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Quantifying the Euphrates Electric Conductivity Depending on Parameters by Dimensional Analysis Method

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Abstract

The searching about methods to connect the variables with each other to reach equations including multi variables. The dimensional analysis is a method to facilitate the solution of difficult mathematic equations and experimental formulas; therefore methods of simplifying the difficult equations and obtaining a new equation with different variables is needed. In this study will use 2 methods (statically with dimensionally analysis) to obtain electric conductivity of water of Euphrates river by multi parameters that are time (t), temperature (Te), density, viscosity, discharge and water depth in upstream of Alhindya barrage which located in Babylon governorate, Iraq during winter 2019. The equations were obtained for EC with Te and t by data were collected from Alhindya barrage office with $R^2 = 0.999$ and $R^2 = 0.995$ by statically ways. Dimension analysis was utilized via 2 stages. In first stage was obtained on equation of EC with respect to Te, water density (ρ) and dynamic viscosity (μ) with constant time, depth of water and discharge and we obtain on R^2 was 0.994 and $R^2 = 0.986$. In second stage was obtained formula of EC with respect to Te, water density (ρ), dynamic viscosity (μ), with variable time, depth of water and discharge with we obtain on $R^2 = 0.945$ and $R^2 = 0.94$. The result of research indicates that applying the dimension analysis to connect more than one variable with each other to find best solutions and best methods to facilitate the solving the equations. From dimension analysis gave a clear visualization of the association of several variables to give a result that helps measure the electrical conductivity of water in the absence of a water test device.

Keywords

Electric Conductivity, Temperature, Dimension Analysis, Statistical Analysis

1. Introduction

The using of dimensional analysis and statically methods is the best way to solve and simplify equations as well as connect the variables with each other. These methods which help on simplification equation and connection among parameters are dimensions analyses. The idea of using dimension analysis is to simplify the physical laws that not depend on arbitrarily by selecting basic units of measuring [1] and sumulating more than many phenomena in nature [2]. [3] states that in Dimensional analysis theory is explained by a similarity law for the phenomenon below consideration. In dimension analysis the variables turn to dimension simple which are Mass, Length, Time and Temperature (M LT θ). [4] used the Statistical analysis of water quality elements in Harike Lake on the confluence of Beas and Sutlej rivers which sites in Punjab town of India. They claim that utilization the water quality indices to test the water for reducing some pollutants and become suitable to drink use and industrial use. [5] worked on changing of the parameters that are, total nitrogen, total phosphorus, and chemical oxygen demand concentrations with temperature. They point out that, If temperature reduces, the concentrations of parameters reduces too. [6] searched about using a dimensional analysis of wide rectangular river section when the wind velocity negligible by using the Froude number, slope of river, Reynolds number (R), other number, relative of roughness and the re-aeration in streams, rivers and canals. When the temperature was constant, the dimensionless reaeration rate indicates no dimensional but function of the water force (F), channel slope, R, and relative roughness dimensionless. [7] studied the mathematical and experimental complication equations of fluid dynamics led to two alternatives: either the subject is mostly avoided or used as an exact mathematical discipline. In result they noticed that dimension analysis is a powerful device in physics; introducing fluid dynamics through the dimension analysis to deal with laminar and turbulent flow. [8] points out that dimensional analysis is a procedure that can be used to connect the functional relationship and can be expressed in terms of non-dimensional parameters. Moreover, dimension analysis can be defined as simplifying a physical problem by converting to dimensional homogeneity to decrease the number of relevant variables. It was particularly important for presenting experimental data; tackling not amenable problems to a direct theoretical solution; checking equations; establishing the relative importance of particular physical phenomena; physical modeling [9]. In this paper, dimensional analysis will be used to connect electric conductivity with multi parameters (river discharge, river depth, water viscosity, water density, water temperature and time) in upstream of Euphrates river of Alhindyia barrage.

2. Experimental Works

2.1. Location of Study

The study was carried out on Euphrates river at laboratory of Alhindya barrage project. The laboratory of Alhindya barrage office is located in left side of Euphrates river at Sadat Alhindiya township which belongs to Musib town of Babylon province. The place study was located within the line of Latitude 44˚43'42"N and line of longitude 44˚16'8"E. Figure 1 shows the Google map of location of study and Figure 2 illustrates site of study in Iraq map.

Alhindya barrage office that belongs to the state commission of dams and reservoirs belongs to Ministry of Water Resource of Iraq. The test was done by researcher, engineers and officer of Alhindya barrage project to check the results of testing water.

2.2. The Device Was Utilized by Laboratory Project as Following

- Test temperature via mercury thermometer made by Hanna company.
- Test of acidity and alkalinity via portable digital PH meter made via Hanna company.
- Test EC and salinity via portable digital conductivity meter type CG857 made by Schott Gerate expressed on data via micro siemenis per cm.

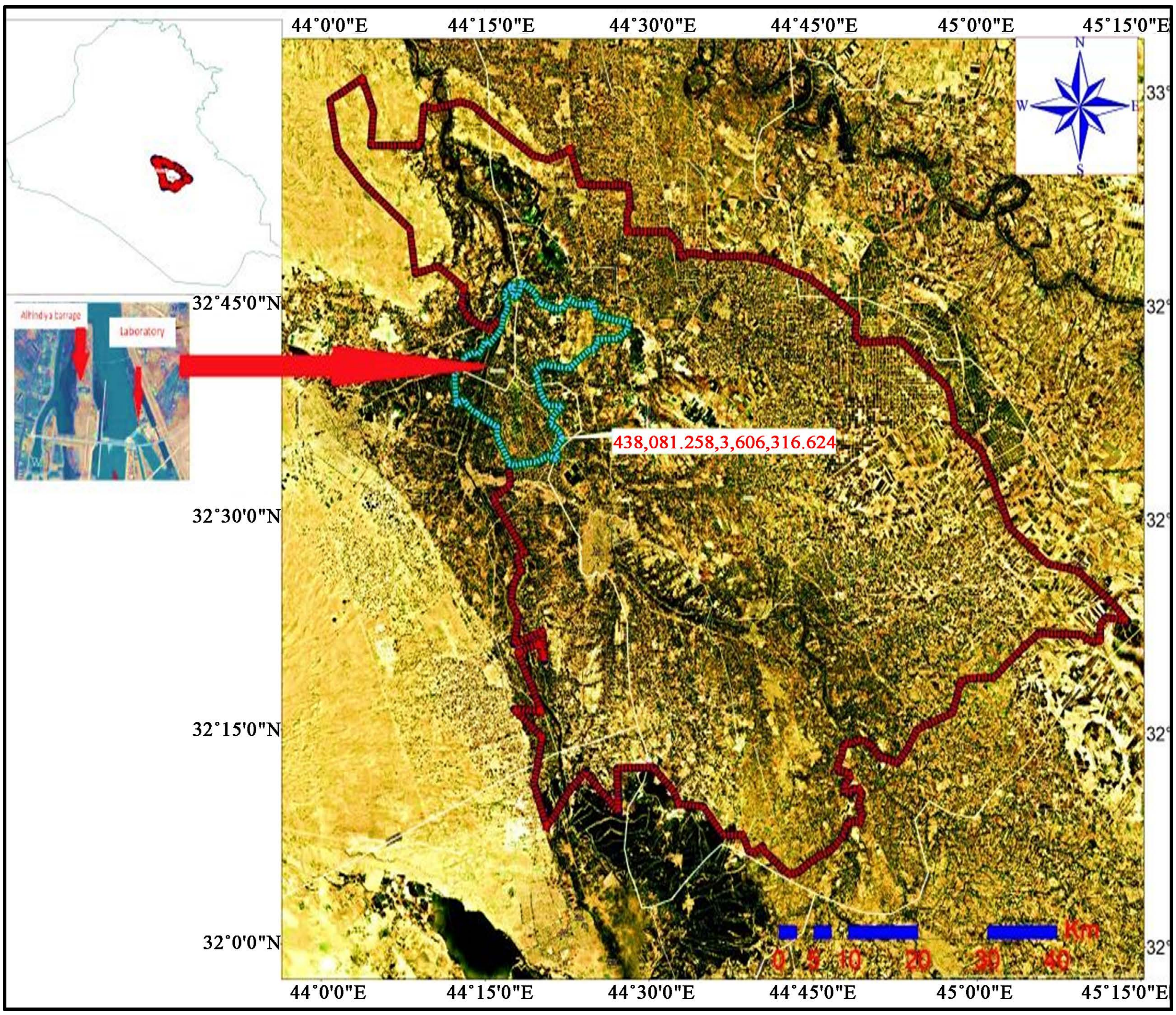

Figure 1. The map study by GIS 10.8.

- Utilizing new device in present years named YSI incorporated 650 MDS to test the PH, turbidity, TDS, EC and temperature shows in Figure 3. This device has a monitor with keys board to show the concluding test on monitor after putting the water sample in device.

2.3. Equation and Work Study

2.3.1. Discharge Computation

The discharge is quantity of water transferred through sections of the stream and measured by m^3/s. In general measuring the discharge of water is obtained by multiplying section area with average velocity of this section. In traditional methods, the discharge measurement is done by Acoustic Doppler Current Profiler device (ADCP) shown in Figure 4.

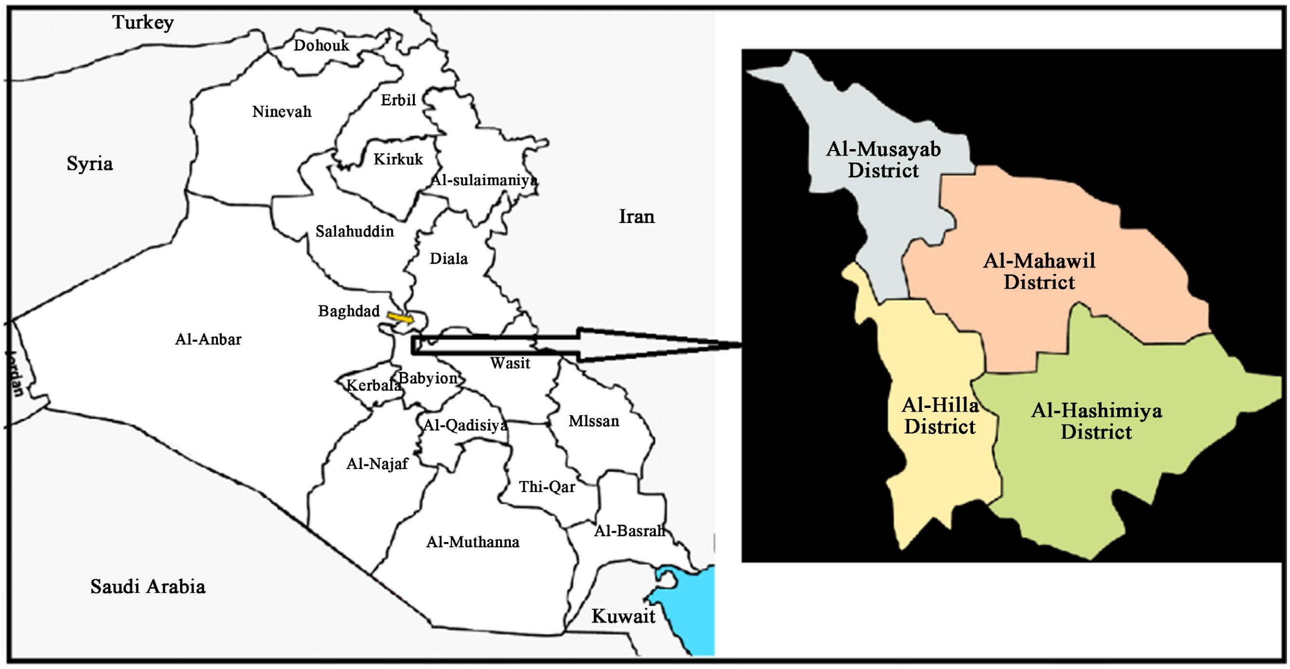

Figure 2. Site of study in Iraq map.

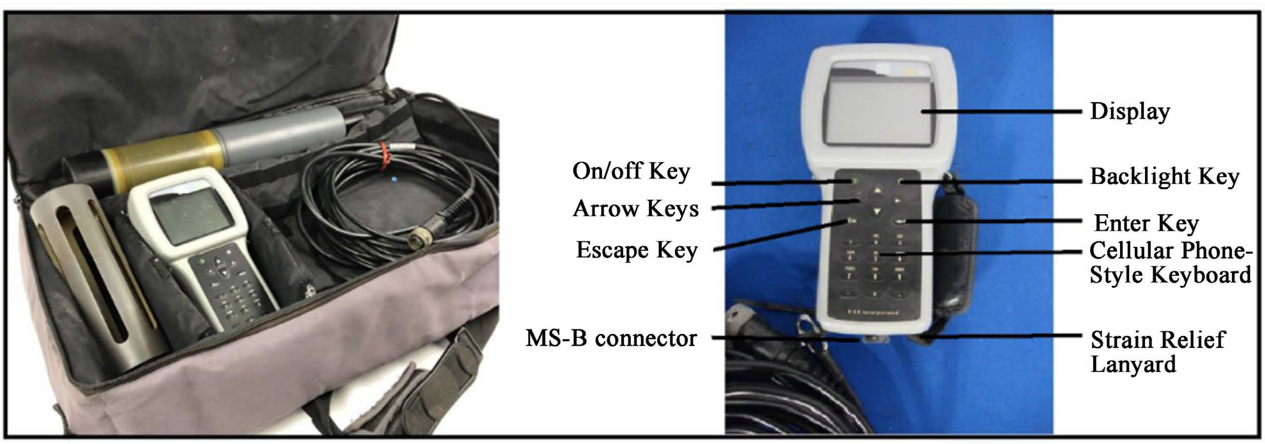

Figure 3. The device YSI incorporating 650 MDS that tested EC, TDS and Te.

Figure 4. Calculation discharge by ADCP device.

Figure 5. The stuff gauge and Radar Level Recorder (RLR) were installed of Alhindiya barrage.

2.3.2. Measuring of Water Depth

To measure the depth of water manually is done by stuff gauges which are installed in upstream Alhindiya barrage and downstream of Alhindiya barrage, Shat Al-Hilla and other branches that take water from upstream of Alhindiya barrage (Beni-Hassan, Husinia, Musib and Kifil project). The staff gauge installed via project office for ensuring corresponding the reading. In modern ways use Radar Level Recorder called SUTRON device that is new instrument that records water level and send data via satellite to National Water Center. These devices were set up in U/S and D/S of Alhindiya barrage on Euphrates and downstream of branch canals which take water from Alhindiya barrage as shown in Figure 5.

3. Computation Formulas

The equations which will calculate formula of electric conductivity (EC) depending on multi parameter (Temperature, time, density, viscosity, depth of water and discharge) were computed by two methods as following. Two methods can be used by statically way and dimensions analysis way as following.

3.1. Statically Analysis

Table 1 is shown the relation among a time measuring by hour through day was (3/2/201) and depth of water was 7 m with temperature (Te), total dissolved solid, EC and PH. It represents relation of parameters through 1 day to know changing of parameters during the day.

The relation between variation of electric conductivity of water with changing of temperature shows in Figure 6.

The relation between variation of electric conductivity of water with changing of time in hour during one specific day which is 3/2/2019 as example and the relation shows in Figure 7.

From figures and table we obtain on the following equations

$$EC = 370.7Te^{0.36} \tag{1}$$

$$EC = 901.56t^{0.079} \tag{2}$$

Table 1. The relation between time (hour) through specific day (3/2/2019) and depth of water 7 m with Te, total dissolved solid, EC and PH.

Time (hour)	Te (˚C)	TDS (ppm)	EC (Ms/cm)	PH
1	11.71	788	905	7.66
2	13.35	793	948	7.67
3	14.55	795	980	7.66
4	15.58	795	1003	7.65
5	16.67	795	1028	7.64
6	17.13	795	1039	7.63

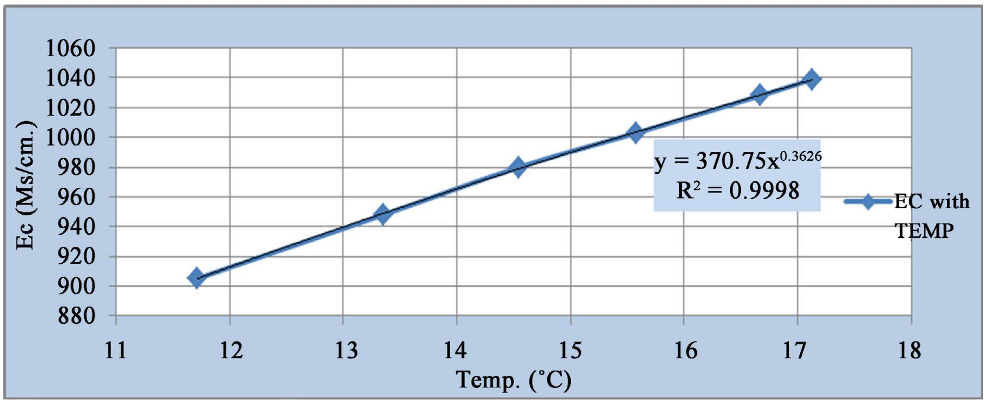

Figure 6. The relation between temperature and EC.

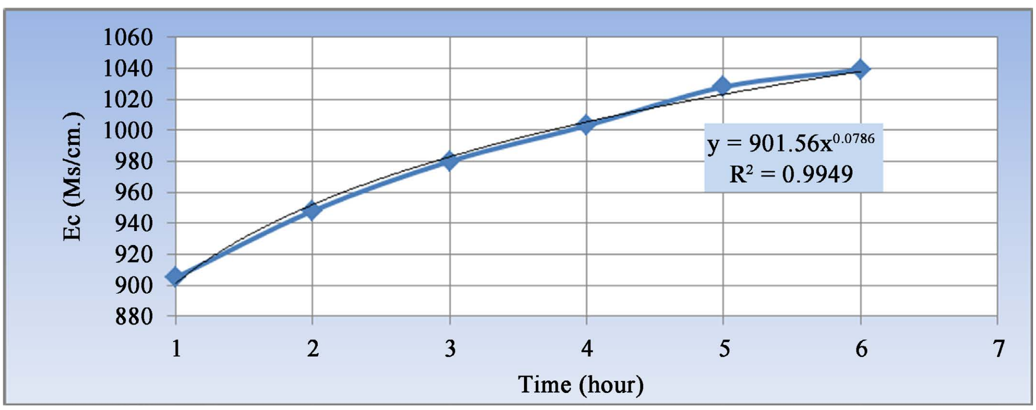

Figure 7. The relation between time and EC.

$$\text{EC} = C * 334208.3 * Te^{0.363} * t^{0.079} \tag{3}$$

$C = \text{EC}/334208.3 * Te^{0.363} * t^{0.079}$ from applying the data of time and temperature obtained $C = 0.001$

$$\text{EC} = 340.53 * Te^{0.363} * t^{0.079} \tag{4}$$

With $R^2 = 0.9998$ of EC with temperature and $R^2 = 0.9949$ of EC with time as show in Figure 2 and Figure 3. The predicting of the equations resulted from curves and work was compared the values of EC from Equation (4) with true value of EC. The value of correlation coefficient (r) and Willmott's index of agreement (d), as follow:

Equation (4) is statically equation represent changing of electric conductivity with varying of temperature and time.

3.2. Willmott's Index of Agreement

The Willmott's index of agreement Willmott *et al.* [10] was ranged between 0 and 1, in which 0 indicated no agreement between observed and predicted values and 1 indicated perfect agreement.

$$d = 1 - \frac{\sum_{i=1}^{n} \left(p_i - o_i\right)^2}{\sum_{i=1}^{n} \left[\left(p_i - o_{avg}\right) + \left(o_i - o_{avg}\right)\right]^2} \tag{5}$$

where:

p_i = EC from equation (4) (Ms/cm),

o_i = EC from test (Ms/cm), and

o_{avg} = Mean value of the EC from test (Ms/cm).

$$r = \frac{n\sum_{i=1}^{n} xy - \left(\sum x * \sum y\right)}{\sqrt{\left(n\sum x^2 - \left(\sum x\right)^2\right)\left(n\sum y^2 - \left(\sum y\right)^2\right)}} \tag{6}$$

x = EC from Equation (4) (Ms/cm),

y = EC from test (Ms/cm), and

n = number of tests found that $r = 0.9997$and $d = 0.892$.

3.3. The Dimension Analysis

Using dimension analysis to solve more equations in paper will be applied to connect the electric conductivity with multi parameter as shown:

Table 2 shows the relation of weight density (weight of water dividing on volume of water) was symbolized ρ (kg/m^3) of water (kg/m^3) with changing of temperature depending on Engineering Tool Box (2003) [11].

Figure 8 the relationship of density (kg/m^3) with temperature (˚C) from Table 2 which was mentioned above.

Table 3 shows the relation of dynamic viscosity (mega Pascal as pressure unit multiply with second as time unit) that was symbolized μ (Mpa·s) with changing of temperature depending on the International Association for the properties of water and steam (IAPWS R12-08), 2008 [12]. The Pascal unit is kilo Newton on

Table 2. Change of density with temperature.

Te (˚C)	ρ (kg/m³)	Te (˚C)	ρ (kg/m³)
0	999.84	30	995.65
4	999.975	37	993.3316
10	999.70	40	992.2
15	999.10	50	988.04
20	998.21	60	983.2
22	997.77	80	971.8
25	997.05	100	958.37

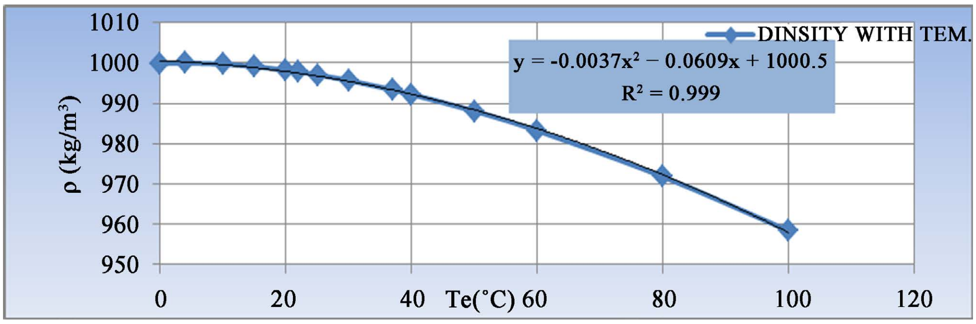

Figure 8. The relationship of density with temperature.

Table 3. The relationship of viscosity (μ) with temperature.

T (˚C)	μ (Mpa·s)	T (˚C)	μ (Mpa·s)
2	1.6735	17	1.0798
3	1.619	18	1.0526
4	1.5673	19	1.0266
5	1.5182	20	1.0016
6	1.4715	21	0.9775
7	1.4271	22	0.9544
8	1.3847	23	0.9321
9	1.3444	24	0.9107
10	1.3059	25	0.89
11	1.2692	26	0.8701
12	1.234	27	0.8509
13	1.2005	28	0.8324
14	1.1683	29	0.8145
15	1.1375	30	0.7805
16	1.1081	17	1.0798

square meter. Calculation the salinity and dissolved solids wit electric conductivity at site was constant as equation by laboratory test TDS (total dissolved solids) = EC ds/m * 1000 * 0.67 not effect on EC.

Figure 9 the relationship of dynamic viscosity (Mpa·s) with temperature (˚C) from Table 3 which was mentioned above.

3.3.1. First Method

Calculating the electric conductivity by using constant time, constant discharge and constant depth.

The methodology of using the dimension analysis by to methods (constant time, depth and discharge) in sadat Alhindiya barrage with monitoring and gaging the discharge and depth of water also monitoring time with testing electric conductivity continually through study. The density and viscosity was calculated depending on temperature of water. From Bukingham method the choosing the electric conductivity as variable depending on multi independent variable as flowing methods depending on Observations have the following characteristics:

Qualitative (standardized operation such as length (*L*), force (*F*), and time (*T*).

This characteristic is the dimension Quantitative involves both a number and standard of comparison or units.

Basic Quantities are the quantities to which all other quantities of a phenomenon can be reduced as shown Table 4.

The methodology of work by three steps as shown in Table 4.

Table 4 THREE STEPS IN DIMENSIONAL ANALYSIS

Step 1

Measure the discharge and depth of water, test the, EC, Temperature of water,

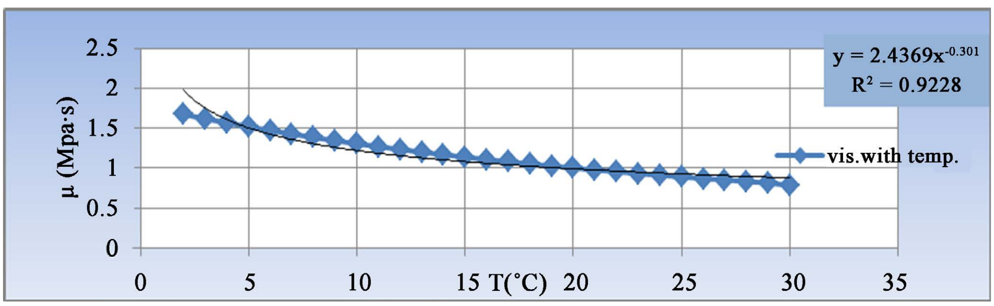

Figure 9. Relationship between temperature (Te) and viscosity.

Table 4. Basic Quantities are the quantities to which all other quantities of a phenomenon.

Observations		
Qualitative		Quantitative
L		Numbers
M	Dimensions	
T		Units
Temperature		

density and viscosity also calculate time.

General relationship

List all pertinent

Independent primary quantities

Write in general form:

$$\alpha = a1^{c1} a2^{c2} a3^{c3} \quad \ldots$$

$$\mathrm{EC} = f\left(t, Te, Q, d, \rho, \mu\right)$$

$$\mathrm{EC} = C\alpha t^{c1} Te^{c2} Q^{c3} d^{c4} \rho^{c5} \mu^{c6}$$

Step 2: Dimensional Analysis, Write dimensional equation

$$\left(ML^{-3}\right) = C\alpha T^{c1} \theta^{c2} \left(L^{3}T^{-1}\right)^{c3} L^{c4} \left(ML^{-3}\right)^{c5} \left(ML^{-1}T^{-1}\right)$$

B. Write auxiliary equations (by axiom 1 equate exponents of dimensions)

$$M: 1 = c5 + c6, \quad c6 = 1 - c5$$

$$L: 3 = 3c3 + c4 - 3c5 - c6,$$

$$T: 0 = c1 - c3 - c6, \quad c1 = c3 - c5 + 1$$

π-term relationship, Substitute exponents back in general form

$$\mathrm{EC} = C\alpha * t^{c3-c5+1} Te^{c2} Q^{c3} d^{2c5-3c3-2} \rho^{c5} \mu^{1-c5}$$

$$\mathrm{EC} = C\alpha * \left(\frac{Qt}{d^{3}}\right)^{c3} Te^{c2} \left(\frac{\rho d^{2}}{t\mu}\right)^{c5} \frac{t\mu}{d^{2}} \tag{7}$$

Write in dimensionless form (π-term relationship) by dividing both sides by coefficients of $C\alpha$ of known exponents.

Laboratory tests are required to solve for $C\alpha$.

Variables in the general relationship = 6

Variables in the π-term relationship = 3

$$\pi 1 = \mathrm{EC} \Big/ \frac{t\mu}{d^{2}}, \quad \pi 2 = \frac{Qt}{d^{3}}, \quad \pi 3 = \frac{\rho d^{2}}{t\mu} = \text{Renold number} \tag{8}$$

Very simply stated it says that the number of π-terms (dimensionless groups) is equal to the number of quantities minus the number of dimensions. $s = n - b$, s = number of π-terms, N = number of quantities involved = 6, b = number of dimensions = 3, s = 6 − 3 = 3, the number of dimension is 3

$$\mathrm{EC} = f\left(t, Te, Q, d, \rho, \mu\right)$$

$$t = T, \quad Te = \theta, \quad Q = L^{3}T^{-1}, \quad d = L, \quad \rho = ML^{-3}, \quad \mu = ML^{-1}T^{-1}, \quad \mathrm{EC} = ML^{-3}$$

$$\left(ML^{-3}\right) = C\alpha T^{c1} \theta^{c2} \left(L^{3}T^{-1}\right)^{c3} L^{c4} \left(ML^{-3}\right)^{c5} \left(ML^{-1}T^{-1}\right)$$

$$M: 1 = c5 + c6; \quad c6 = 1 - c5$$

$$L: -3 = 3c3 + c4 - 3c5 - c6, \quad T: 0 = c1 - c3 - c6; \quad c1 = c3 - c5 + 1$$

$$\mathrm{EC} = \mathrm{C}\alpha t^{c3-c5+1} Te^{c2} Q^{c3} d^{2c5-3c3-2} \rho^{c5} \mu^{1-c5}$$

$$\mathrm{EC} = C\alpha \left(\frac{Qt}{d^{3}}\right)^{c3} * Te^{c2} * \left(\frac{\rho d^{2}}{t\mu}\right)^{c5} \frac{t\mu}{d^{2}} \tag{7}$$

after than using staticals method by Excel programs and field work by measures the discharge, depth water, density and viscosity of water also time as well as temperature and electric conductivity to solve unknown in Equation (8) by multi relation dimensions analysis

The method of dimension analysis of Glenn Murphy [2], Buckingham, [13] (π theory) and Frank M. White [12].

Table 4 shows relationship between the electric conductivity (EC) and $\pi 1$ (dimensionless) that equals square of depth of water divided on time multiply with water kinematic viscosity (dynamic viscosity of water on density of water) which represent Renold number (dimensionless) = $d^2/(v^*t)$ where velocity of water = depth (d)/time (t). d = depth of water (m), t = time (second).

Figure 10 relationship between EC (Micro Siemens per centimeter) and $\pi^3 = \rho d^2/t\mu = d^2/tv$ = Renold number as show in Table 5 at below.

Table 6 shows the EC (Ms/cm) with respect to Q (m^3/s), t (s), depth (m) cubic depth and $\pi^2 = Q^* t/d^3$.

Time (t) constant one hour equal 3600 second.

Figure 11 and Table 7 the Relation between electric conductivity from test (EC true) and EC from equation to obtain correlation coefficient R^2 equal to 0.986.

If t = 3600 s = 1 hr and d = 7 m the equation become

$$EC = 3605.1 * Te^{-0.169} * \rho^{-0.116} * \mu^{-0.358} \quad (9)$$

Table 5. Relation between the electric conductivity (EC) and Renold number = $d^2/(v^*t)$.

EC (Ms/cm)	$d^2/(v^*t)$+
905	8684.2154
948	10419.682
980	11955.074
1003	13565.004
1028	14229.679
1039	15248.236

+$v = \mu/\rho$ = kinematic viscosity (m^2/s).

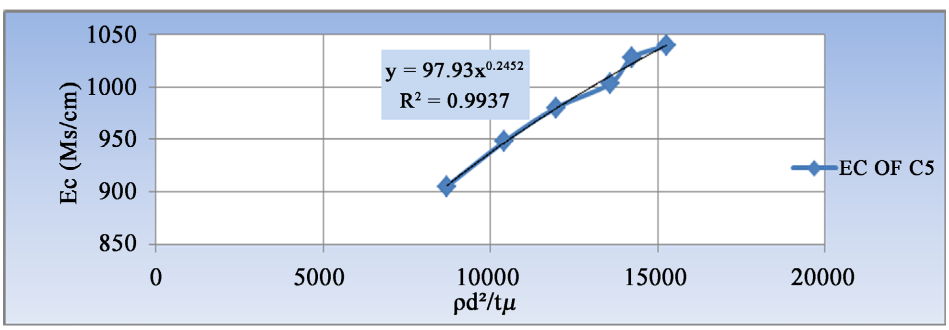

Figure 10. illustrates relationship between EC and $\rho d^2/t\mu$. [ρ = density (kg/m^3), μ = viscosity (Mpa.s), t = time (second (s), d = depth of water (m), Q = discharge (m^3/s), $\pi^2 = Q^* t/d^3$].

Table 6. The EC (Ms/cm) with respect to Q (m^3/s), t (s), depth (m) cubic depth and $\pi 2 = Q^* t/d^3$.

EC (Ms/cm)	Q (m^3/s)	t (s)	d (m)	d^3	$\pi 3 = Q^* t/d^3$
905	345	3600	7	343	3620.99
948	345	3600	7	343	3620.99
980	345	3600	7	343	3620.99
1003	345	3600	7	343	3620.99
1028	345	3600	7	343	3620.99
1039	345	3600	7	343	3620.99

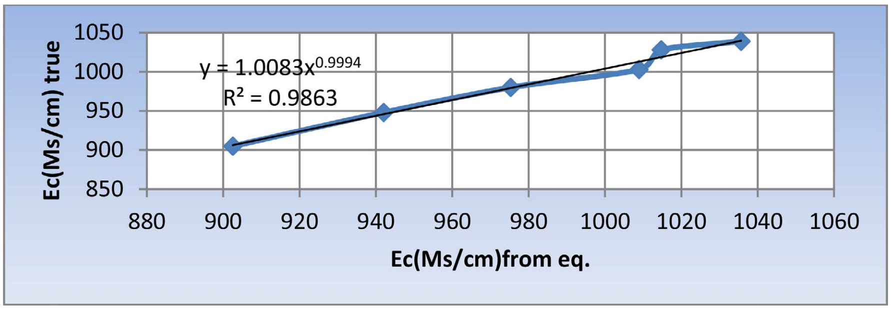

Figure 11. Relation between electric conductivity from test (EC true) and EC from equation.

Table 7. The value of electric conductivity from test (EC true) and EC from equation

EC (Ms/cm) true	EC (Ms/cm)from eq.
905	907.6
948	947.6
980	981.3
1003	1015.3
1028	1021.3
1039	1042.4

3.3.2. Second Method

Calculating the electric conductivity by using variable depth, time and discharge Using the relationship of the electric conductivity with variable depth of water, time, and discharge.as shown in Table 8 EC and discharge (Q), time (t) and depth of water (d).

Figure 12 the relationship of EC and $Q^* t/d^3$.

Figure 13 and Table 8 shows the relationship of EC (real) and EC from equation to obtain correlation coefficient R^2 equal to 0.94.

From variables, statically and dimensional analysis obtain on Equation (10) as result of EC formula with respect to Q, Te, ρ, μ, d, t which it gave final equation in below.

Table 8. EC and discharge (Q), time (t) and depth of water (d) depending on [2] and [14] of Equations (7) and (8) as $\pi 2 = \frac{Qt}{d^3}$.

EC (Ms/cm)	Q (m^3/s)	t (day)	d (m)	d^3	$Q*t/d^3$
1310	225	1	6.5	274.625	70787.44
1120	225	9	6.5	274.625	637086.9
1126	218	15	6.5	274.625	1,028,777
1077	280	23	6.5	274.625	2,026,094
1036	240	32	6.5	274.625	2,416,211
1002	250	35	6.5	274.625	2,752,845
1014	278	38	6.5	274.625	3,323,549
1017	239	50	6.5	274.625	3,759,599
924	239	56	6.5	274.625	4,210,751
904	259	61	6.8	314.432	4,341,268
912	246	75	6.6	287.496	5,544,703
916	251	82	6.55	281.0114	6,328,159

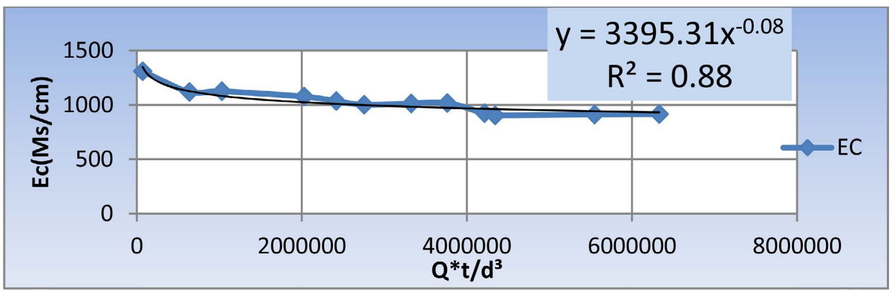

Figure 12. Relation between EC (Ms/cm) with $\pi 2 = \frac{Qt}{d^3}$.

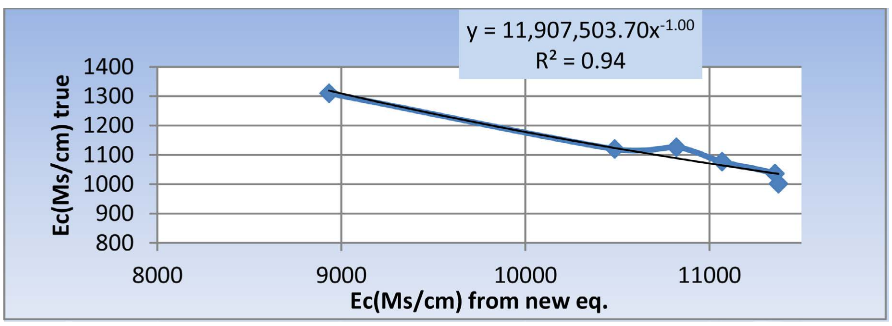

Figure 13. The relationship of EC (real) and EC from equation.

$$EC = 1350.3 * Q^{0.0092} Te^{-0.0416} \rho^{-0.0282} \mu^{-0.0868} d^{0.146} t^{-0.0776} \tag{10}$$

Figure 14 shows the method of sampling by water quality device to test the EC in site

From Table 9 can be calculated the chi square.

chi square computed = 3.26. chi square critical (0.95, 2) = 5.9900

The chi-square formula

Both of chi-square tests use the same formula to calculate the, chi-square (X^2):

$$X^2 = \sum (O - E)^2 / E \tag{11}$$

where:

X^2 is the chi-square test statistic

Σ is the summation operator (it means "take the sum of")

O is the observed frequency

E is the expected frequency

Comparing the chi-square value to the critical value $X^2 = 0.23$

Since there are six groups, there are five degrees of freedom. For a test of significance at $\alpha = 0.05$ and df = 5, the X^2 critical value is 5.99. The X^2 value is less than the critical value as shown Table 10.

Table 9. The checking by equation between EC (real) value and EC value from equation.

EC (Ms/cm)true from test	EC (Ms/cm) from equation
1310	1332.8
1120	1135.5
1126	1100.3
1077	1075.7
1036	1048.4
1002	1046.7

Figure 14. Using the water quality device to test the EC in river site.

Table 10. Using chi-square formula depending on EQ.11.

EC (Ms/cm) from test (O)	EC (Ms/cm) from equation E	$(O_j - E_j)^2/E_j$
1310	1332.8	0.3900
1120	1135.5	0.2116
1126	1100.3	0.6003
1077	1075.7	0.0016
1036	1048.4	0.1467
1002	1046.7	1.9089

Since computed < critical values, so is fitting at 5% significance level.

4. Result and Discussion

From statically analysis it was obtained the equation of EC with temperature (Te) and time (t) were $R^2 = 0.9998$ and $R^2 = 0.995$, respectively. The correlation coefficient (r) = 0.9997 and index of agreement (d) = 0.892 near to 1 which is good. Depending on result and analysis the formula is good to image the electric conductivity when do not found device to test the water; therefore check of water by equation to obtain on simple result and fast.

In dimension analysis two equations were obtained, the first equation discharge, depth of water and time were fixed and was obtained $R^2 = 0.986$ while in second equation all parameter were variables (Q,d,t) and $R^2 = 0.94$ from analysis shown the dimension analysis in second method better than first method because of the dimension analysis is more comprehensive than first method. It gave a clear visualization of the association of several variables to give a result that helps measure the electrical conductivity of water in the absence of a water test device as shown in figures, and tables and equations to obtain on result is Equation (10) as result optimal equation by dimension analysis gave. The validation of the proposed method using independent datasets and compare the results with those obtained by measuring electric conductivity in site with measuring depth, discharge and other independent variables found near from site test as Willmott's Index of Agreement $d = 0.89$ is good in classification also chi square computed was 3.26 less than chi square critical 5.99 Since computed < critical values, so is fitting at 5% significance level. In this method we obtain on equation will be monitoring and management the water quality by monitoring electric conductivity with multi parameters of river water on a daily basis to ensure water quality at any time when the test devices not present (not found) or malfunctioning. Samples are collected from the middle of the river at a depth of 30 to 20 cm below the surface of the water by means of a bucket and a rope. Then the sample is placed in a beaker for examination, after which the examination device is brought in. The sample is examined and the process is repeated daily and recorded in a record with time, temperature and other parameters. The process is repeated several times to ensure quality and to confirm the validity of the results. Finally, the equipment and containers are cleaned and washed with distilled water and kept in the designated places. When used again, they are also washed with distilled water before use.

5. Conclusion

The obtained results of equations among EC with Te and t via data that were collected from Alhindya barrage office are $R^2 = 0.999$ and $R^2 = 0.995$. The dimension analysis was used by two stages. The first stage used equation of EC with Te, ρ and μ with keeping time, depth of water and discharge constant and $R^2 = 0.9937$ and $R^2 = 0.9863$ respectively. In the second stage, the obtained formula of EC with *Te*, ρ, μ, *t*, *d* and *q* and obtained results were $R^2 = 0.945$ and $R^2 = 0.94$. Results of this search can be applied by the dimension analysis to more than formula and connect several variables with each other to find best solutions and best methods and facilitate the solution of the equations. Moreover, these equations help in calculation conductivity of water in Iraq as case study and at any time also during change of discharge and depth. It gave a clear visualization to calculate the electric conductivity of water during absence of a water test device.

Recommendation

Working on equations by dimension analysis to dissolved oxygen (DO) and BOD5 with the time and temperature as well as discharge and depth of water to check the DO and BOD in reducing discharge and increasing discharge.

Using the dimension analysis to find equations of electric conductivity of lake, ground water, and other rivers and streams with multi parameter such as temperature, time, discharge and depth of water.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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