

## CHAPTER 4

### RESULTS AND DISCUSSION

#### 4.1 Assumptions and Experimental Data

Table 4.1 Show the total glycerine loss of the soap plant from 1985 (Start up year) until the first half year of 1991 .It shows that the causes of the problem could be from the un-proper design or un-proper operation or control system .

After the experiment of the company show that the most significant or highest glycerine loss is due to the evaporator unit ,so the data of evaporator was collected and show in the Table 4.2 .

From the data and closely observe at the evaporator unit ,we found that

- a) The operating condition is fluctuation and always out of control.
- b) Itis the open system and could let the glycerine loss to the drainage .
- c) The evaporated water volume from the two evaporator is not much different but the entrainment separator of the first evaporator is three times smaller volume than the second one.

##### 4.1.1 Assumption

- a) Glycerine loss is due to the un-proper entrainment separator .

If we change or add a new entrainment separator ,we can reduce the vapor velocity so it could be trapped in the entrainment separator and will not be let to carry over to the vacuum system.

- b) Glycerine loss is due to the un-proper control system that will cause the solution level or temperature to be too high or the pressure is too low or high vacuum that will make the higher vapor velocity .

- c) Glycerine loss is due to the un-optimum condition.

## 4.1.2 Experimental Data before an Improvement

YEAR	SOAP TONAGE	(LOSS) / GAIN	
		KGS.	%
o 1985	N/A	(-43,772)	(-18)
o 1986	4,119	(-45,754)	(-14)
o 1987	7,562	(-95,670)	(-14)
o 1988	9,666	(-103,122)	(-12)
o 1989	11,007	(-149,766)	(-15)
o 1990	11,004	(-155,139)	(-12)
o 1991	1ST HALF	(-49,408)	(-11)

Table 4.1 Glycerine loss before improvement the soap plant.



## 4.2 Separator System

### 4.2.1 The Experimental Data after Installing Packed Bed at the first Evaporator

Table 4.3 The experimental data after installing packed bed at the first evaporator

Date	Packed Bed Height (Cm.)	Flushing Water Rate (Cu.M./Hr.)	Time	% Glycerol in Recycle Water
28/4/33	5.00	0.30	8.20	0.05
			8.25	0.01
			8.30	0.01
			8.35	0.01
			8.40	0.01
			8.45	0.01
			8.50	0.01
			8.55	0.01
			9.00	0.01
			9.05	0.01
			9.35	0.01
			10.05	0.01
			12.05	0.06
			12.35	0.02
			13.05	0.02
			13.35	0.02
			14.05	0.01
Average				0.02

Table 4.3 (Continue)

Date	Packed Bed Height (Cm.)	Flushing Water Rate (Cu.M./Hr.)	Time	% Glycerol in Recycle Water
3/5/33	5.00	0.30	11.00	0.54
			11.30	0.44
			12.00	0.11
			12.30	0.03
			13.00	0.03
			13.30	0.03
			14.00	0.03
			14.30	0.03
			15.00	0.02
			15.30	0.02
			16.00	0.02
			16.30	0.02
			17.00	0.02
			17.30	0.02
			18.00	0.02
			18.30	0.03
			19.00	0.02
			19.30	0.02
			20.00	0.03
			20.30	0.03
			Average	0.08

Table 4.3 (Continue)

Date	Packed Bed Height (Cm.)	Flushing Water Rate (Cu.M./Hr.)	Time	% Glycerol in Recycle Water
4/5/33	5.00	0.25	8.30	0.02
			9.00	0.02
			9.30	0.02
			10.00	0.02
			10.30	0.02
			11.00	0.02
			11.30	0.04
			12.00	0.02
			12.30	0.01
			13.00	0.02
			13.30	0.02
			14.00	0.03
			14.30	0.03
			15.00	0.02
			15.30	0.01
			16.00	0.02
			16.30	0.02
			17.00	0.02
			17.30	0.02
			18.00	0.02
			Average	0.02

Table 4.3 (Continue)

Date	Packed Bed Height (Cm.)	Flushing Water Rate (Cu.M./Hr.)	Time	% Glycerol in Recycle Water
7/5/33	5.00	0.20	8.30	0.04
			9.00	0.03
			9.30	0.04
			10.00	0.01
			10.30	0.01
			11.00	0.01
			11.30	0.01
			12.00	0.02
			12.30	0.02
			13.00	0.03
			13.30	0.05
			14.00	0.05
			14.30	0.05
			15.00	0.05
			15.30	0.06
			16.00	0.03
			16.30	0.03
			17.00	0.03
			17.30	0.04
			18.00	0.04
			Average	0.03

Table 4.3 (Continue)

Date	Packed Bed Height (Cm.)	Flushing Water Rate (Cu.M./Hr.)	Time	% Glycerol in Recycle Water
8/5/33	5.00	0.15	8.00	0.05
			8.30	0.05
			9.00	0.05
			9.30	0.02
			10.00	0.03
			10.30	0.04
			11.00	0.03
			11.30	0.01
			12.00	0.02
			12.30	0.03
			13.00	0.02
			13.30	0.02
			14.00	0.03
			14.30	0.06
			Average	0.03



Table 4.3 (Continue)

Date	Packed Bed Height (Cm.)	Flushing Water Rate (Cu.M./Hr.)	Time	% Glycerol in Recycle Water
15/5/33	8.00	0.30	8.00	0.46
			8.30	0.05
			9.00	0.03
			9.30	0.03
			10.00	0.04
			10.30	0.04
			11.00	0.04
			11.30	0.05
			12.00	0.06
			12.30	0.20
			13.00	2.07
			13.30	1.98
			14.00	0.04
			14.30	0.02
			15.00	0.01
			15.30	0.03
			16.00	0.02
			16.30	0.03
			17.00	0.03
			17.30	0.03
Average				0.26

Table 4.3 (Continue)

Date	Packed Bed Height (Cm.)	Flushing Water Rate (Cu.M./Hr.)	Time	% Glycerol in Recycle Water
16/5/33	8.00	0.10	8.30	1.35
			9.00	0.01
			9.30	0.07
			10.00	0.04
			10.30	0.04
			11.00	0.03
			11.30	
			12.00	0.58
			12.30	0.12
			13.00	0.06
			13.30	0.04
			14.00	0.05
			14.30	0.04
			15.00	0.04
			15.30	0.05
			16.00	0.05
			16.30	0.04
			17.00	0.16



4.2.2 The Experimental Data after Installing the Larger Entrainment  
Separator at the First Evaporator

Table 4.4 The experimental data after installing the larger entrainment  
separator at the first evaporator .

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
21-5-91	10:02	0.00	13.03	25.86	0.00	9.05	72.85
	10:30	341.70			0.00		
	11:00	658.80			56.35		
	11:30	1,133.50			219.98		
	12:00	1,575.00			376.75		
	13:00	2,275.10	13.08	25.63	652.29	8.95	74.67
	13:30	2,723.80			834.58		
	14:00	3,040.50			934.75		
	14:30	3,246.90			1,018.55		
	15:00	3,616.80			1,134.50		
	15:30	3,946.20			1,278.22		
	16:00	4,445.40	13.16	25.12	1,436.02	8.95	73.64
TOTAL	5.97	4,445.40	13.09	25.54	1,436.02	8.98	73.72
		GLYCERINE (LOSS)/GAIN	(12.83)		KGS./HR.		
		=	(1.72)%				

Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
22-5-91	08:00	21,823.30			6,709.69		
	08:30	22,141.90			6,709.69		
	09:00	22,380.90			6,719.17		
	09:30	22,928.50			6,926.15		
	10:00	23,395.80	13.91	25.17	7,118.90	9.62	74.04
	10:30	23,883.50			7,319.88		
	11:00	24,324.90			7,505.10		
	11:30	24,749.40			7,665.44		
	13:00	26,299.00			8,288.57		
	13:30	26,841.20	14.40	23.92	8,465.85	9.28	71.72
	14:00	27,401.90			8,637.15		
	14:30	27,857.90			8,781.14		
	15:00	28,430.50			8,998.90		
	15:30	28,919.20			9,187.88		
	16:00	29,557.60	11.93	23.86	9,231.47	9.56	75.25
	TOTAL	8.00	7,734.30	13.41	24.32	2,521.78	9.49
GLYCERINE (LOSS)/GAIN			(2.87)		KGS./HR.		
		=	(0.30)%				

Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
23-5-91	08:00	0.00			0.00		
	08:30	550.40			203.51		
	09:00	1,092.90			379.25		
	09:30	1,585.30			538.00		
	10:00	2,069.10	14.03	23.47	706.50	9.00	75.64
	10:30	2,535.20			869.35		
	11:00	3,070.70			1,064.30		
	11:30	3,701.90			1,338.57		
	12:00	4,215.30			1,481.52		
	13:00	5,435.20	12.86	23.29	1,916.95	9.50	75.90
	13:30	5,967.30			2,130.46		
	14:00	6,509.50			2,303.95		
	14:30	7,018.40			2,501.75		
	15:00	7,489.50			2,688.85		
	15:30	8,159.60			2,885.60		
	16:00	8,788.30	12.85	24.44	2,917.27	11.21	71.30
TOTAL	8.00	8,788.30	13.25	23.73	2,917.27	9.90	74.28
		GLYCERINE (LOSS)/GAIN	10.15		KGS./HR.		
		=	0.92 %				

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Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% CI.	% GLY.	ACC.KGS.	% CI.	% GLY.
01-6-91	08:00	0.00			0.00		
	09:00	717.80			272.00		
	10:00	1,377.80	12.16	26.20	515.00		
	11:00	1,963.90			739.00		
	12:00	2,547.90			989.00		
	13:00	2,996.70	12.13	25.34	1,157.00	3.01	75.24
	14:00	3,830.00			1,325.00		
	15:00	4,642.50			1,564.00		
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TOTAL	7.00	4,642.50	12.15	25.77	1,564.00	3.01	75.24
		GLYCERINE (LOSS)/GAIN	(2.30)		KGS./HR.		
		=	(0.42)%				



Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
04-6-91	08:00	0.00			0.00		
	08:30	380.40			0.00		
	09:00	727.00			0.00		
	09:30	1,054.50			2.55		
	10:00	1,499.90	12.54	23.16	124.85	8.09	81.39
	10:30	1,840.80			240.55		
	11:00	2,154.30			347.84		
	11:30	2,415.80			413.31		
	12:00	2,915.30			513.30		
	13:00	3,397.30	12.58	23.26	608.98	7.71	81.74
	13:30	3,654.20			699.02		
	14:00	3,928.20			790.32		
	14:30	4,147.30			874.02		
	15:00	4,280.50			933.16		
	15:30	4,669.00			1,019.65		
	16:00	5,128.40	12.54	22.65	1,091.08	8.42	79.58
	16:30	5,554.10			1,165.95		
TOTAL	8.50	5,554.10	12.59	23.02	1,165.95	8.07	80.90
		GLYCERINE (LOSS)/GAIN	(39.46)		KGS./HR.		
		=	(6.04)%				

Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
05-6-91	08:00	14,732.50			3,115.11		
	08:30	15,145.20			3,115.11		
	09:00	15,328.10			3,214.62		
	09:30	15,819.90			3,354.82		
	10:00	16,076.70	12.32	24.84	3,462.96	8.45	76.18
	10:30	16,380.50			3,566.30		
	11:00	16,524.70			3,668.78		
	11:30	16,994.80			3,770.05		
	12:00	17,565.50			3,826.17		
	13:00						
	13:30	18,748.90	12.14	24.81	4,089.61	9.44	75.72
	14:00	19,068.30			4,255.34		
	14:30	19,444.30			4,351.52		
	15:00	19,769.60			4,518.70		
	15:30	20,258.30			4,699.89		
	16:00	20,648.00	12.24	24.92	4,897.21	8.66	74.01
TOTAL	8.00	5,915.50	12.23	24.86	1,782.10	8.85	75.30
		GLYCERINE (LOSS)/GAIN	(16.05)		KGS./HR.		
		=	(2.17)%				

Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
06-6-91	08:00	0.00			0.00		
	08:30	224.30			30.18		
	09:00	516.50			61.32		
	09:30	886.80			205.85		
	10:00	1,447.90	12.36	23.42	412.60	8.38	73.33
	10:30	2,020.70			620.66		
	11:00	2,619.60			845.54		
	11:30	3,099.50			1,026.89		
	12:00	3,774.90			1,244.88		
TOTAL	4.00	3,774.90	12.36	23.42	1,244.88	8.38	73.33
GLY CERININE CLASS GAIN			7.29		KGS./HR.		
		=	0.76 %				

Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
07-6-91	08:00	21,756.00			5,636.95		
	08:30	21,386.20			5,791.65		
	09:00	22,304.30			5,944.26		
	09:30	22,859.60			6,097.61		
	10:00	23,245.50	13.49	24.29	6,250.65	8.34	75.31
	10:30	23,522.70			6,412.73		
	11:00	24,468.20			6,539.84		
	11:30	24,828.80			6,718.08		
	12:00	25,430.40			6,789.98		
	13:00	26,074.60			6,798.03		
	13:30	26,373.60	13.60	26.86	6,806.01	8.71	74.20
	14:00	26,760.30			6,963.29		
	14:30	27,054.70			7,002.25		
	15:00	27,372.70			7,163.32		
	15:30	27,876.00			7,340.85		
	16:00	28,234.20	13.37	21.12	7,521.47	8.26	71.77
TOTAL	8.00	6,478.20	13.49	24.09	1,884.52	3.44	73.76
		GLYCERINE (LOSS)/GAIN	(21.32)		KGS./HR.		
		=	(2.63)%				

Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
11-6-91	08:00	0.00			0.00		
	08:30	188.50			92.00		
	09:00	526.20			145.00		
	09:30	708.00			246.00		
	10:00	1,009.00	13.55	22.41	378.00	7.97	76.71
	10:30	1,192.60			401.00		
	11:00	1,306.20			492.00		
	11:30	1,530.20			541.00		
	12:00	1,772.40			602.00		
	13:00	1,982.20	13.45	22.26	611.00	8.77	75.82
	13:30	2,071.90			654.00		
	14:00	2,194.60			703.00		
	14:30	3,021.60			703.00		
	15:00	3,565.60			703.00		
	15:30	3,955.90	13.37	22.79	713.00	8.08	75.79
	16:00	4,154.80			817.00		
	16:35	4,317.60			1,023.60		
TOTAL	8.58	4,317.60	13.46	22.49	1,023.60	8.27	76.11
		GLYCERINE (LOSS)/GAIN	(22.35)		KGS./HR.		
		=	(4.44)%				

Table 4.4 (Continue)

DATE	TIME	FEED			OUTPUT		
		ACC.KGS.	% Cl.	% GLY.	ACC.KGS.	% Cl.	% GLY.
12-6-91	08:00	10,890.00			2,417.84		
	08:30	10,934.80			2,417.84		
	09:00	11,035.60			2,417.84		
	09:30	11,047.40			2,417.84		
	10:00	11,118.00			2,417.84		
	10:30	11,186.90			2,417.84		
	11:00	11,281.30			2,463.80		
	11:30	11,428.10			2,601.61		
	12:00	11,434.00			2,601.61		
	13:00	11,837.90			2,720.39		
	13:30	12,187.50			2,763.23		
	14:00	12,332.00			2,862.77		
	14:30						
	15:00	13,062.80	12.68	27.65	3,190.76	9.12	75.01
	15:30						
	16:00	13,741.90			3,499.14		
	17:00	14,483.00			3,687.51		
TOTAL	9.00	3,593.00	12.68	27.65	1,269.67	9.12	75.01
		GLYCERINE (LOSS)/GAIN	(4.57)		KGS./HR.		
		=	(1.14%)				



## LEVEL CONTROL EVAP # 1

VALVE NO. 13

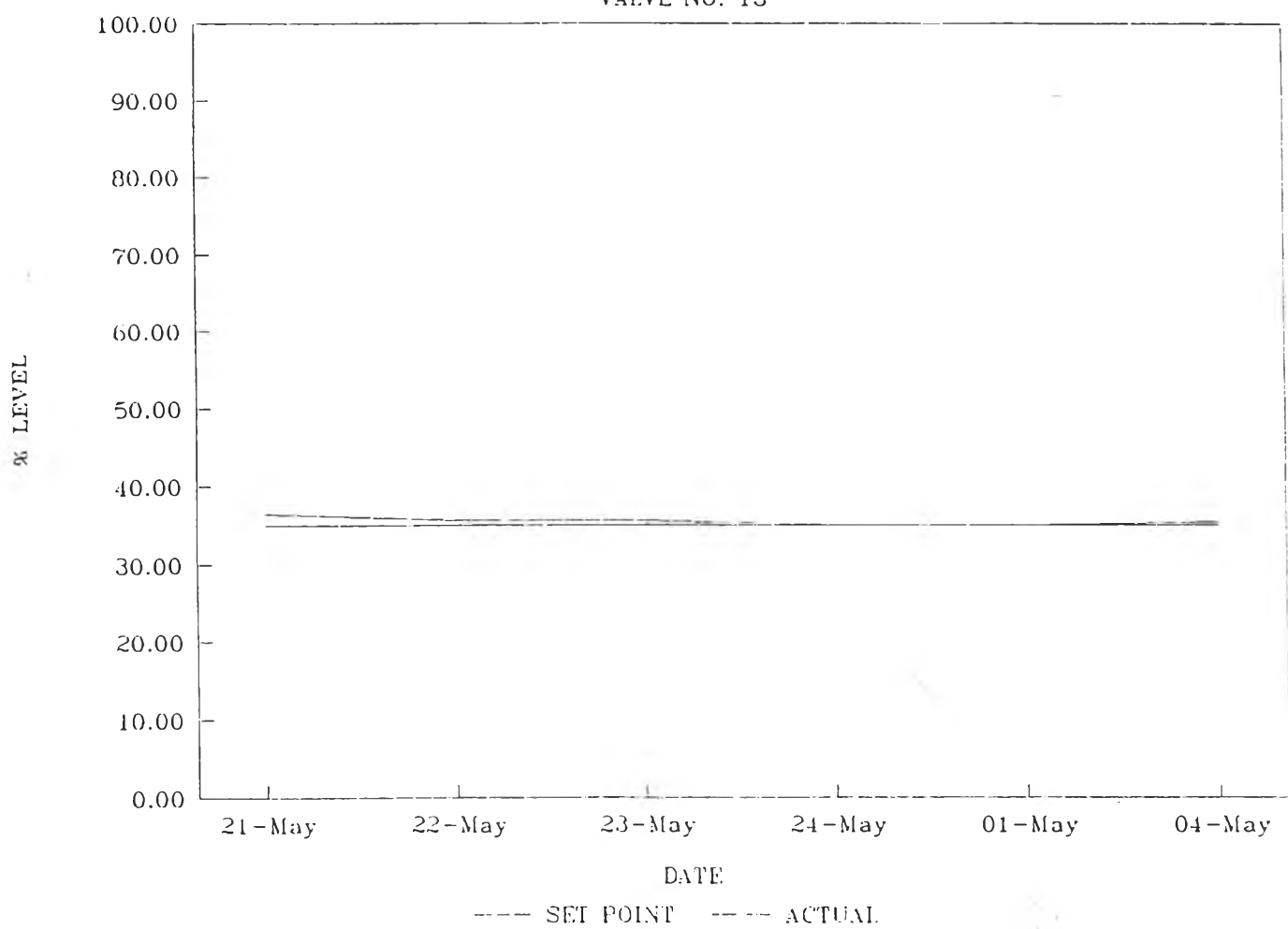


Fig 4.1 First Evaporator Level Control



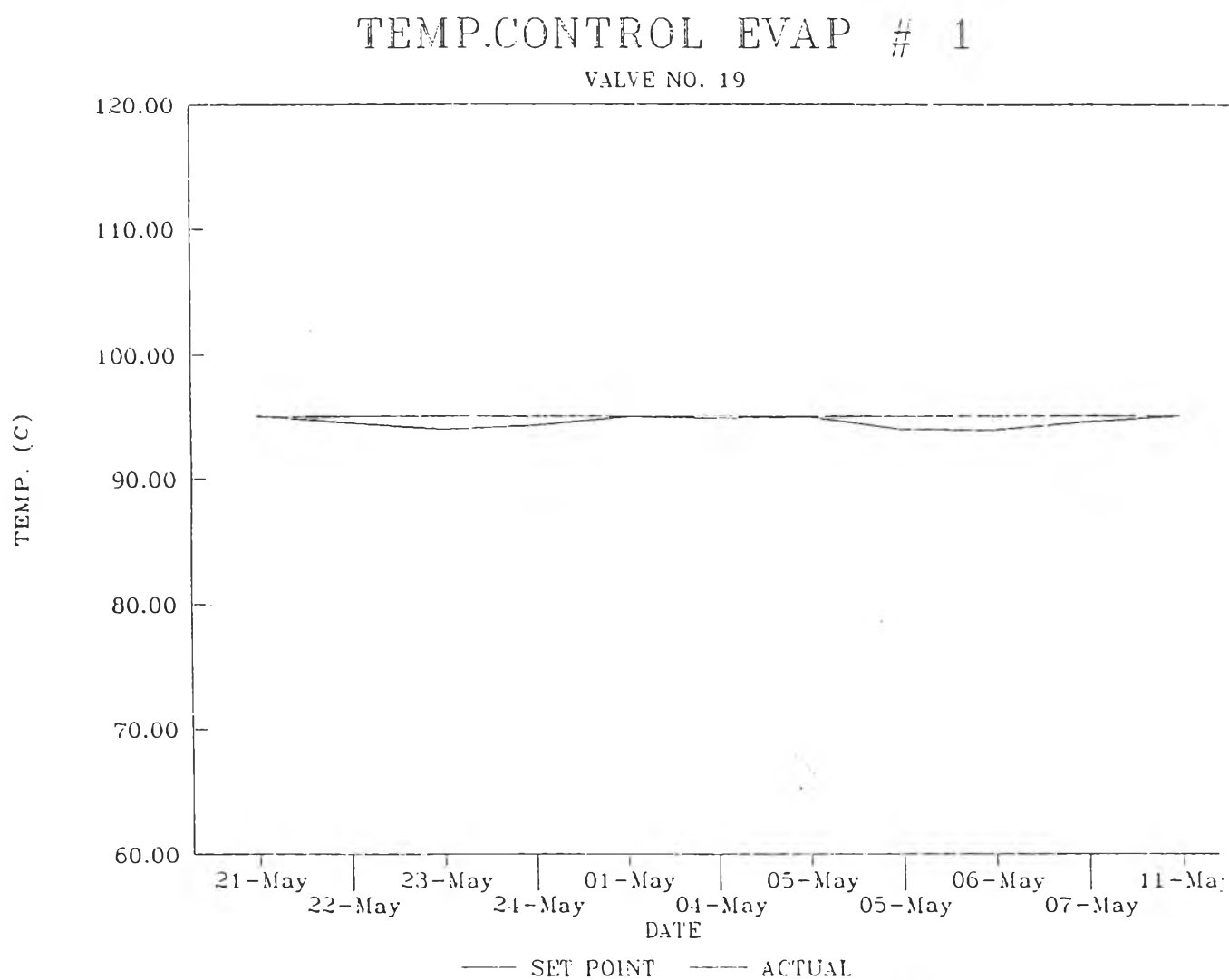


Fig 4.2 First Evaporator Temperature control

# VACUUM CONTROL EVAP # 1

VALVE NO. 20

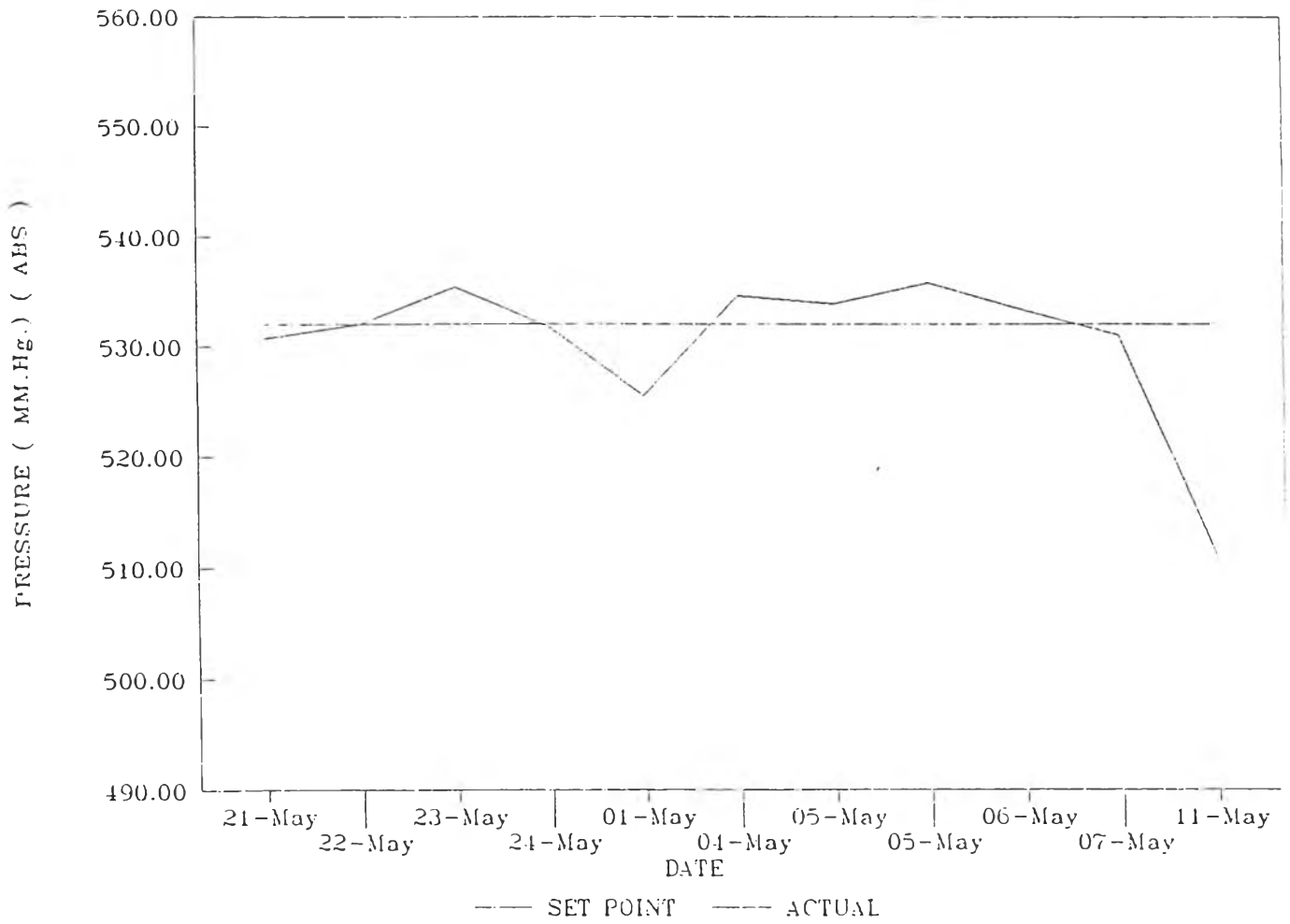


Fig 4.3 First Evaporator Vacuum Control

# LEVEL CONTROL EVAP # 2

VALVE NO.14

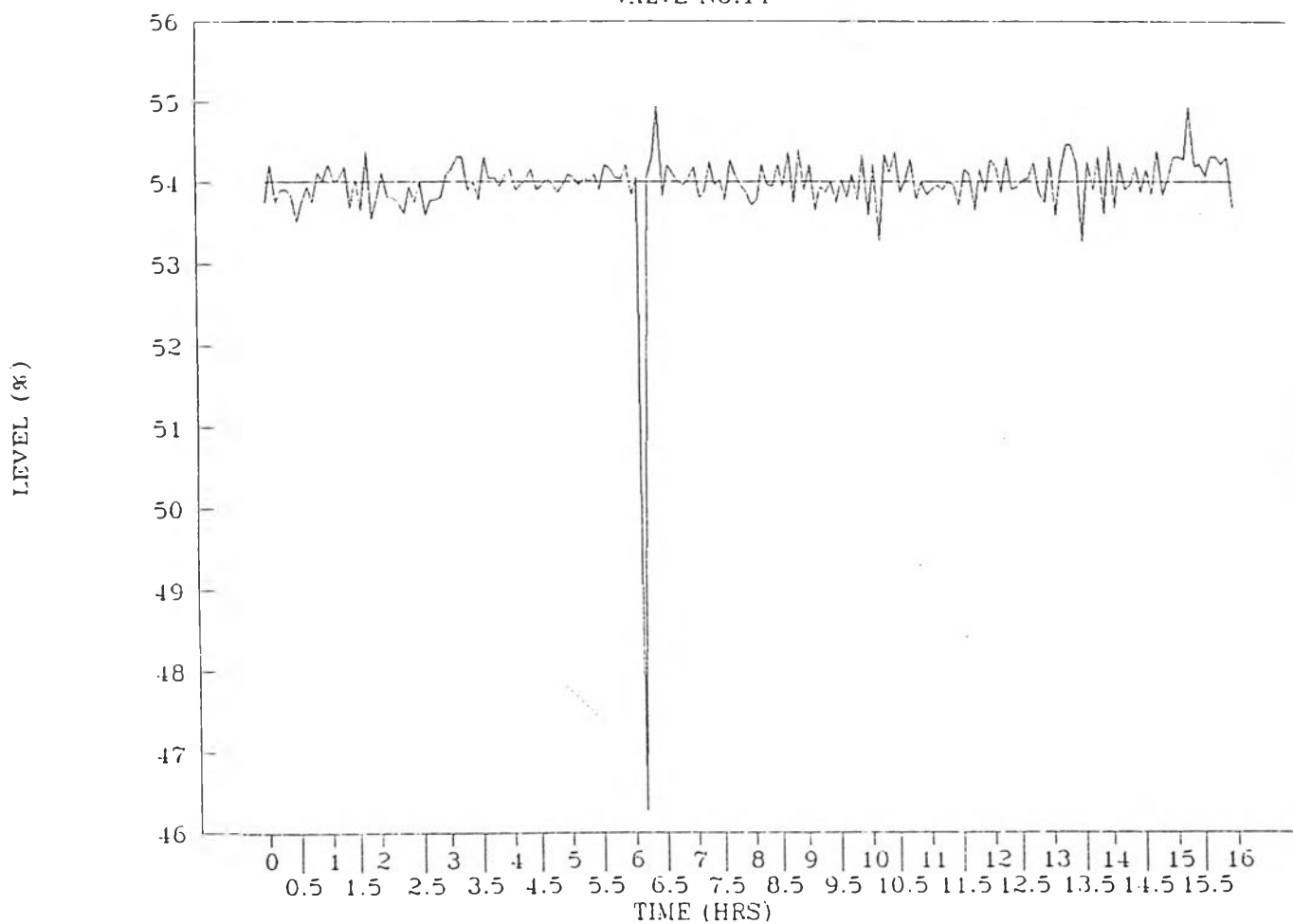


Fig 4.4 Second Evaporator Level Control

## TEMP. CONTROL EVAP # 2

VALVE NO. 18

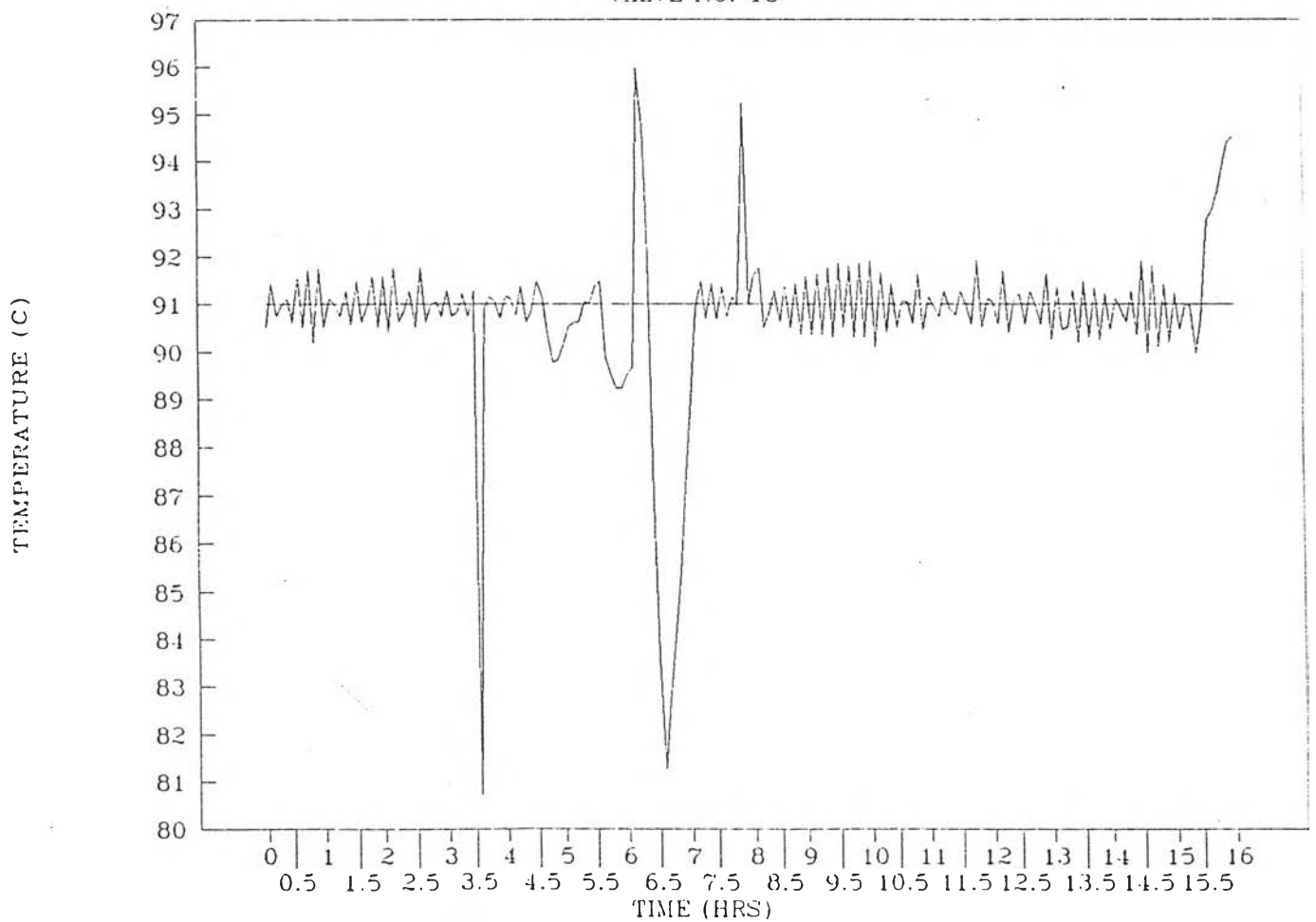


Fig 4.5 Second Evaporator Temperature Control

# VACUUM CONTROL EVAP # 2

VALVE NO.16

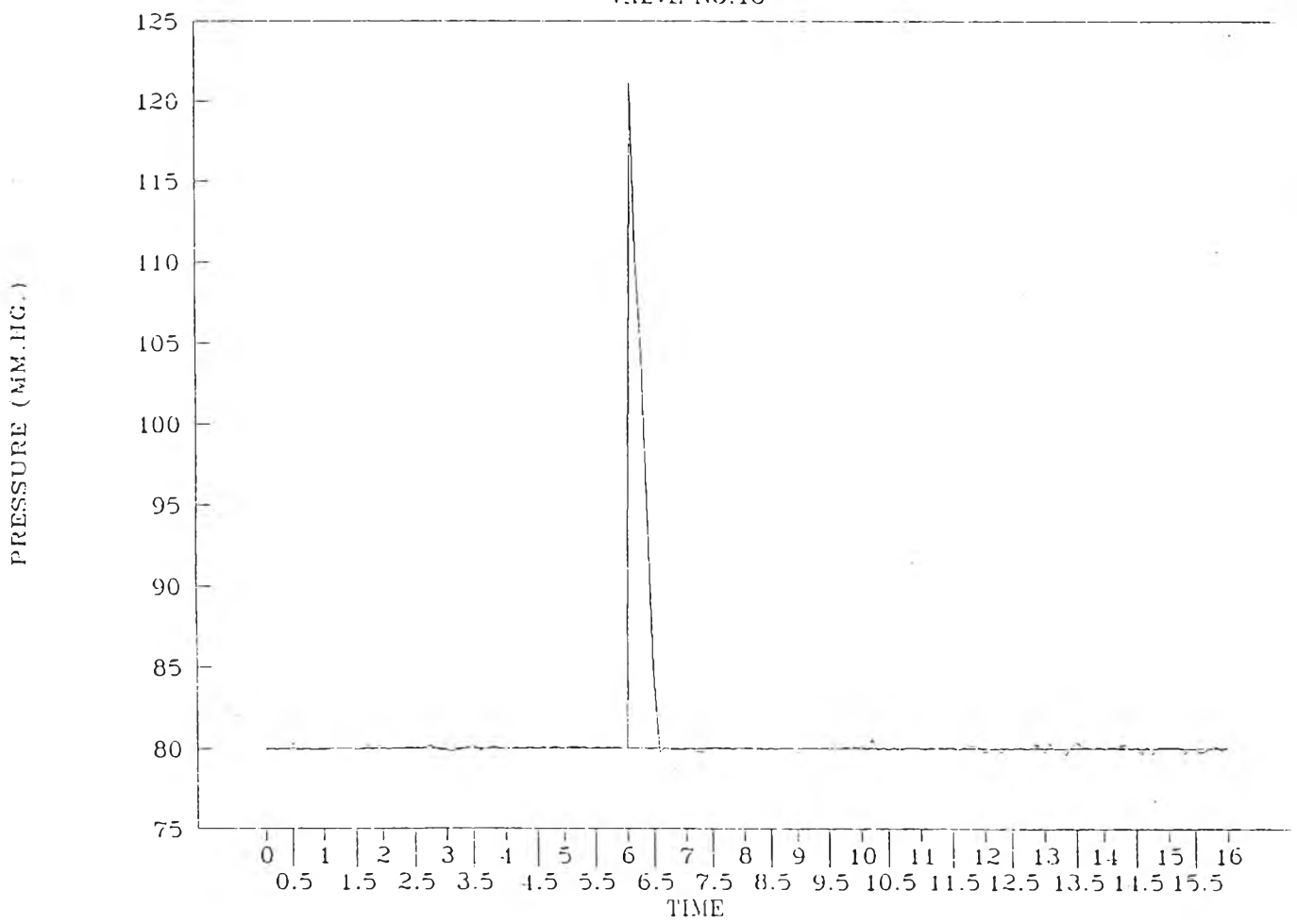


Fig 4.6 Second Evaporator Vacuum Control

#### 4.4 Discussion

Table 4.6 Show the result after installing the packed bed .It shows that packed bed can trap glycerine from the evaporator unit at a very little level, but from the result at Table 4.7 ,the average glycerine loss at the evaporator is reduced from 5.65 % to 1.55 % .It shows that the hypothesis that we set from the observation of the evaporator is the main effect of the glycerine loss .And the Table 4.8 is to confirm the experiment that the glycerine loss is significantly reduced after the installation of the larger entrainment separator at the first evaporator and modification of the control system .It is reduced from 11-18 % at the past six years to 1 % only at the second half of 1991 .

Date	Packed Bed Height (Cm.)	Flushing Water Rate (Cu.M./Hr.)	Avg. % Gly. In Trap Water	As Anh.Gly. Trapped (Kgs./Hr.)
28/4/33	5.00	0.30	0.02	0.06
3/5/33	5.00	0.30	0.08	0.24
4/5/33	5.00	0.25	0.02	0.05
7/5/33	5.00	0.20	0.03	0.06
8/5/33	5.00	0.15	0.03	0.05
15/5/33	8.00	0.30	0.26	0.78
16/5/33	8.00	0.10	0.16	0.16
22/5/33	10.00	0.15	0.04	0.06
Average			0.08	0.18

Table 4.6 Result of the glycerine recovery after installing the packed bed

DATE	EVAP.#1		EVAP.#2		% GLY.
	TEMP.	PRESS.	TEMP.	PRESS.	(LOSS)/GAIN
21-5-91	95.08	530.70	83.32	81.68	(1.72)
22-5-91	94.95	532.01	85.00	82.53	(0.30)
23-5-91	93.95	535.45	87.66	83.44	0.92
24-5-91	94.21	531.70	89.80	81.54	0.12
01-6-91	94.93	525.48	90.76	80.64	(0.42)
04-6-91	94.81	534.62	88.08	71.68	(6.04)
05-6-91	94.94	533.85	90.40	85.05	(2.17)
06-6-91	93.87	533.25	87.32	86.29	0.76
07-6-91	94.54	530.95	90.16	83.59	(2.63)
11-6-91	95.01	511.06	93.13	79.98	(4.44)
12-6-91	94.93	477.92	100.40	98.67	(1.14)
AVERAGE					(1.55)

Table 4.7 Result of the glycerine loss after adding the larger entrainment separator to the first evaporator.

YEAR	SOAP TONAGE	(LOSS)/GAIN	%
		KGS.	
O 1985	N/A	(43,772)	(18)
O 1986	4,119	(45,754)	(14)
O 1987	7,502	(95,670)	(14)
O 1988	9,666	(103,122)	(12)
O 1989	11,007	(149,766)	(15)
O 1990	11,004	(155,189)	(12)
O 1991	1 ST HALF	(49,408)	(11)
O 1991	2 ND HALF	(2,599)	(1)

Table 4.8 Glycerine loss data from start up plant to 1991 after improving the system