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CONVERSION COEFFICIENT FOR SALINITY MEASUREMENT IN FRESH WATER IN TERMS OF ELECTRICAL CONDUCTIVITY

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Abstract

Because of the lack of precision devices for measuring freshwater salinity directly, which mostly depended on Total Dissolved Suspended (TDS) measurements, this research was designed to develop the special equation for the conversion of electrical conductivity measurement to salinity. The sea water was artificially prepared based on available scientific sources. Their electrical conductivity was measured, after that the equation for the conversion process was developed, depending on regression analysis.
Keywords: Electrical Conductivity; Fresh Water; Salinity.

Introduction

Sea water is the water found in the seas and oceans of the world. Its salinity is about 3.5% (35 g / L). One liter of water contains 35 grams of dissolved salts (mostly Na^+ and Cl^-) and the sea water density is about 1.025 g/ml at 4°C, which is higher than the fresh water density (Chester, 2012), because the soluble salts increase the mass of water without significant change in volume, and the freezing point of sea water decreases with the increase of soluble salts, the typical saline sea ice freezing at -2°C. Millero *et al.* (2008) stated that the pH of seawater is generally limited to between 7.5 and 8.4.

Sodium, chloride, magnesium, sulfate and calcium ions are highly precipitated ions (Gale, 2006). The ratios of ions vary from one to another depending on the time period of the presence of these ions in water. Sodium chloride salts existed long before calcium. In addition, the dissolved solids in sea water are much larger than those dissolved in fresh water, including ions (Gale, 2006). For example, the proportion of dissolved bicarbonates in the sea is about 2.8 and the other ions represent 0.14%. However, bicarbonate dissolved in water rivers accounts for 48% of dissolved ions.

It is known to the researchers that salinity measurement devices were developed exclusively for the measurement of salinity of the seas and oceans, and there were no devices to measure the salinity of the freshwater rivers because of the low concentration of salinity in it and the most of the conversion factor based on measuring TDS (Nayar *et al.,*2016). Most of the devices which can measure the salinity of water lies in two ways, first direct measurement by salinometer, second indirect by refractometer.

The aim of this study is to find the conversion equation for measuring the salinity of the freshwater using the electrical conductivity (EC).

Materials and Methods

The artificial seawater was prepared in the laboratory by Kester *et al.* (1967) method, which is a mixture of dissolved mineral salts. This artificial seawater consists of two mineral salts, the first of anhydrous salts and the second of hydrous salts that represented the artificial seawater solution, as follows:

Dissolved 41.953 grams of synthetic seawater salts with enough deionized distill water to yield one liter synthetic seawater solution, which was equivalent to 35‰ of seawater. After that pH of the solution must be adjusted to 8.2 using 0.1 N solution of NaOH or HCl. Table (1) shows these values.

Table 1 : Chemical composition of seawater

Chemical composition	Percentage % / weight gm
NaCl	58.49 / 24.510
$MgCl_2$	26.46 / 11.100
Na_2SO_4	9.750 / 4.0904
$CaCl_2$	2.760 / 1.1579
KCl	1.640 / 0.6901
$NaHCO_3$	0.470 / 0.1971
KBr	0.240 / 0.0998
H_3PO_3	0.071 / 0.0297
$SrCl_2.6H_2O$	0.095 / 0.0398
NaF	0.007 / 0.0629

- Measurements the electrical conductivity of this solution, with Hana Instrument Company Device.
- Prepared a series of dilutions from a laboratory artificial seawater with deionized distill water from the stock (35‰), which as follows: 25, 20, 15, 10, 5, 4, 3, 2 and 1‰, using a formula $V_1*N_1=V_2*N_2$ with measuring the electrical conductivity for each concentration.

Results and Discussion

The values which listed in Table (1) for artificial seawater, are based on the formula of Kester *et al.* (1967), is considered the closest formula when compared to the values of natural sea water components. While, many formulas were developed to prepare seawater beforehand (Lyman and Fleming, 1940; Harvey, 1960; Culkin, 1965). These formulas were not comprehensive for the type of chemical compounds involved in seawater components, but in the form of ions. While Kester *et al.* (1967) gave all the chemical formulas involved in artificial seawater, which conducted several measurements of different temperatures for electrical conductivity, which achieved no significant differences between natural and artificial seawater except in rare cases because of the sudden rise in temperature between artificial water and natural seawater, which he neglected.

The artificial saline solution should be aerated,while the value of pH must be unchanged and not exceed 0.02 units for at least two hours, when the artificial seawater prepared (Lyman and Fleming,1940), this tended to equilibrium the gases with the atmosphere.

While Mostafa *et al.* (2010) stated that the artificially prepared saline solution must have a constant pH value and the percentage of change does not exceed 0.02 for a period of four months. Therefore, the present study was based on what was previously mentioned by the researchers. The artificial seawater solution was prepared in the laboratory with the temperature between 23±1°C and the unchanged in the pH value of the solution throughout the measurement process. Bearing in mind that the solution is not contaminated with different microorganisms, in addition, the value of the evaporation coefficient of the solutions must be constant, when conducting laboratory measurements (Millero *et al.,* 2008).

Laboratory measurements were repeated three times in a sequence, with constant laboratory conditions from temperature and pH, considering the preservation of the solution from pollution or shortage due to evaporation

The recorded values of the electrical conductivity were taken from the three laboratory experiments and placed on the table (2). It was observed by measuring the electrical conductivity of the artificial seawater solution after making a standardization process for the device the following results.

Table 2 : Artificial seawater concentrations ‰ of seawater with electrical conductivity measurements ± Sd.

Artificial seawater concentrations ‰	Electrical conductivity µS/cm
35	55632.58±2.09
25	39741.78±3.00
20	31796.38±1.99
15	23850.98±2.87
10	15905.58±0.08
5	7960.18±0.99
4	6371.10±0.45
3	4782.02±0.78
2	3192.94±0.98
1	1603.86±0.66

From Table 2, the statistical analysis of salinity values versus the conductivity values was performed using the correlation coefficient. Where the statistical analysis showed the positive correlation strength between salinity and conductivity values as it reached r=0.999, which indicates that the process of preparation of artificial sea water was within the measurements adopted in preparation (Kester *et al.* 1967), as well as the accuracy of the device used in the measurement process. This relationship has been developed in Figure (1). From this relationship, the equation for the conversion process was derived

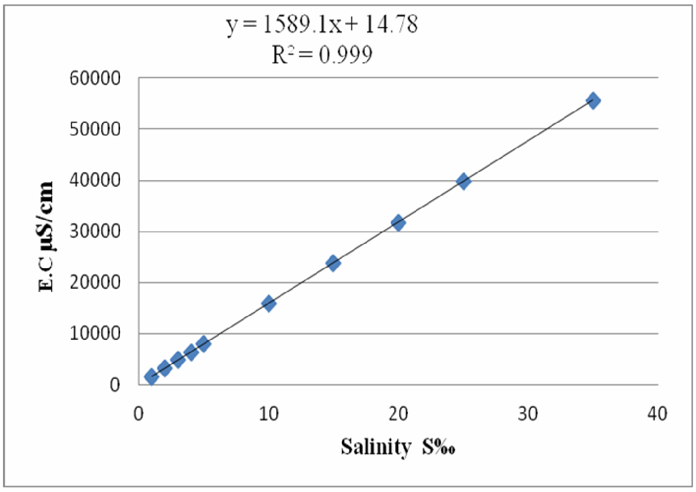

Fig. 1 : Regression analysis of the values of EC and Salinity concentration

From this the formula that is reliable to convert the values of electrical conductivity to salinity of fresh water is:

$$y\% = \frac{(\mathrm{X})\mathrm{conductivity} - 14.78}{1589.1}$$

Whereas: X = conductivity (µS/cm)

Y = Salinity (‰)

References

Chester, Jickells, Roy, Tim (2012). Marine Geochemistry. Blackwell Publishing.

Culkin, F. (1965). The major constituent of seawater. J.P. Riley and G.:121-161.

Gale, Thomson."Ocean Chemical Processes". Retrieved 2 December (2006).

Harvey, H.W. (1960). The chemistry and fertility of seawater. University Press. Cambridge, 240p.

Kester, D.R.; Duedall, I.W.; Connors, D.N. and Pytkowicz, R.M. (1967). Preparation of Artificial Seawater. *Limnology & Oceanography* **12**: 176—179.

Lyman, J. and Fleming, R.H. (1940). Composition of seawater. J. Marine Res., 3: 134-146.

Millero, F.J.; Feistel, R.; Wright, D.G.; McDougall, T.J. (2008). "The composition of Standard Seawater and the definition of the Reference-Composition Salinity Scale". Deep Sea Research Part I: Oceanographic Research Papers. **55**(1): 50–72.

Mostafa, H.S.; John, H.L.; Syed, M.Z. (2010). Thermophysical properties of seawater: a review of existing correlations and data. Desalination and Water Treatment. 16: 354–380.

Nayar, K.G.; Sharqawy, M.H.; Banchik, L.D.; Lienhard, V. and John, H. (2016). "Thermo-physical properties of seawater: A review and new correlations that include pressure dependence". Desalination. **390**: 1–24.