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Annexes

Sample Calculations

A.1 Calibration Calculation

From the data obtained, we use the "least squares" method to calculate a straight line that best fits our data and returns an array that describes the line. The equation for the line is:

$$y = m_1x_1 + m_2x_2 + \dots + b \text{ or } y = mx + b$$

where the dependent y-value is a function of the independent x-values. The m-values are coefficients corresponding to each x-value, and b is a constant.

We can describe any straight line with the slope and the y-intercept. The slope of a line, often written as m, take two points on the line, (x₁,y₁) and (x₂,y₂); the slope is equal to (y₂ - y₁)/(x₂ - x₁). The y-intercept of a line, often written as b, is the value of y at the point where the line crosses the y-axis.

The equation of a straight line is $y = mx + b$. Once the values of m and b is known, any point on the line can be calculated by putting the y- or x-value into that equation.

In regression analysis, we use Microsoft Excel to calculate for each point the squared difference between the y-value estimated for that point and its actual y-value. The sum of these squared differences is called the residual sum of squares. Microsoft Excel then calculates the sum of the squared differences between the actual y-values and the average of the y-values, which is called the total sum of squares (regression sum of squares + residual sum of squares). The smaller the residual sum of squares is compared with the total sum of squares, the larger the value of the coefficient of determination, r^2 , which is an indicator of how well the equation resulting from the regression analysis explains the relationship among the variables.

The y-values predicted by the regression equation may not be valid if they are outside the range of the y-values used to determine the equation.

A.1.1 Revolution vs. Voltage Input Calibration

<i>Voltage</i>	<i>Observed Revolution</i>	<i>Predicted Revolution</i>	<i>Residuals</i>	<i>Standard Residuals</i>
30	101.933	115.3811	-13.4481	-2.789934629
40	164.050	162.9255429	1.124457143	0.233279193
50	212.875	210.4699857	2.405014286	0.498942798
60	260.425	258.0144286	2.410571429	0.500095679
70	308.825	305.5588714	3.266128571	0.677589043
80	354.575	353.1033143	1.471685714	0.305315021
90	403.500	400.6477571	2.852242857	0.591724565
100	450.200	448.1922	2.0078	0.416536964
110	498.925	495.7366429	3.188357143	0.66145463
120	544.925	543.2810857	1.643914286	0.341045456
130	594.575	590.8255286	3.749471429	0.777863057
140	639.350	638.3699714	0.980028571	0.20331613
150	681.775	685.9144143	-4.139414286	-0.858760365
160	731.950	733.4588571	-1.508857143	-0.313026583
170	775.000	781.0033	-6.0033	-1.245440959

Table A.1 Comparison between the observed data and the predicted data

From linear regression analysis, we found that when the Y interception is -27.2522 and the slope is 4.754, the following equation is gotten nearest to the group of the data.

$$\text{Revolution (RPM.)} = (4.754 \times \text{Voltage Input (V)}) - 27.252$$

Figure A.1 shows a comparison between the observed and predicted revolution.

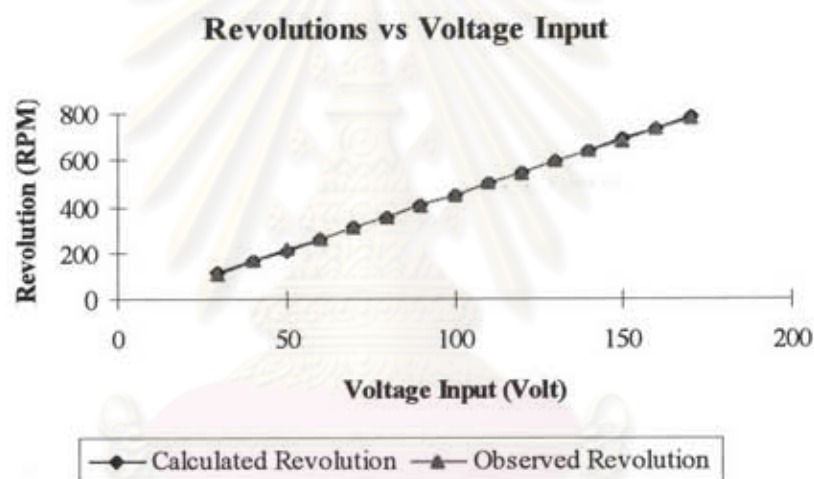


Figure A.1 Comparison between calculated and observed revolution

A.1.2 Conductivity vs. Concentration Calibration

Concentration (Mol/l)	Observed Conductivity	Predicted Conductivity	Residuals
0	0.2	0.16	0.04
0.005	1.65	1.696	-0.046
0.01	3.24	3.232	0.008
0.015	4.73	4.768	-0.038
0.02	6.34	6.304	0.036

Table A.2 Comparison between the observed data and the predicted data

From linear regression analysis, we found that when the Y interception is 0.16 and the slope is 307.2, the following equation is nearest to the group of the data.

$$\text{Conductivity (mS/m)} = (307.2 \times \text{Concentration (Mol/l)}) + 0.16$$

Figure A.2 shows comparison between the observed and predicted conductivity.

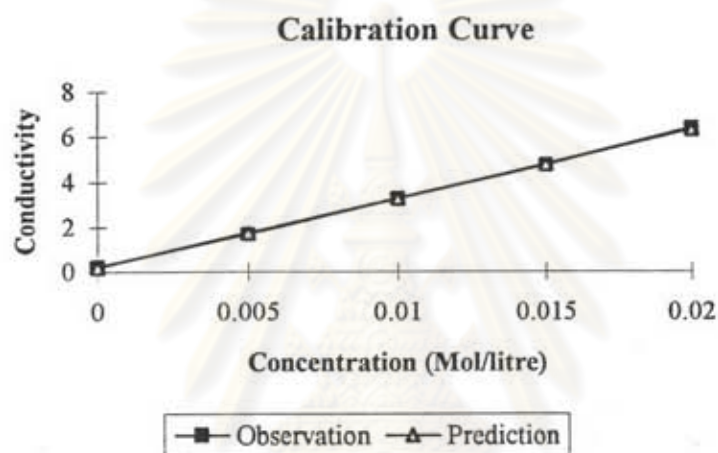


Figure A.2 Comparison between calculated and observed conductivity

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A.2 Scale-up Calculation

From theory, the revolution of the impeller is changed when the mixing system is changed in order to maintain dynamic similarity. Equation A-1 shows the relation to solve for the new revolution.

$$N_2 = N_1 \left(\frac{D_{T1}}{D_{T2}} \right)^n \quad (\text{A-1})$$

- $n = 1$ for equal liquid motion
 $D_{T1} = 20$ cm. for the smallest tank diameter
 $N1 = 264.87, 441.57$ and 618.27 RPM
 $D_{T2} = 25$ and 30 cm. For scale-up tank diameter

From Eq.A-1, the following table is the calculated impeller revolution in the smaller tanks.

Tank Diameter (cm.)	Impeller Revolution (RPM)		
20	264.87	441.57	618.27
25	211.896	353.256	494.616
30	176.58	294.38	412.18

Table A.3 Impeller Revolution for Scale-up Method

A.3 Data Processing for Residence Time Determination

For continuous mixing experiment, the processed data were further processed as follows:

- A.3.1 Use the calibrated equation to convert from the recorded conductivity data to the true concentration.
- A.3.2 Normalize the concentration by dividing with initial concentration
- A.3.3 The product of time, normalized corrected count at that time and counting time interval was calculated starting from the time of injection.
- A.3.4 The residence time was calculated by using Equation (A-3)

$$\bar{t} = \frac{\int_0^{\infty} tC dt}{\int_0^{\infty} C dt} \quad (\text{A-2})$$

And if the distribution curve is known only at a number of discrete time value t_i then

$$\bar{t} \cong \frac{\sum t_i C_i \Delta t_i}{\sum C_i \Delta t_i} \quad (\text{A-3})$$



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