2	
Channel	Length	17	µm
	Width	4	
	Height	2	

4. MATERIALS USED

Glass is used as substrate and cap material for the device. Electrodes are made of gold materials because they are inert and offer a relatively large anodic potential ranges and very favourable electron transfer kinetics. The channel is fixed and provides the conductive path between the two electrodes.

Table 2. Material properties

Property Name	Sea water	Water	Gold	DI water
Density (kg/µm3)	1.02e-15	9.98e-16	1.93e-14	1.0e-15
Electrical Conductivity (pS/µm)	4.8e+6	2.0e+2	4.4e+13	5.5

5. DESIGN

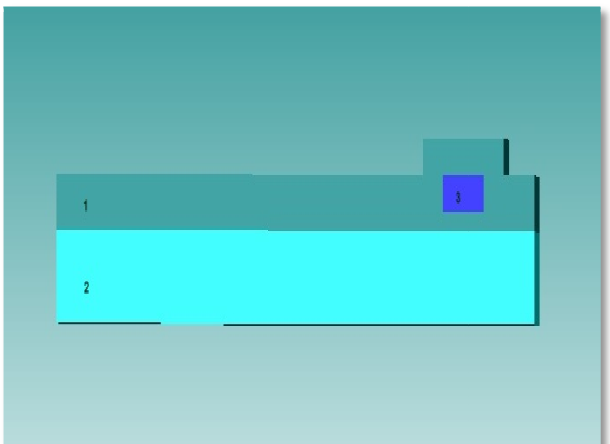

Figure1. Structure of Device

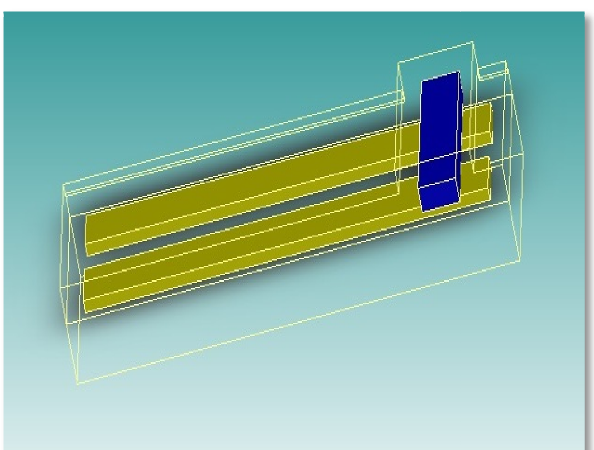

Figure 2. 3-D view of Device

Figure 1.Shown below is the sensor part. The design consist of basically four main part the substrate and cap which is made of glass and the gold electrodes and the micro channel. In first figure this side view number 1,2 are substrate and cap respectively made of glass material and number 3 is channel input and output is at other side. When we hide the cap we can see the electrode made of gold material is in shown figure 2.

6. SIMULATION RESULTS

In this paper the simulation of three different samples of water (pure water, sea water, and water) are taken and same voltage is applied across electrode and the electrolyte resistance is measured. The resistance calculated is used to calculate the resistivity of the electrolyte. When the voltage is fixed at the electrode and the different electrolyte are taken in channel one by one the tools measure the various changes in that occurs because of that electrolyte and plot it in analyser. The various results are shown for understanding those changes. The changes in current density is measured and for electrode spacing the current density is measured and it is understood the more conductive is solution the less is the resistivity according to this the sea water is more conductive as compared to water and pure water so the resistivity should come out would be less. Similarly pure water or DI water are less conductive so there resistivity will be higher than other samples. The various results with plot are shown and through the resistance value shown the resistivity of the electrolyte are calculated.

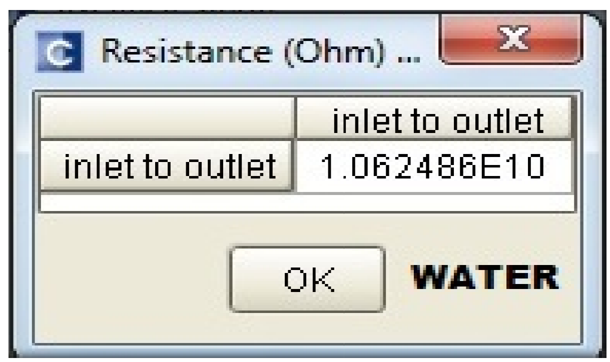

Figure 3. Resistance of tap water

Figure 4. Resistance of tap water

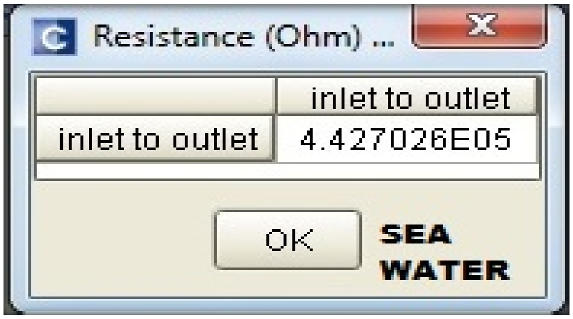

Figure 5. Resistance of Sea water

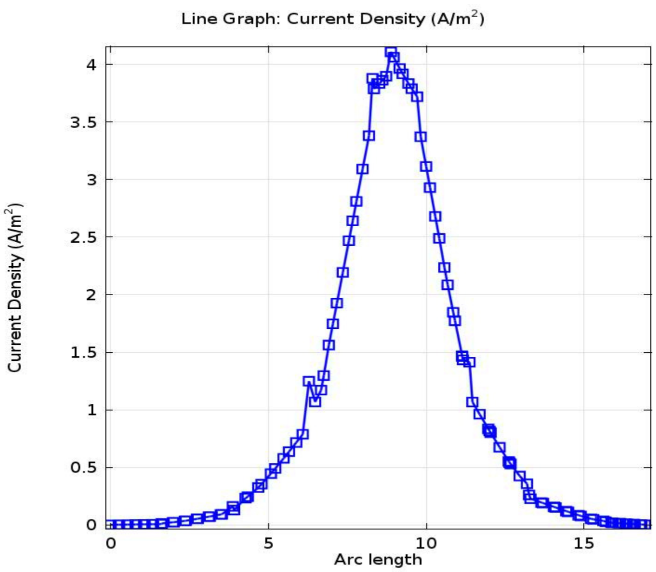

Figure 6. Plot Between Current Density and arc length with gap 2.5µm in electrodes for SEA water

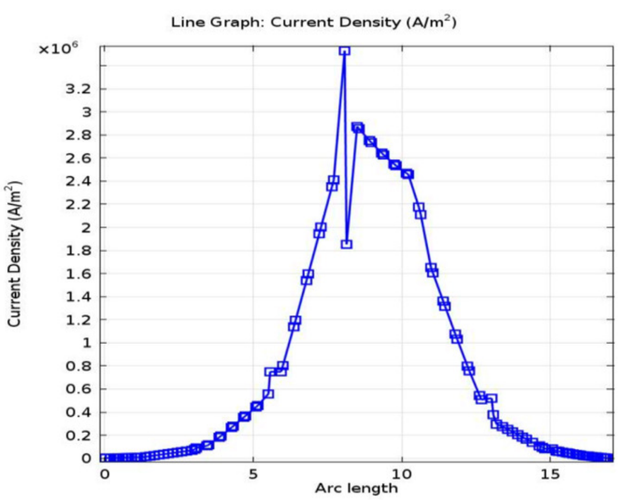

Figure 7. Plot Between Current Density and arc length with gap 5µm in electrodes for SEA water

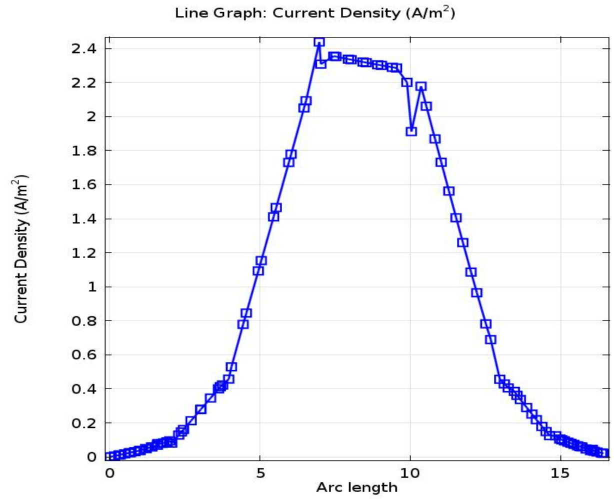

Figure 8. Plot Between Current Density and arc length with gap 7.5µm in electrodes for SEA water.

Table 3. Results summary

SAMPLE	RESISTANCE OF SAMPLE (Ω)	RESISTIVITY OF SAMPLE (MΩ/cm)
SEA WATER	4.42e5	2e-5
NORMALWATER	1.06e10	0.49
DI WATER	3.86e11	18.16

7. CONCLUSION

The study of three electrolytes has been done i.e. SEAWATER, DI WATER, and WATER. In this context the resistivity of these electrolytes has been studied. The difference between resistivity is evident from the Resistance as calculated in the experiment. The resistance of SEAWATER, WATER DI, and WATER are 4.42e51Ω, 3.86e11Ω, 1.06e10Ω and the resistivity are 2e-5 M Ω /cm, 18.16 M Ω /cm, 0.49 M Ω /cm respectively. From these results it has been determined that the resistance of sea water is least hence it is more conductive then other samples. The effect of gap between two electrodes and electrode length on current density has also been studied different values of gap are 2.5µm, 5µm, 7.5µm. The result shows that current density decreases with increase in the electrode gap. There is negligible change for electrode lengths 45µm, 35µm, 25µm, 15µm.

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