CHAPTER IV

EXPERIMENTAL ANALYSIS

4.1 Introduction

In this chapter, this work shows experimental results from the SPSS method. The method of estimation of yield and capacity of granulated fertilizer is divided into three cases of granulated fertilizers, i.e. the high liquid phase, the moderate liquid phase, and the low liquid phase fertilizer formulations.

This work plots simulation data of the SPSS method and actual plant data for both yield and capacity versus sulfuric acid concentration. Also, tables containing all parameters of those linear regression line are shown.

4.2 Determination of Regression to Estimate Process Yield and Process Capacity

4.2.1 Estimation of Process Yield by Regression Analysis

4.2.1.1 Estimation of Process Yield by Regression Analysis of the High Liquid Phase Fertilizer Formulation

By means of this classification, the high liquid phase fertilizer with a 16–20–0 formulation, contains the highest slurry of all other fertilizer formulations from the reactor. Their data, processed by the regression analysis via SPSS, show the scattered plots in Figures (4.2) and (4.3). All regression lines of the 16-20-0 fertilizer formulation state a reverse relation between the sulfuric acid concentration and yield. Also, Table (4.1a) and (4.2a) show data on the parameters extracted from the simulation results.

The 16–20-0 fertilizer formulation shows a similar reverse relation between the sulfuric acid concentration and yield for each individual experimental set, which represents each lot of production. Regarding the highest heat of all other fertilizer formulations. First, mentioned in Chapter 2, both the heat of reaction and the liquid phase are significant control variables for the yield of production, but the liquid phase theory – referred to in the fertilizer Manual of United Nations Industrial Development Organization, 1980 – describes the relation of temperature, - heat of reaction - and water needed for fertilizer granulation as shown in Figure (4.3) below.

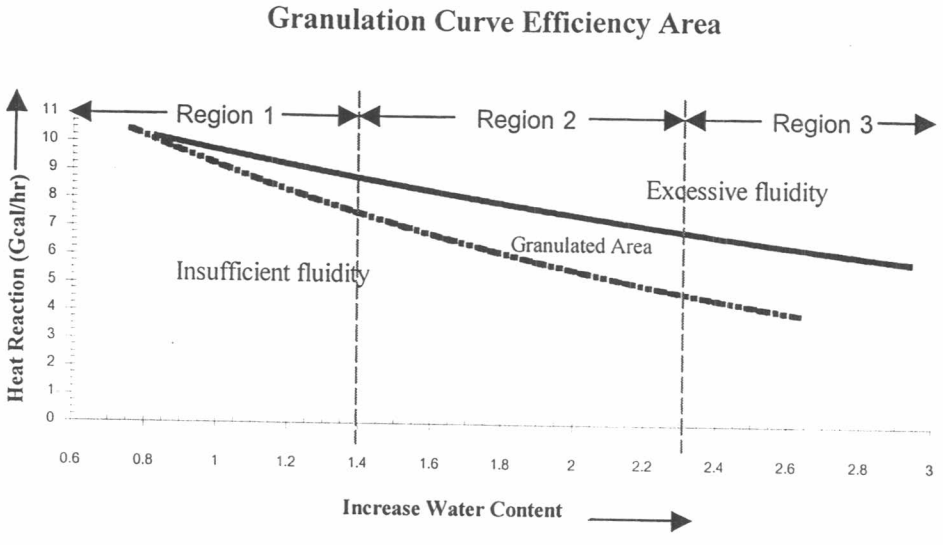

Figure (4.1) Relationship between Increase in Water Content and Heat of Reaction

In Figure (4.1), the 16–20–0 fertilizer formulation is located at the point number 1, having a small granulation area for operation because, with only a little more sulfuric acid concentration added, the yield becomes worse.

4.2.1.2 Estimation of Process Yield by Regression Analysis of Moderate Liquid Phase Fertilizer Formulation

This case – accounting for the 16-16-8, 13-13-21, and 15-15-15 fertilizer formulations - shows (via the SPSS regression analysis) Figure (4.4) and (4.5) for the 16-16-8 fertilizer formulation, Figure (4.6) for the 13-13-21 fertilizer formulation, and Figure (4.7) and (4.8) for the 15-15-15 fertilizer formulation. The trends of all estimated linear regression lines of these become dubious. The calculation parameters are shown in Table (4.3a) to (4.7a).

These irresolute results are considered according to the "Liquid phase theory", showing the operating region of the moderate liquid phase case at the point number 3 in Figure (4.1). These operating points, possessing more granulated area than the point number 1, can be affected by operators' skills in many directions such as upward, downward, right, and left. Therefore, it is difficult to estimate the relation by the SPSS regression numerical method.

4.2.1.3 Estimation of Process Yield by Regression Analysis of Low Liquid Phase Fertilizer Formulation

These considerably useful cases, composed of the 16–8–8 and 15-7-18 fertilizer formulations, were processed by the linear regression analysis via SPSS, as shown in Figure (4.9), (4.10), and (4.11) for the 16–8–8 fertilizer formulation and Figure (4.12) for the 15–7-8 fertilizer formulation. In this regard, all of these obviously show a direct relation between sulfuric acid concentration and yield. Finally, there are tables of linear regression parameters, shown as Tables (4.8a) to (4.11a).

These cases show the opportunities to develop more beneficial yield, described by the following reasons: First, their direct relations of the estimated regression results come from the low heat of reaction, increasing the yield with increase in the concentration of sulfuric acid as well as increasing the heat of reaction for good yield of granulation. Second, the best yield can be explained by Figure (4.1). Their operating points of the low liquid phase are the point region 3, which owns a largest granulated area. Regarding the total raw material feeds, now their maximum feeding to the limiting reactor is achieved while the limit of granulated area is not. Then, this is revealed as extension of the sizing of the plug flow reactor, which can increase yield and capacity of the manufacturing plant with a low cost.

4.2.2 Estimation of Process Capacity by Regression Analysis

4.2.2.1 Estimation of Process Capacity by Regression Analysis of High Liquid Phase of Fertilizer Formulation

There is only one fertilizer formulation, the 16-20-0 formulation, showing the estimation of linear regression analysis in Figure (4.2) and (4.3) and linear regression parameters in Table (4.1a) and (4.2a). These results show a direct relation between sulfuric acid concentrations and capacity of production.

These entire results show direct relation between sulfuric acid concentrations and capacity. This is in confusion with the basic assumption of their highest heat of reaction. In this respect, the present commercial production -using more sulfuric acid and ceasing the natural gas for drying system are beneficial as utility cost reduction is obtained. This is because of the balanced heat in process caused by using the higher process heat of reaction from sulfuric acid to compensate lower heat of process from the end of drying system.

4.2.2.2 Estimation of Capacity by Regression Analysis of Moderate Liquid Fertilizer Formulation

The results reveal an unclear relation between sulfuric acid concentration and the capacity of production. Those are shown in Figure (4.4) and (4.5) for the 15-15-15 fertilizer formulation, Figure (4.6) for the 13-13-21 fertilizer formulation, and Figure (4.7) and (4.8) for the 16–16–8 fertilizer formulation. The unclear approximation are confirmed by the fact that the direct relation and the reverse relation appears concurrently on the linear regression of both the 15–15–15 and 16–16–8 formulations.

These reasons of the phenomena from the SPSS numerical regression are the same with those between sulfuric acid concentrations and yield described in 4.2.1.2.

4.2.2.3 Estimation of Process Capacity by Regression Analysis of Low Liquid Phase Fertilizer Formulation

Both the 16–8–8 and 15-7-18 fertilizer formulations show beneficial results of this work. Figure (4.9), (4.10), and (4.11) for the 16–8–8 fertilizer formulation and Figure (4.12) for the15–7-18 fertilizer formulation demonstrate that, the more sulfuric concentration is, the higher capacity of production becomes.

Actual production shows the highest capacity as it approaches the 150 % of the design capacity. It can be considered that it has the same trend for both actual production and regression analysis methods because of the same reason stated in 4.2.1.3, the low liquid phase fertilizer produces more heat of reduction when added with more sulfuric acid.

Table (4.1) Summary of Estimated Parameters of SPSS Simple Linear Regression Model

Fertilizer Formulation (month)	Yield	Capacity	β_0	β_1	R^2	Significance F_0
16-20-0	/		57.743	-0.342	0.010	0.239
(June)		/	65.569	0.404	0.035	0.025
16-20-0	/		54.936	-0.295	0.007	0.311
(July)		/	68.518	0.111	0.002	0.573
16-16-8	/		65.818	-0.010	0.000	0.985
(April)		/	66.794	0.223	0.060	0.157
16-16-8	/		62.081	-0.136	0.005	0.718
(September)		/	80.452	-0.395	0.039	0.307
13-13-21	/		64.563	-0.108	0.001	0.874
(April)		/	-	-	-	-
15-15-15	/		53.206	0.375	0.036	0.222
(May)		/	67.181	0.150	0.157	0.009
15-15-15	/		59.871	-0.003	0.000	0.992
(August)		/	72.598	-0.116	0.017	0.455
16-8-8	/		41.957	0.617	0.075	0.046
(January)		/	-	-	-	-
16-8-8	/		55.037	0.121	0.004	0.660
(April)		/	67.477	0.142	0.222	0.001
16-8-8	/		29.348	1.435	0.383	0.001
(July)		/	68.030	0.659	0.197	0.026
15-7-18	/		40.041	0.652	0.147	0.070
(April)		/	50.666	0.545	0.064	0.245

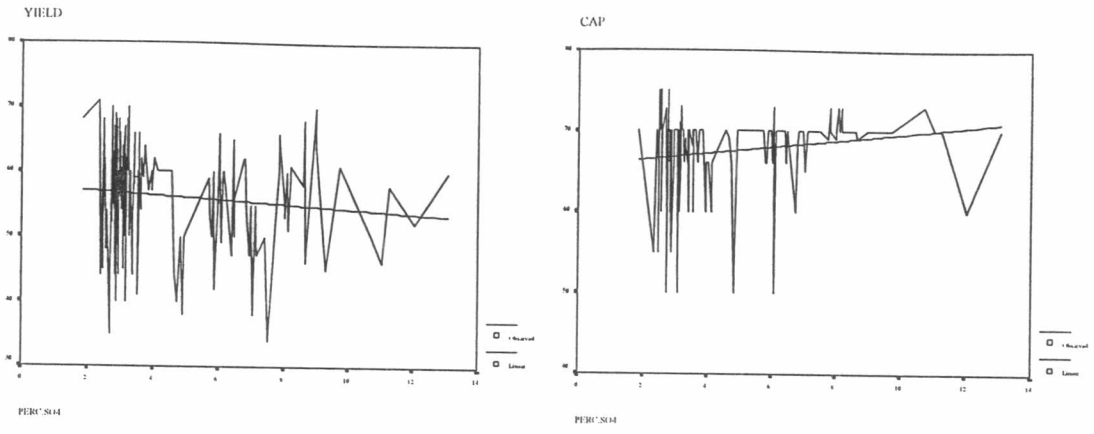

Figure (4.2) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 16-20-0 of June

Table (4.2a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 16-20-0 of June

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.099[a]	.010	.003	8.28762

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	95.945	1	95.945	1.397	.239[a]
	Residual	9684.530	141	68.685		
	Total	9780.476	142			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YIELD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	57.743	1.528		37.785	.000
	PERC.SO4	-.342	.290	-.099	-1.182	.239

a. Dependent Variable: YIELD

Table (4.2b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 16-20-0 of June

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.188[a]	.035	.028	5.08647

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	133.457	1	133.457	5.158	.025[a]
	Residual	3647.979	141	25.872		
	Total	3781.436	142			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: CAP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	65.569	.938		69.908	.000
	PERC.SO4	.404	.178	.188	2.271	.025

a. Dependent Variable: CAP

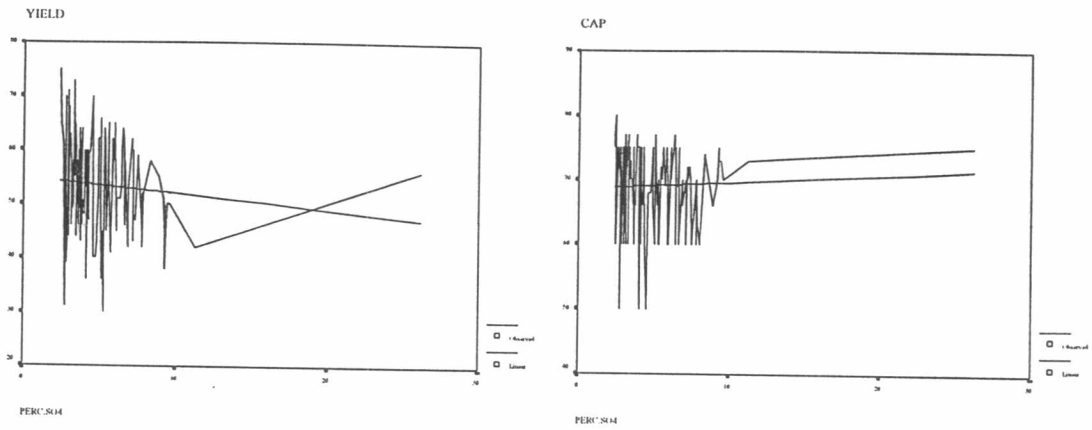

Figure (4.3) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 16-20-0 of July

Table (4.3a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 16-20-0 of July

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.086[a]	.007	.000	8.97779

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	83.346	1	83.346	1.034	.311[a]
	Residual	11284.090	140	80.601		
	Total	11367.437	141			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YIELD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	54.936	1.619		33.942	.000
	PERC.SO4	-.295	.290	-.086	-1.017	.311

a. Dependent Variable: YIELD

Table (4.3b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 16-20-0 of July

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.048[a]	.002	-.005	6.06730

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.762	1	11.762	.320	.573[a]
	Residual	5153.698	140	36.812		
	Total	5165.460	141			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: CAP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	68.518	1.094		62.642	.000
	PERC.SO4	.111	.196	.048	.565	.573

a. Dependent Variable: CAP

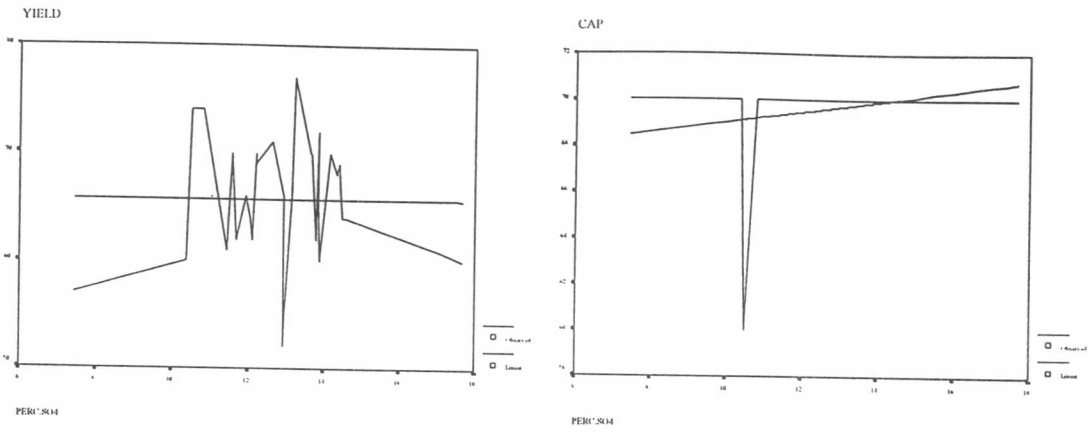

Figure (4.4) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 16-16-8 of April

Table (4.4a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 16-16-8 of April

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.003[a]	.000	-.030	5.63412

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.012	1	.012	.000	.985[a]
	Residual	1047.531	33	31.743		
	Total	1047.543	34			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YIELD

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	65.818	6.891		9.551	.000
	PERC.SO4	-.010	.522	-.003	-.019	.985

a. Dependent Variable: YIELD

Table (4.4b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 16-16-8 of April

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.245[a]	.060	.031	1.66359

a. Predictors: (Constant), PERC.SO4

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.814	1	5.814	2.101	.157[a]
	Residual	91.329	33	2.768		
	Total	97.143	34			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: CAP

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	66.794	2.035		32.828	.000
	PERC.SO4	.223	.154	.245	1.449	.157

a. Dependent Variable: CAP

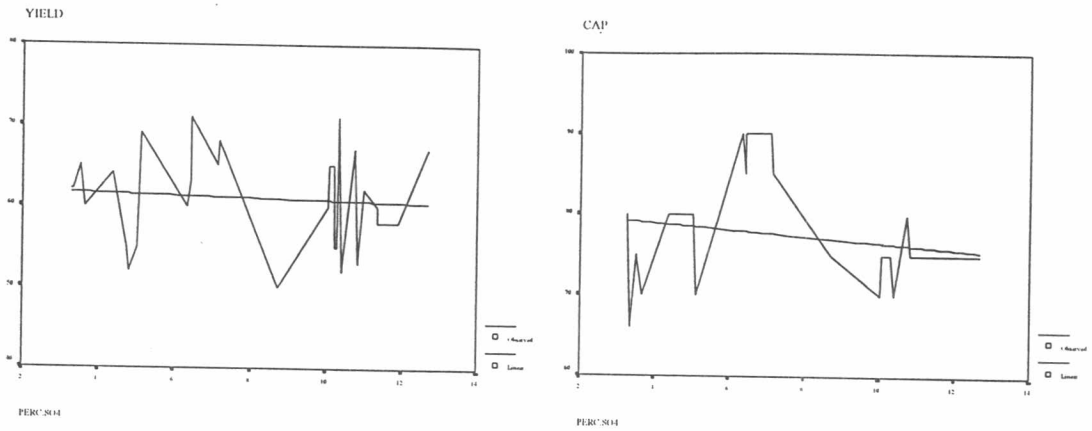

Figure (4.5) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 16-16-8 of September

Table (4.5a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 16-16-8 of September

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.070[a]	.005	-.032	6.00369

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.804	1	4.804	.133	.718[a]
	Residual	973.196	27	36.044		
	Total	978.000	28			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YIELD

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	62.081	3.164		19.619	.000
	PERC.SO4	-.136	.371	-.070	-.365	.718

a. Dependent Variable: YIELD

Table (4.5b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 16-16-8 of September

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.196[a]	.039	.003	6.13136

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	40.766	1	40.766	1.084	.307[a]
	Residual	1015.027	27	37.594		
	Total	1055.793	28			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: CAP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	80.425	3.232		24.887	.000
	PERC.SO4	-.395	.379	-.196	-1.041	.307

a. Dependent Variable: CAP

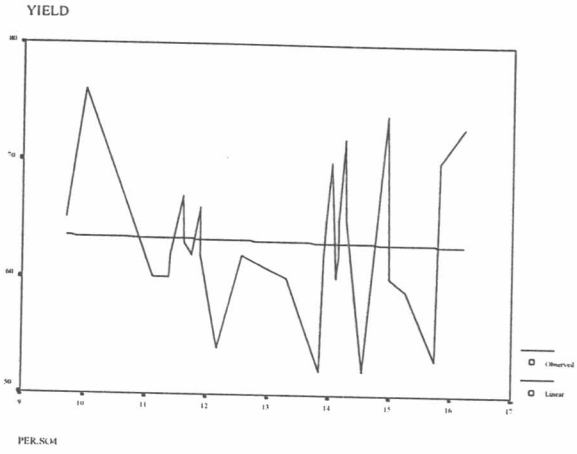

Figure (4.6) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 13-13-21 of April

Table (4.6) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 13-13-21 of April

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	PER.SO4 [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.030[a]	.001	-.035	6.27483

a. Predictors: (Constant), PER.SO4

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.010	1	1.010	.026	.874[a]
	Residual	1102.457	28	39.373		
	Total	1103.467	29			

a. Predictors: (Constant), PER.SO4

b. Dependent Variable: YIELD

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	64.563	9.004		7.171	.000
	PER.SO4	-.108	.674	-.030	-.160	.874

a. Dependent Variable: YIELD

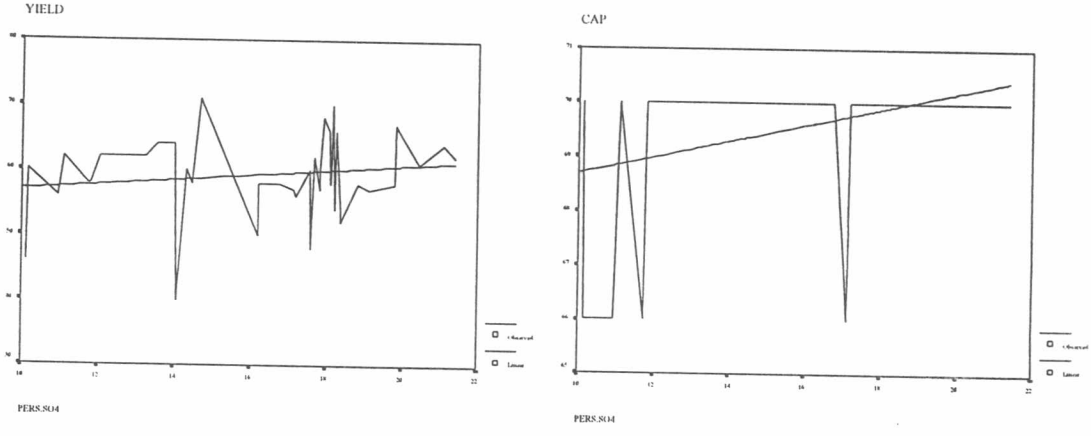

Figure (4.7) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 15-15-15 of May

Table (4.7a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 15-15-15 of May

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERS.SO4 [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.190[a]	.036	.013	6.05781

a. Predictors: (Constant), PERS.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	56.490	1	56.490	1.539	.222[a]
	Residual	1504.579	41	36.697		
	Total	1561.070	42			

a. Predictors: (Constant), PERS.SO4

b. Dependent Variable: YIELD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	53.206	5.000		10.642	.000
	PERS.SO4	.375	.302	.190	1.241	.222

a. Dependent Variable: YIELD

Table (4.7b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 15-15-15 of May

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERS.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.396[a]	.157	.136	1.09258

a. Predictors: (Constant), PERS.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.104	1	9.104	7.626	.009[a]
	Residual	48.943	41	1.194		
	Total	58.047	42			

a. Predictors: (Constant), PERS.SO4

b. Dependent Variable: CAP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	67.181	.902		74.503	.000
	PERS.SO4	.150	.054	.396	2.762	.009

a. Dependent Variable: CAP

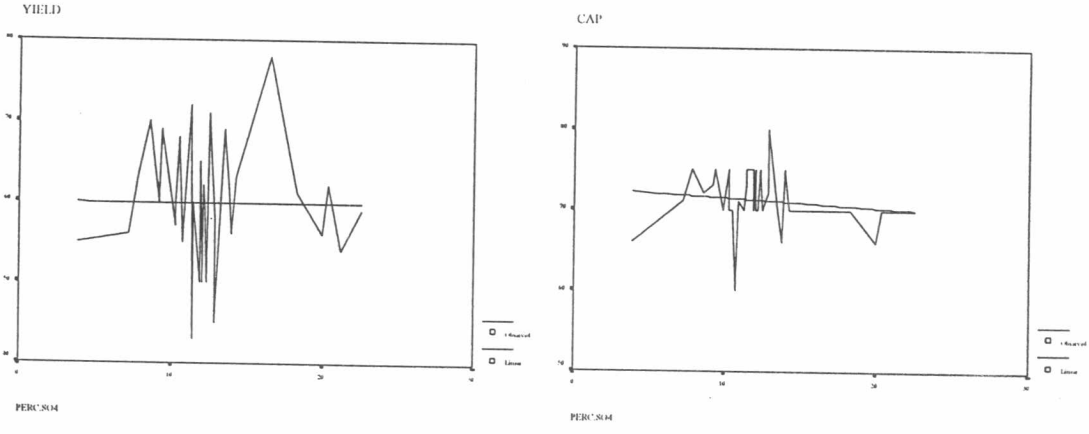

Figure (4.8) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 15-15-15 of August

Table (4.8a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 15-15-15 of August

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.002[a]	.000	-.030	7.75567

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.006	1	.006	.000	.992[a]
	Residual	1984.965	33	60.150		
	Total	1984.971	34			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YIELD

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	59.871	4.366		13.714	.000
	PERC.SO4	-.003	.333	-.002	-.010	.992

a. Dependent Variable: YIELD

Table (4.8b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 15-15-15 of August

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.131[a]	.017	-.013	3.58001

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.341	1	7.341	.573	.455[a]
	Residual	422.945	33	12.817		
	Total	430.286	34			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: CAP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	72.598	2.015		36.026	.000
	PERC.SO4	-.116	.154	-.131	-.757	.455

a. Dependent Variable: CAP

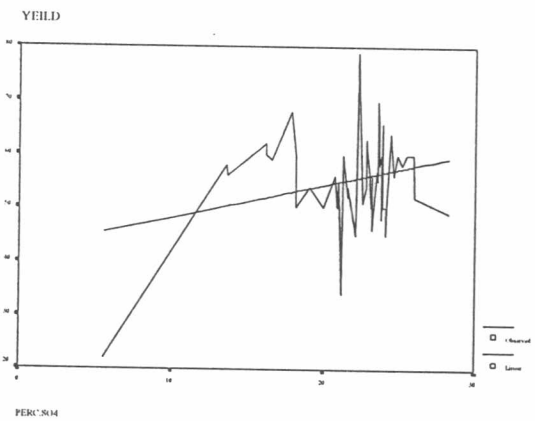

Figure (4.9) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 16-8-8 of January

Table (4.9) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 16-8-8 of January

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4 [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YEILD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.273[a]	.075	.057	8.29161

a. Predictors: (Constant), PERC.SO4

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	288.294	1	288.294	4.193	.046[a]
	Residual	3575.040	52	68.751		
	Total	3863.333	53			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YEILD

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	41.957	6.682		6.279	.000
	PERC.SO4	.617	.301	.273	2.048	.046

a. Dependent Variable: YEILD

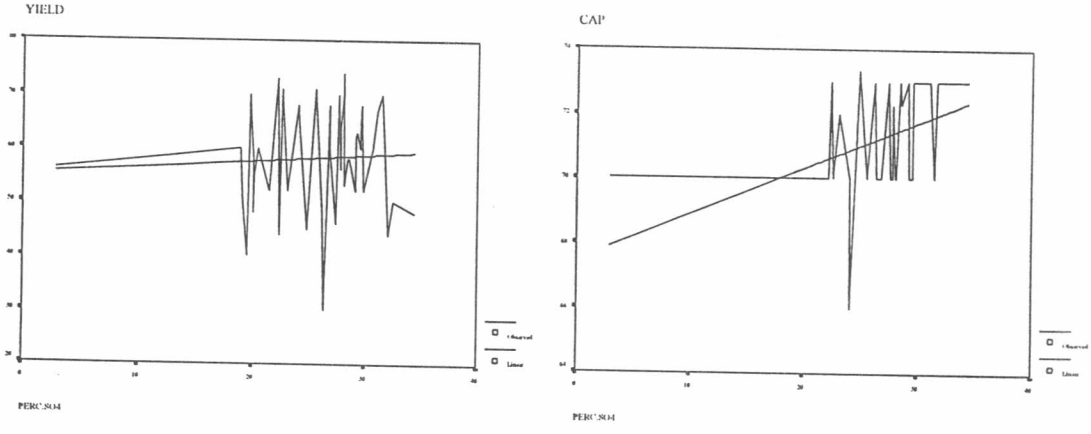

Figure (4.10) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 16-8-8 of April

Table (4.10a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 16-8-8 of April

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.067[a]	.004	-.018	9.95879

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.405	1	19.405	.196	.660[a]
	Residual	4363.813	44	99.178		
	Total	4383.217	45			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YIELD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	55.037	7.147		7.701	.000
	PERC.SO4	.121	.273	.067	.442	.660

a. Dependent Variable: YIELD

Table (4.10b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 16-8-8of April

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.471[a]	.222	.204	1.45895

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	26.714	1	26.714	12.551	.001[a]
	Residual	93.656	44	2.129		
	Total	120.370	45			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: CAP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	67.477	1.047		64.446	.000
	PERC.SO4	.142	.040	.471	3.543	.001

a. Dependent Variable: CAP

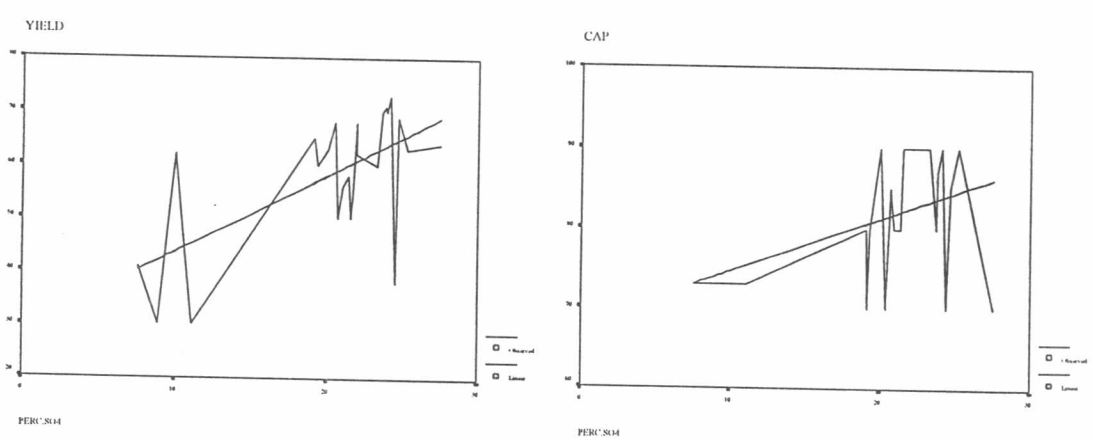

Figure (4.11) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 16-8-8 of July

Table (4.11a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 16-8-8 of July

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.619[a]	.383	.356	9.83704

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1382.350	1	1382.350	14.285	.001[a]
	Residual	2225.650	23	96.767		
	Total	3608.000	24			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YIELD

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	29.348	7.934		3.699	.001
	PERC.SO4	1.435	.380	.619	3.780	.001

a. Dependent Variable: YIELD

Table (4.11b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 16-8-8 of July

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.444[a]	.197	.163	7.17094

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	291.045	1	291.045	5.660	.026[a]
	Residual	1182.715	23	51.422		
	Total	1473.760	24			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: CAP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	68.030	5.784		11.762	.000
	PERC.SO4	.659	.277	.444	2.379	.026

a. Dependent Variable: CAP

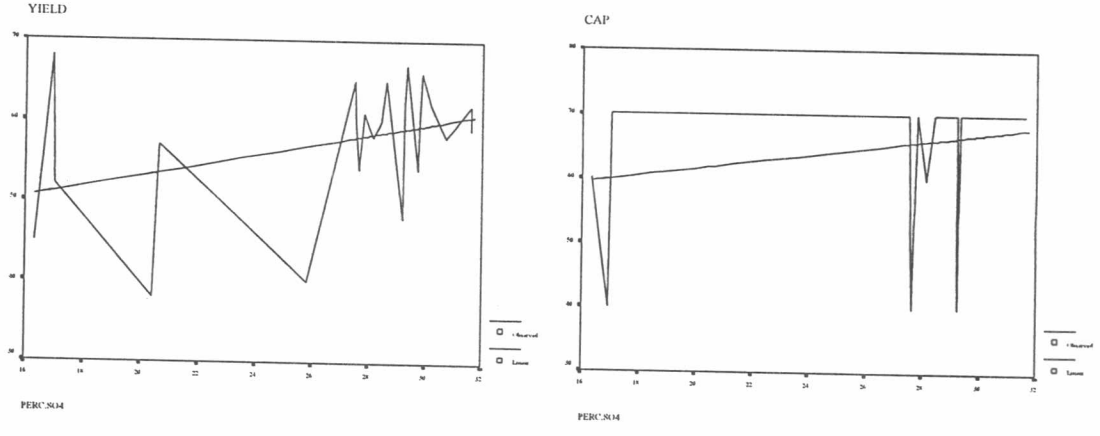

Figure (4.12) Linear Regression Line between Sulfuric Acid Concentration and Process Yield, Capacity of 15-7-18 of April

Table (4.12a) Linear Regression Line between Sulfuric Acid Concentration and Process Yield of 15-7-18 of April

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: YIELD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.384[a]	.147	.107	7.71906

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	216.391	1	216.391	3.632	.070[a]
	Residual	1251.261	21	59.584		
	Total	1467.652	22			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: YIELD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	40.041	9.268		4.320	.000
	PERC.SO4	.652	.342	.384	1.906	.070

a. Dependent Variable: YIELD

Table (4.12b) Linear Regression Line between Sulfuric Acid Concentration and Process Capacity of 15-7-18 of April

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PERC.SO4[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: CAP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.253[a]	.064	.019	10.28744

a. Predictors: (Constant), PERC.SO4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	151.454	1	151.454	1.431	.245[a]
	Residual	2222.459	21	105.831		
	Total	2373.913	22			

a. Predictors: (Constant), PERC.SO4

b. Dependent Variable: CAP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	50.666	12.352		4.102	.001
	PERC.SO4	.545	.456	.253	1.196	.245

a. Dependent Variable: CAP