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DEPT:CHEMICAL ENGINEERING

MAT NO: 16/ENG01/010

ASSIGNMENT 6

MANUAL

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Dept: Chemical Engineering

1. Manual method

$d = \alpha \beta^t$

$\ln d = \ln \alpha + t \ln \beta$

$d = a_0 + a_1 t$

$\Sigma d = a_0 N + \Sigma a_1 t$

$\Sigma \ln d t = a_0 \Sigma t + a_1 \Sigma t^2$

$$\begin{bmatrix} N & \Sigma t \\ \Sigma t & \Sigma t^2 \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \end{bmatrix} = \begin{bmatrix} \Sigma d \\ \Sigma t \ln d \end{bmatrix}$$

t(hr)	d(m)	ln d	t ln d	t^2
0	2	0.69314	0	0
1	5	1.609438	1.609438	1
2	19	2.944439	5.888878	4
3	50	3.912023	11.73607	9
4	151	5.01728	20.06912	16
5	470	6.152733	30.76366	25
6	1435	7.26892	43.61352	36
7	4572	8.414496	58.90147	49
8	12936	9.467769	75.74216	64
9	41125	10.62437	95.61934	81
10	111021	11.61747	116.1747	100
			460.1184	385

$$\underbrace{\begin{bmatrix} 11 & 55 \\ 55 & 385 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} a_0 \\ a_1 \end{bmatrix}}_{X} = \underbrace{\begin{bmatrix} 67.72209 \\ 460.1184 \end{bmatrix}}_{B}$$

$X = A^{-1} B$

$$A^{-1} = \frac{1}{(385 \times 11) - (55 - 55)} \begin{bmatrix} 385 & -55 \\ -55 & 11 \end{bmatrix}$$

$$A^{-1} = \frac{1}{1210} \begin{bmatrix} 385 & -55 \\ -55 & 11 \end{bmatrix}$$

$$A^{-1} = \frac{1}{1210}\begin{bmatrix} 385 & -55 \\ -55 & 11 \end{bmatrix}$$

$$X = A^{-1}B$$

$$X = \frac{1}{1210}\begin{bmatrix} 385 & -55 \\ -55 & 11 \end{bmatrix}\begin{bmatrix} 67.72209 \\ 460.1184 \end{bmatrix}$$

$$X = \frac{1}{1210}\begin{bmatrix} (385 \times 67.72209) - (55 \times 460.1184) \\ (-55 \times 67.72209) - (11 \times 460.1184) \end{bmatrix}$$

$$X = \frac{1}{1210}\begin{bmatrix} 26073.00465 - 25306.512 \\ -3724.71495 + 5061.3024 \end{bmatrix}$$

$$X = \frac{1}{1210}\begin{bmatrix} 766.49265 \\ 1336.58745 \end{bmatrix}$$

$$X = \begin{bmatrix} a_0 \\ a_1 \end{bmatrix} = \begin{bmatrix} 0.633465 \\ 1.104618 \end{bmatrix}$$

$$\ln d = \ln \alpha + \ln \beta$$

$$\ln d = \ln 0.633465 + 1.104618t$$

$$\alpha = e^{0.633465} = 1.8841$$

$$\beta = e^{1.104618} = 3.0181 \quad , d = \alpha \beta^{t}$$

Hence $d = 1.8841 \times 3.0181^{t}$

t(hr)	ln d	ln d sim	ln(d) simerror	ln(d) merror
0	0.693147	0.633465	-5.528088581	-5.46341
1	1.609438	1.738083	-4.418470865	-4.54712
2	2.944439	2.842701	-3.313853149	-3.21211
3	3.912023	3.947318	-2.209235433	-2.24753
4	5.01728	5.051936	-1.104617716	-1.13927
5	6.152733	6.156554	0	-0.00382
6	7.28892	7.261171	1.104617716	1.112366
7	8.414496	8.365789	2.209235433	2.257942
8	9.457769	9.470407	3.313853149	3.311216
9	10.62437	10.57502	4.418470865	4.467818
10	11.67747	11.67964	5.528088581	5.460921
			134.219829	134.2815

ln d sim = a0 + a1x

COMMENT

The values of R and Rsquare obtained when solved with MATLAB, manual and Excel were the same. The value of Rsquare is greater than 0.8 so it is valid and the values of alpha and beta are also valid.

$\ln(d)_{sim\,error} = \cancel{\ln(d)_{sim}}\ \ln(d)_{sim} - mean(\ln(d))$

$\ln(d)_{mean}$

$= 0.693147 + 1.806488 + 2.944439 + 3.912023 + 5.01728 + 6.152733 + 7.26892 + 8.414498 + 9.467769 + 10.62437 + 11.61747$

$= 6.156554$

$\ln(d)_{mean\,error} = \ln d - \ln(d)_{mean}$

$$R = \frac{\sqrt{\Sigma(y_{sim} - y_{mean})^2}}{\sqrt{\Sigma(y - y_{mean})^2}}$$

$sumsq.\ \ln(d)_{sim\,error} = (y_{sim} - y_{mean})^2$

$sumsq.\ (\ln(d))_{mean\,error} = (y - y_{mean})^2$

$$R = \frac{\sqrt{134.219829}}{\sqrt{134.2615}} = 0.999845$$

$R^2 = 0.999845^2$

$= 0.99969$

EXCEL WITH REGRESSION TOOL

t(hr)	lnd
0	0.693147
1	1.609438
2	2.944439
3	3.912023
4	5.01728
5	6.152733
6	7.26892
7	8.414496
8	9.467769
9	10.62437
10	11.61747
55	67.72209

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.999845
R Square	0.99969
Adjusted R Square	0.999655
Standard Error	0.068038
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	134.2198	134.2198	28994.14	4.23E-17
Residual	9	0.041663	0.004629		
Total	10	134.2615			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.633465	0.038379	16.50562	4.9E-08	0.546646	0.720284	0.546646	0.720284
X Variable 1	1.104618	0.006487	170.2767	4.23E-17	1.089943	1.119293	1.089943	1.119293

alpha=exp(0.633465) = 1.884127

beta= exp(1.1046) = 3.018017

MATLAB

```
commandwindow
clear
clc
baby=xlsread('matlabexcel1')
[xr xc] = size(baby)
t0 = ones(xr,1);
t1 = baby(:,1);
d = baby(:,2);
t =[t0 t1]
paul = regress(d,t)
a0 =paul(1)
a1=paul(2)
ysim = a0 + a1*t1
Rvalue = corr(d,ysim)
Rsquare = Rvalue^2
```

baby =

0	0.69315
1	1.6094
2	2.9444
3	3.912
4	5.0173
5	6.1527
6	7.2689
7	8.4145
8	9.4678
9	10.624
10	11.617

xr =

11

```
xc =

     2


t =

     1     0
     1     1
     1     2
     1     3
     1     4
     1     5
     1     6
     1     7
     1     8
     1     9
     1    10


paul =

      0.63347
       1.1046


a0 =

      0.63347
```

a1 =

1.1046

ysim =

0.63347
1.7381
2.8427
3.9473
5.0519
6.1566
7.2612
8.3658
9.4704
10.575
11.68

Rvalue =

0.99984

Rsquare =

0.99969

alpha=exp(0.63347) = 1.8841

beta= exp(1.1046) = 3.018017