Background Report Reference

AP-42 Section Number: 8.13

Background Chapter: 4

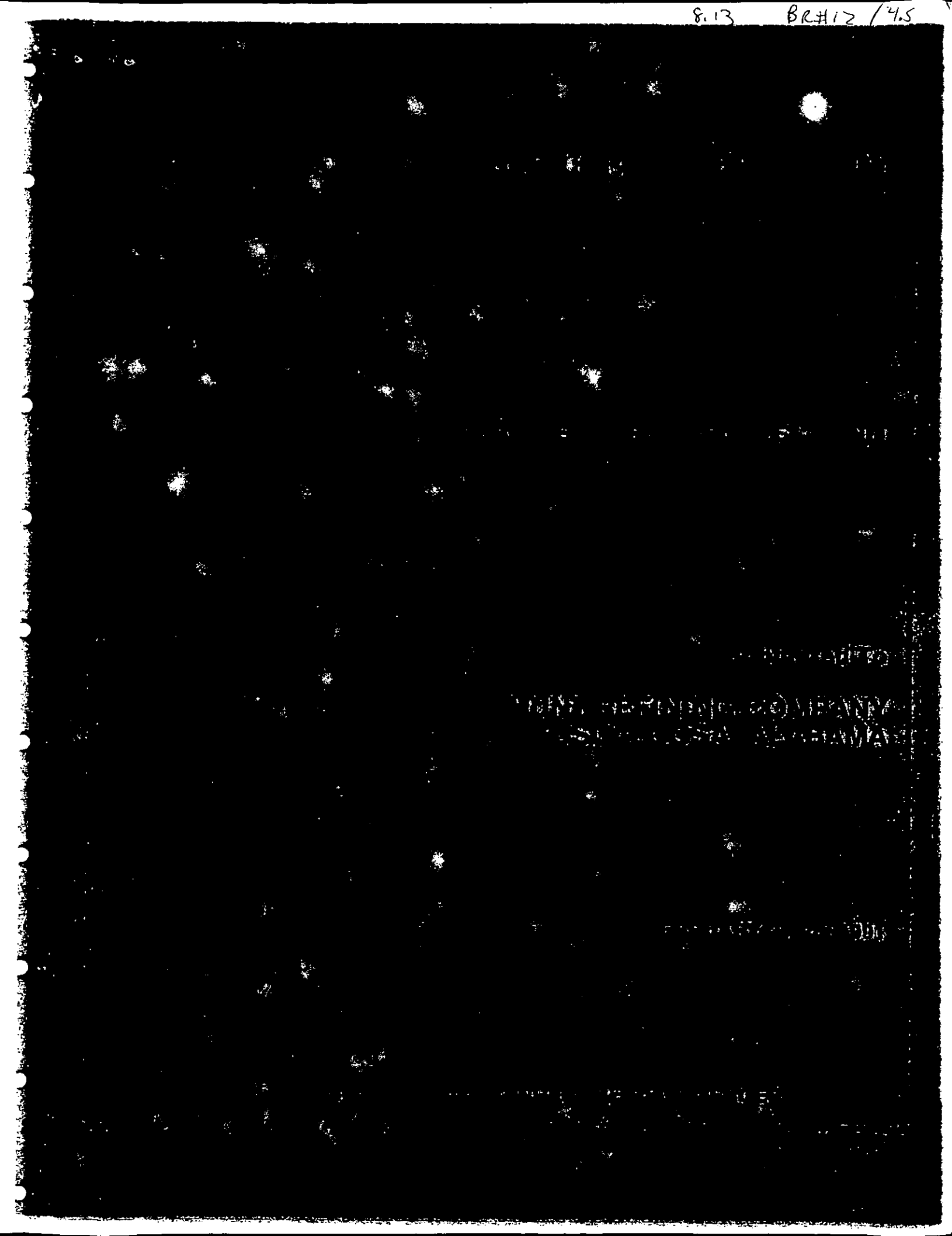
Reference Number: 12

Title: Compliance Test Report: Hunt Refining Company-Number One Sulfur Recovery Unit

TTL, Inc.

February 1991

Research
storage file



SULFUR RECOVERY STUDY

ON THE

NUMBER ONE SULFUR RECOVERY UNIT

FOR

HUNT REFINING COMPANY'S PETROLEUM REFINERY

TUSCALOOSA, ALABAMA

February 27 and 28, 1991

Contents

INTRODUCTION

This report documents the sulfur recovery efficiency tests performed on the Number One Sulfur Recovery Unit of the Petroleum Refinery operated by Hunt Refining Company in Tuscaloosa, Alabama, on February 27 and 28, 1991. The purpose of these tests was to measure the sulfur recovery efficiency of this process unit and to evaluate its performance under the Alabama Department of Environmental Management's Air Pollution Control Rules and Regulations.

Mr. Charles Markin was present during the tests and was responsible for the operation of this equipment. Messrs. Garry Pearson and Lee Lindley performed the tests for TTL, Tuscaloosa, Alabama.

DESCRIPTION OF INSTALLATION & PROCESS OPERATION

The tests described in this report were conducted on the sulfur gas incinerator in the Number One Sulfur Recovery Unit of Hunt Refining Company's Tuscaloosa Refinery.

The operation consisted of mixing two gas streams together to produce a raw, high-hydrogen sulfide gas stream for elemental sulfur recovery. The two gas streams are called acid gas and sour gas. After mixing, the gas streams are forced through a catalytic sulfur recovery unit. From the sulfur recovery unit, the gas stream is fed into an incinerator for conversion of the remaining hydrogen sulfide to sulfur dioxide that is allowed to discharge into the air. Figure 1 shows the gas process flow of the Hunt Refining Company's Number One Sulfur Recovery Unit.

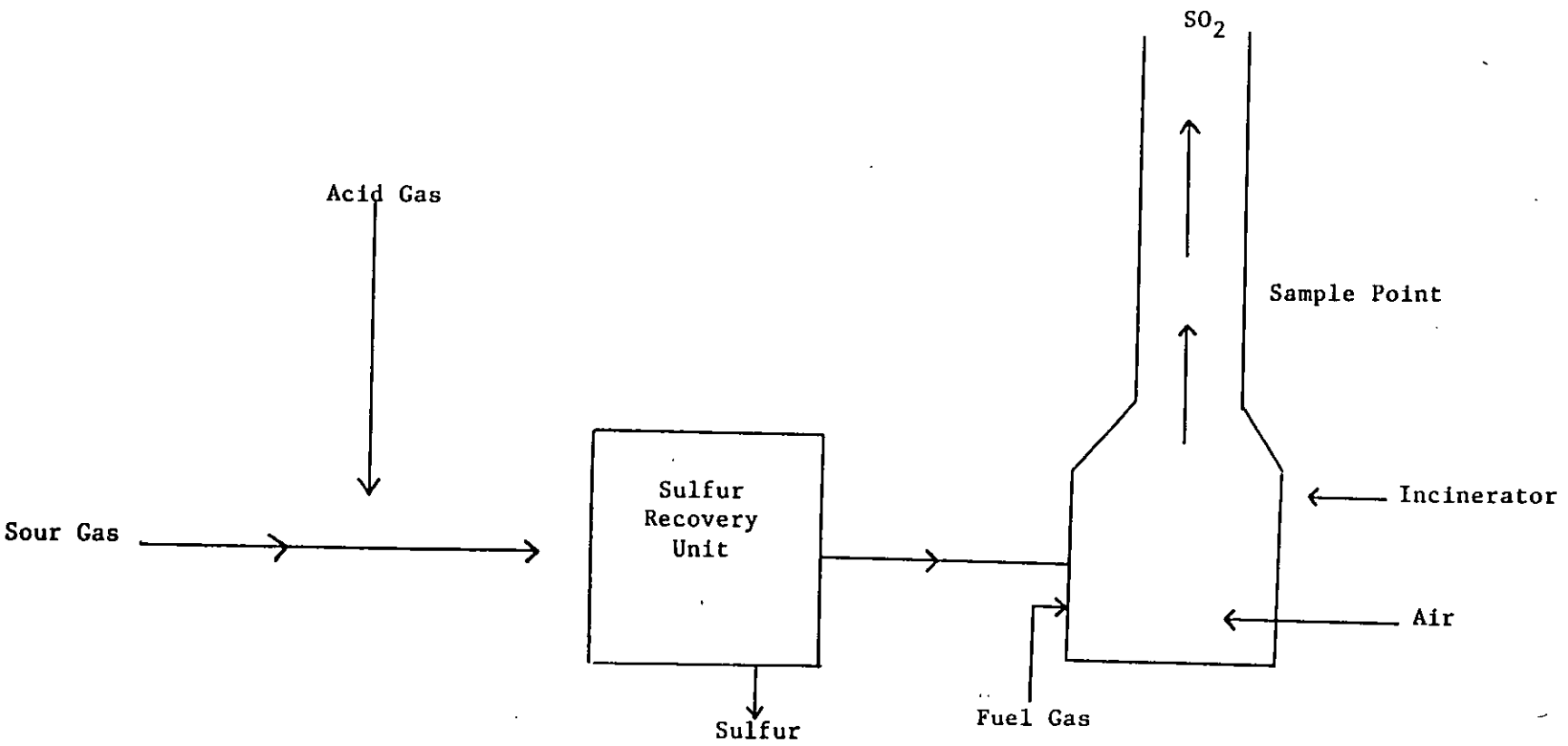


Figure 1. Gas Process Flow Sheet

SUMMARY OF PARAMETERS AND EMISSION RATES

Tables I is summary of results of the tests performed on the effluent gas from the Number One Sulfur Recovery Unit and incinerator on February 27 and 28, 1991.

The sulfur feed rates to the recovery unit during the test were 2945, 2982, and 2698 lb/hr for an average of 2875 lb/hr. The production rates of sulfur during the tests were 2837, 2909, and 2617 lb/hr for an average of 2788 lb/hr. Therefore, the sulfur recovery efficiencies for this unit during these tests were 96.35, 97.56, and 97.02 percent for an average of 96.97 percent.

During the tests, the average discharge characteristics of the discharge stack were as follows:

Temperature	1015 °F
Moisture	9.97 %
Velocity	9.554 fps
Flow	8,949 ACFM

TTL, Inc.

Jack E. Davis, CIH

James C. Bambarger, P.E.

TABLE I

TEST RESULTS

		Run No. 1		Run No. 2		Run No. 3		Average
		H_2S	SO_2	H_2S	SO_2	H_2S	SO_2	
Stack Gas Temperature (F)		1020	930	1025	1030	1046	1041	1015
Moisture Content (% By Volume)		8.34	3.36	21.49	5.54	10.16	10.93	9.97
Stack Gas Velocity (actual ft/sec)		7.361	9.052	8.590	8.788	11.94	11.60	9.554
Volumetric Flow Rate (actual cfm)		6895	8479	8046	8231	11180	10863	8949
Volumetric Flow Rate (dscfm)		2272	3137	2264	2776	3544	3424	2903
Concentration (gr/dscf)	SO_2		7.96		6.07		5.42	6.49
	H_2S	0.0220		0.0224		0.0314		0.0253
Mass Rate (lb/hr)	SO_2		214		145		159	173
	H_2S	0.427		0.436		0.955		0.606
Sulfur Mass Rate (lb/hr)	as SO_2		107.2		72.3		79.6	86.4
	as H_2S	0.402		0.410		0.899		0.570
Total			108		72.7		80.5	86.9
Sulfur Production Rate (lb/hr)		3005	2669	2909	2909	2617	2617	
Average			2837		2909		2617	2788
Total Sulfur Feed Rate (lb/hr)			2945		2982		2698	2875
Recovery Efficiency			96.35		97.56		97.02	96.97

Source for: #6 & #7

On August 20 and 21, 1991, TTL performed SO_2 emission tests on the number two sulfer recovery unit of the petroleum refinery operated by Hunt refiy company in Tuscaloosa, AL. The tests were conducted on the sulfer gas incinerator in the number two sulfur plant. The tests consisted three runs and the results are summarized below.

	Run #1	Run #2	Run #3
volumetric flow rate (dscfm)	2,753	3,004	2,824
Concentration of SO_2 (mg/dscf)	2.40	1.71	2.24
Concentrat of SO_2 (mg/min)	6,607.2	5,136.8	6,325.8

$$2,753 \frac{dscf}{m} \times 2.40 \frac{mg}{dscf} = 6,607.2$$

	Run #1	Run #2	Run #3
Concentrat of SO_2 (~~mg~~ lb/hr)	0.874	0.679	0.837

$$6,607.2 \frac{mg}{min} \times \frac{60\,min}{hr} \times \frac{1\,gr}{10^3\,mg} \times \frac{1\,lb}{453.59\,g} = 0.874\ lb/hr$$

	Run #1	Run #2	Run #3
Sulfur production rate (lb/hr)	2,704	1,637	2,247
SO_2 emission (lb/ton product)	0.646	0.829	0.745

$$\frac{0.874 \frac{lb}{hr}}{2,704 \frac{lb}{hr} \times \frac{1\,ton}{2000\,lb}} = 0.646$$

The tests were conducted using Method 6.

rating: "C"
sample volume too small

Source Test # 6

Hunt Refining Co (#1 sulfur recovery unit)

Tuscaloosa, AL

Control: incinerator

Sulfur recovery eff. 96.35, 97.56 & 97.02

Avg = 96.98

# of stages ?

control: gas strea → a catalytic sulfur recovery unit → incine

		Run 1	Run 2	Run 3
	Sulfur feed rate (lb/gr)	2945	2982	2698
*	product rate of sulfur (lb/gr)	2837 ~~1905~~	2909 ~~2647~~	2617 ~~2788~~
	Sulfur recovery eff	96.35	97.56	97.02
X	So2 emiss	214	145	159

The sampling test was conducted using EPA Reference Method 6

The test consisted of three 60-minute runs.

Note: These source test will not be used because there is no inform on the number of catalytic stages

EVALUATOR Steven Sharpe EVALUATION DATE 6-26-92

METHOD 6: SECONDARY EMISSIONS TEST REPORT EVALUATION

STATE: AL FACILITY: Hunt Refining Co Tuscaloosa Alabama TEST DATE: 27-28 Feb 91

PROCESS(ES) TESTED: #1 & #2 Sulfure Recovery Unit

SAMPLING DURATION ~~3~~ 2
must have at least 3 runs, each ≥ 1 hour duration; if midget impingers, each run is two 20 minute samples

~~[illegible]~~

Sample Volume too small

PRODUCTION RATE 3
is production rate during testing representative of normal production

CONTROL DEVICE(S)
are devices described, and their eff[illegible]ncies given

Field file #1 stage & recovery cell.

METHOD 1 3
are calculat[illegible] [illegible]ovided

METHODS 2,3 3
are data and calcu[illegible] [illegible]cluded for gas velocity, cyclonic flow, [illegible]lecular weight determination, and [illegible] source of barometric pressure noted

METHOD 4 3
are data and calculations included for moisture content determination, and is moisture content realistic [< saturation]

FIELD DATA —
is field data on standard forms, and does raw data correspond with printout

BOILER TESTS N/A
calculation of F_0 fr[illegible] [illegible]urate

Scrubber Cal #6C?

SAMP[illegible] 3
pro[illegible] [illegible]densation; te[illegible]

EQUIPME[illegible] 3
was a boros[illegible] [illegible]s probe liner used

CALIBRATION
were both pre- and post-test calibrations performed for:

meter box 2

pitot tube 2

temperature sensor 2

nozzle (3 ϕ) 2

LEAK CHECKS 2
both pre- and post-test

BLANKS 3
were reagent blanks analyzed, and were any problems addressed

REAGENT PURGE 2
IPA must be purged w/ air for 10 minutes following sampling

~~METHOD 11~~

Rating C

Hunt Refining

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Recovery Efficiency			96.35		97.56		97.02	96.97

PRODUCTION DATA SHEET

CLIENT: Hunt Oil Company
Tuscaloosa, Alabama

TEST SITE: Sulfur Gas Incinerator

RUN	DATE	TIME	DURATION	SULFUR PRODUCTION RATE
I-H_2S	2/27/91	1:41 PM 2:41 PM	60 Minutes	3005 lb/hr
I-SO_2	2/27/91	8:45 AM 9:45 AM	60 Minutes	2669 lb/hr
II-H_2S	2/27/91	4:45 PM 5:45 PM	60 Minutes	2909 lb/hr
II-SO_2	2/27/91	3:17 PM 4:17 PM	60 Minutes	2909 lb/hr
III-H_2S	2/28/91	9:45 AM 10:45 AM	60 Minutes	2617 lb/hr
III-SO2	2/28/91	8:10 AM 9:10 AM	60 Minutes	2617 lb/hr

HUNT REFINING COMPANY REPRESENTATIVE: Ted Johnson

DATE: 4-2-91

TTL REPRESENTATIVE: Gary C. Pearson

DATE: 3-29-91

PARAMETER		
RUN NO.	H2S #1	SO2 #1
DATE	2-27-91	2-27-91
Dp	0.01	0.01
SQR(Dp)	0.077	0.099
Dh	0.01	0.01
tm	79.9	59.7
ts	1020.1	929.8
As	15.611	15.611
An	0.00034180	0.00034225
Vm	1.965	2.084
Vmc	1.965	2.084
Y	1.01581	1.01581
Th	60	60
Lp	0	0
La	0.00068	0.00068
Vlc	3.8	1.6
CO2	2.80	2.81
O2	11.15	10.39
N2	86.06	86.79
CO	0.00	0.00
Kp	85.49	85.49
Cp	0.84	0.84
Pbar	30.15	30.15
Pg	0.005	0.005
Ps	30.150	30.150
Pm	30.151	30.151
Vw(std)	0.179	0.075
Vm(std)	1.966	2.166
Bws	0.0834	0.0336
Md	28.893	28.866
Ms	27.985	28.501
vs	7.361	9.052
EA	96.3	83.0
Qa	6895.1	8478.8
Qstd	2272.0	3137.0
Vn	5.97	5.86
I	65.906	52.521
mH2S	2.803	
cH2S	0.022	
H2SMR	0.427	
SMR(H2S)	0.402	
mSO2		1120.2
cSO2		7.963
SO2SMR		214.12
SMR(SO2)		107.16
SMR	107.56	
SPR	3005	2669
SPRavg	2837	
TSFR	2944.6	
%REC	96.35	

PARAMETER		
RUN NO.	H2S #2	SO2 #2
DATE	2-27-91	2-27-91
Dp	0.01	0.01
SQR(Dp)	0.088	0.093
Dh	0.01	0.01
tm	80.3	80.8
ts	1024.7 1025	1030.3
As	15.611	15.611
An	0.00034225	0.00034225
Vm	2.098	2.009
Vmc	2.098	2.009
Y	1.01581	1.01581
Th	60	60
Lp	0	0
La	0.00068	0.00068
Vlc	12.2	2.5
CO2	2.84	3.30
O2	10.16	8.77
N2	87.00	87.93
CO	0.00	0.00
Kp	85.49	85.49
Cp	0.84	0.84
Pbar	30.15	30.15
Pg	0.005	0.005
Ps	30.150	30.150
Pm	30.151	30.151
Vw(std)	0.574	0.118
Vm(std)	2.098	2.007
Bws	0.2149	0.0554
Md	28.861	28.879
Ms	26.527	28.276
vs	8.590	8.788
EA	79.3	60.7
Qa	8046.0	8231.4
Qstd	2263.8	2776.1
Vn	7.46	5.95
I	70.473	54.984
mH2S	3.057	
cH2S	0.022	
H2SMR	0.436	
SMR(H2S)	0.410	
mSO2		791.5
cSO2		6.073
SO2SMR		144.518
SMR(SO2)		72.327
SMR	72.7	
SPR	2909	2909
SPRavg	2909	
TSFR	2981.7	
%REC	97.56	

PARAMETER		
RUN NO.	H2S #3	SO2 #3
DATE	2-28-91	2-28-91
Dp	0.02	0.01
SQR(Dp)	0.124	0.120
Dh	0.01	0.01
tm	74.5	63.6
ts	1045.6	1041.0
As	15.611	15.611
An	0.00034180	0.00034225
Vm	1.979	2.049
Vmc	1.979	2.049
Y	1.01581	1.01581
Th	60	60
Lp	0	0
La	0.00068	0.00068
Vlc	4.8	5.5
CO2	2.72	3.12
O2	10.27	9.09
N2	87.01	87.79
CO	0.00	0.00
Kp	85.49	85.49
Cp	0.84	0.84
Pbar	30.10	30.10
Pg	0.005	0.005
Ps	30.100	30.100
Pm	30.101	30.101
Vw(std)	0.226	0.259
Vm(std)	1.997	2.111
Bws	0.1016	0.1093
Md	28.846	28.863
Ms	27.744	27.676
vs	11.936	11.598
EA	80.9	64.6
Qa	11180.4	10863.4
Qstd	3543.6	3424.4
Vn	6.30	6.70
I	42.920	46.875
mH2S	4.077	
cH2S	0.031	
H2SMR	0.955	
SMR(H2S)	0.899	
mSO2		742.7
cSO2		5.419
SO2SMR		159.06
SMR(SO2)		79.60
SMR	80.5	
SPR	2617	2617
SPRavg	2617	
TSFR	2697.50	
%REC	97.02	