PETRO CHEM ENVIRONMENTAL SERVICES, INC.

Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

TABLE OF CONTENTS

Rcf #31 10/14/90

Tested for phenols but none detected air toxics incl. benzene formaldehyde

Used heat flow & fuel content from 12/90 tests

SUMMARY OF RESULTS

COMPANY : PACIFIC ENERGY
UNIT : OXNARD LANDFILL ENGINE #2
DATE : 12-20-90
REPORT : 62-372

DESTRUCTION REMOVAL EFFICIENCY OF HYDROCARBONS

OUTLET C1–C6+ TOTAL HYDROCARBON ANALYSIS

RUN #	INLET LB/HR	C1–C6+ OUTLET LB/HR	DRE % REDUCTION
#1	757.81	578.46	23.7
#2	757.81	452.24	40.3
#3	757.81	372.92	50.8

Avg = 38.3

OUTLET C1–C5: EXCLUDES C6+

RUN #	INLET LB/HR	C1–C5 OUTLET LB/HR	DRE % REDUCTION
#1	757.81	137.07	81.9
#2	757.81	130.24	82.8
#3	757.81	129.52	82.9

Avg = 82.5

INTRODUCTION

On December 20th, 1990, Petro-Chem Environmental Services (PCES) performed an engineering test for PACIFIC ENERGY SYSTEMS. The unit tested was at the Oxnard Landfill, Engine #2. Testing was to determine the destruction removal efficiency of hydrocarbons. The following parameters were tested using the following procedures:

Parameter	Methods	#Tests/Engine
Inlet hydrocarbon rate (lbs/hr)	Fuel Gas Analysis/Fuel Rate	2
Outlet hydrocarbon rate (lbs/hr)	Fuel gas Analysis/Fuel Rate EPA Method 18	3
%O2, N2, CO2	EPA MEthod 3 ORSAT ANalysis	3
Removal Efficiency (%)	Mathmatical Calculation	3

All testing was performed by Mr. Bob Martin of Petro-Chem Environmental Services. The fuel analysis was performed by Pacific Gas Technology of Bakersfield, CA.

DISCUSSION

DISCUSSION

The hydrocarbon data for Oxnard Landfill Engine #2 was reduced in two (2) ways.

1. The outlet C1-C6+ total hydrocarbons were analyzed for destruction removal efficiency.

2. Outlet C6+ was omitted from the analysis of DRE; assuming that the C6+ was a product of engine oil burn.

3. During Run #1 outlet of HC sample, a spark plug was changed.

INLET HYDROCARBON RATES

COMPANY : PACIFIC ENERGY
UNIT : OXNARD LANDFILL ENGINE #2
DATE : 12-20-90 LAB # 2048-2
REPORT : 62-372

INLET - HYDROCARBONS

SCFM = 733.0

		ppm	lb/hr	ppm as CH4	lb/hr (as Methane)
Methane	(C1)	408700.0	757.810	408700.0	757.810
Ethane	(C2)	0.00	0.0000	0.00	0.00
Propane	(C3)	0.00	0.0000	0.00	0.00
Butane	(C4)	0.00	0.0000	0.00	0.00
Pentane	(C5)	0.00	0.0000	0.00	0.00
Hexane	(C6)	0.00	0.0000	0.00	0.00
	Total	408700.0	757.810	408700.0	757.810

PACIFIC GAS TECHNOLOGY

4200 Easton Drive - Suite 5
Bakersfield, California 93309
805/324-1317
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GAS ANALYSIS BY CHROMATOGRAPH

PETROCHEM ENVIRONMENTAL SERVICES
3207 Antonino Avenue
Bakersfield, CA 93388

Attention: Faythe Blythe

SAMPLED: DECEMBER 20, 1990

SUBMITTED: DECEMBER 28, 1990

REPORTED: DECEMBER 28, 1990

LAB # 2048-2

Sample ID : PACIFIC ENERGY
OXNARD LANDFILL
ENGINE #2, #8

CUSTOMER NUMBER : 01208

CUSTOMER JOB NUMBER: 62-372

ANALYZED GAS

	MOLE %	WT %	CHONS WT %	
OXYGEN	4.43	4.98	CARBON	30.84
NITROGEN	22.53	22.19	HYDROGEN	5.79
CARBON DIOXIDE	32.17	49.78	OXYGEN	41.18
HYDROGEN	ND	0.00	NITROGEN	22.19
CARBON MONOXIDE	ND	0.00	SULFUR	0.00
		0.00		
METHANE	40.87	23.05		
ETHANE	ND	0.00		
PROPANE	ND	0.00		
iso-BUTANE	ND	0.00		
n-BUTANE	ND	0.00		
iso-PENTANE	ND	0.00		
n-PENTANE	ND	0.00		
HEXANE +	ND	0.00		

SPECIFIC GRAVITY * : 0.982

* CALCULATED ACCORDING TO : ASTM D-3588

HYDROGEN SULFIDE (Draeger) : ppm

TOTAL * BTU/cu ft DRY : 414

WET : 407

HYDROCARBON EMISSIONS TESTING
METHODS AND EQUATIONS

REF: EPA METHOD 18; FID ANALYSIS

SAMPLING PROCEDURES:

The sample was drawn via evacuated cannister through a stainless steel/teflon probe into a tedlar bag. Each sample bag was evacuated three (3) times, and then filled.

ANALYTICAL PROCEDURES:

The contents of the tedlar bag are analyzed by gas chromatography. The gas chromatograph is calibrated with an appropriate standard for each carbon #, before and after each set of samples are analyzed. The sample is speciated by carbon #-C1, C2, C3, C4, C5, and C6+ backflush.

SYMBOL IDENTIFICATION:

i = carbon #; i = 1 to 6+
s = refers to standard for that carbon #
Rx_i = response factor for C_i
MW = molecular weight - g/mole
DSCFM = Average volume flow rate of unit tested

EQUATIONS

$$Rx_i = \frac{ppm\ std}{Area_s} \qquad Rx_i = \frac{Area\ std}{ppm\ std}$$

$$Sample\ ppm_i = \frac{1}{Rx_i} \times Area_i$$

$$Sample\ ppm\ (as\ C_1) = Sample\ ppm \times \#\ of\ Carbons$$

$$\frac{lbs}{hr_i} = ppm_i \times MW_i \times DSCFM \times 1.581 \times 10^{-7}$$

$$Total\ non\text{-}methane\ \frac{lbs}{hr} = \sum_{2}^{6+} \frac{lbs}{hr_i}$$

Note 1: If $\frac{lbs}{hr}$ as methane is required, MW will equal 16.0 (MW of methane)

Note 2: # of carbons: ethane = 2; propane = 3; etc...

OUTLET HYDROCARBON RATES

12/21/90

Outlet HCl

Run 1	CH_4	71,193.42	ppm @ 3% O_2 as CH_4
2	CH_4	55,193.94	
3	CH_4	44,285.51	
Avg		56,863.29	

Avg dscfm = 5315.0 @ 9.1% O_2

$= 5315 \left(\frac{20.9 - 3}{20.9 - 9.1} \right) = 8063$ dscfm @ 3% O_2

COMPANY: PACIFIC ENERGY
UNIT : OXNARD LANDFILL ENGINE #2
DATE : 12-20-90
REPORT : 62-372

HYDROCARBON RESULTS

RUN No: 1
GC RUN: 1 & 2 AVG
DSCFM : 5315.0
% O2 : 9.1

Compound	Response Factor	Peak Area	Atten.	ppm	pm @3%O2
C1	664.73	6216705.0	1	9352.20	14186.81
C2	1082.03	0.0	1	0.00	0.00
C3	1682.95	123269.5	1	73.20	111.04
C4	2126.81	100082.5	1	47.10	71.45
C5	2771.48	290010.0	1	104.60	158.67
C6+	3546.62	21662000.0	1	6107.80	9265.22

		ppm	lb/hr	ppm as CH4	lb/hr (as CH4)	ppm @3%O2 as CH4
Methane	(C1)	9352.2	125.739	9352.2	125.739	14186.81
Ethane	(C2)	0.0	0.000	0.00	0.000	0.00
Propane	(C3)	73.2	2.706	220	2.952	333.12
Butane	(C4)	47.1	2.296	188	2.533	285.79
Pentane	(C5)	104.6	6.328	523	7.032	793.36
Hexane	(C6)	6107.8	441.386	36646.8	492.710	55591.33
Total		15684.9	578.45	46930.0	630.97	71190.42
Total (non methane)		6332.70	452.72	37577.8	505.23	57003.61

COMPANY: PACIFIC ENERGY
UNIT : OXNARD LANDFILL ENGINE #2
DATE : 12-20-90
REPORT : 62-372

HYDROCARBON RESULTS

RUN No: 2
GC RUN: 1 & 2 AVG
DSCFM : 5315.0
% O2 : 9.1

Compound	Response Factor	Peak Area	Atten.	ppm	pm @3%O2
C1	664.73	6130355.0	1	9222.3	13989.76
C2	1082.03	0.0	1	0.0	0.00
C3	1682.95	78666.0	1	46.7	70.84
C4	2126.81	33280.5	1	15.6	23.66
C5	2771.48	92357.0	1	33.3	50.51
C6+	3546.62	15802500.0	1	4455.7	6759.07

		ppm	lb/hr	ppm as CH4	lb/hr (as CH4)	ppm @3%O2 as CH4
Methane	(C1)	9222.3	125.739	9222.3	123.992	13989.76
Ethane	(C2)	0	0.000	0.0	0.000	0.00
Propane	(C3)	46.7	1.727	140.1	1.884	212.52
Butane	(C4)	15.6	0.760	62.4	0.839	94.66
Pentane	(C5)	33.3	2.015	166.5	2.239	252.57
Hexane	(C6)	4455.7	321.995	26734.2	359.437	40554.42
	Total	13773.60	452.24	36325.50	488.39	55103.94
Total (non methane)		4551.30	326.50	27103.20	364.40	41114.18

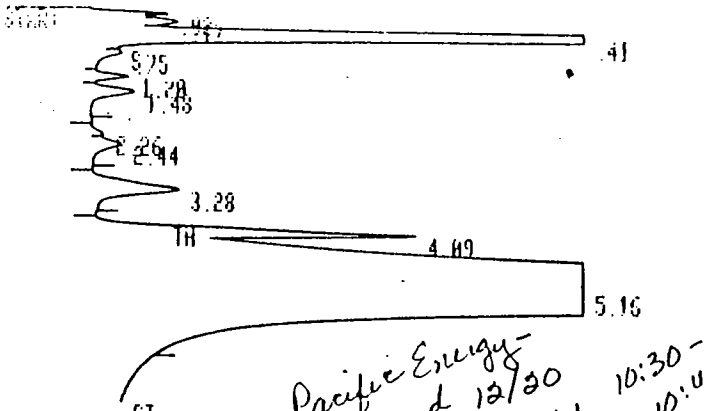
COMPANY: PACIFIC ENERGY
UNIT : OXNARD LANDFILL ENGINE #2
DATE : 12-20-90
REPORT : 62-372

HYDROCARBON RESULTS

RUN No: 3
GC RUN: 1 & 2 AVG
DSCFM : 5315.0
% O2 : 9.1

Compound	Response Factor	Peak Area	Atten.	ppm	ppm @3%O2
C1	664.73	5766355.0	1	8674.70	13159.08
C2	1082.03	0.0	1	0.00	0.00
C3	1682.95	45400.5	1	27.00	40.96
C4	2126.81	43588.5	1	20.50	31.10
C5	2771.48	81688.0	1	29.50	44.75
C6+	3546.62	11945350.0	1	3368.10	5109.24

		ppm	lb/hr	ppm as CH4	lb/hr (as CH4)	ppm @3%O2 as CH4
Methane	(C1)	8674.7	125.739	8674.7	116.63	13159.08
Ethane	(C2)	0.0	0.000	0.0	0.00	0.00
Propane	(C3)	27.0	0.998	81.0	1.09	122.87
Butane	(C4)	20.5	0.999	82.0	1.10	124.39
Pentane	(C5)	29.5	1.785	147.5	1.98	223.75
Hexane	(C6)	3368.1	243.399	20208.6	271.70	30655.42
	Total	12119.80	372.92	29193.8	392.51	44285.51
Total (non methane)		3445.10	247.18	20519.1	275.88	31126.43

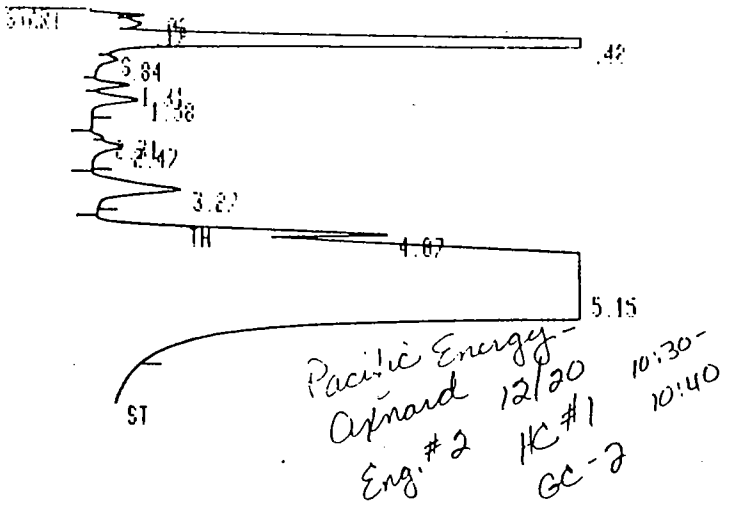


RUN # 909 DEC/27/90 11:39:04

AREA%

	RT	AREA	TYPE	AR/HT	AREA%
	0.02	10291	D BP	0.039	0.040
	0.17	45389	PH	0.106	0.176
C_1	0.41	6095600	SHB	0.108	23.564
	0.75	0	D BP	0.000	0.000
	1.20	46968	D PV	0.102	0.182
C_3	1.48	88029	PB	0.156	0.340
	2.26	19339	PV	0.124	0.075
C_4	2.44	76857	VB	0.196	0.297
C_5	3.28	282550	PB	0.244	1.092
	4.09	653640	PV	0.147	2.527
C_6	5.16	1.8550E+07	VB	0.771	71.708

TOTAL AREA= 2.5868E+07
MUL FACTOR= 1.0000E+00

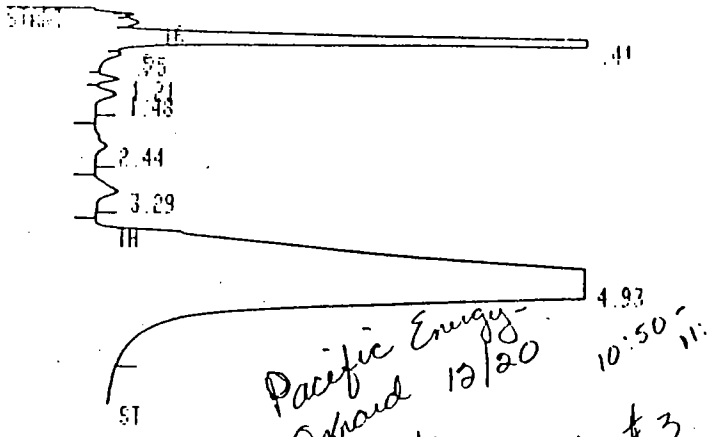


RUN # 912 DEC/27/90 13:19:14

AREA%

	RT	AREA	TYPE	AR/HT	AREA%
	0.02	13432	D BV	0.044	0.042
	0.17	31404	VH	0.120	0.097
C_1	0.42	6391800	SHB	0.113	19.724
	0.84	12240	D BP	0.070	0.038
C_3	1.31	53500	PV	0.105	0.165
	1.58	105010	VB	0.159	0.324
C_4	2.31	18364	BV	0.102	0.057
	2.47	85605	VB	0.193	0.264
C_5	3.27	297470	PB	0.240	0.918
	4.07	624030	PV	0.151	1.926
C_6	5.15	2.4774E+07	VB	0.891	76.447

TOTAL AREA= 3.2407E+07
MUL FACTOR= 1.0000E+00

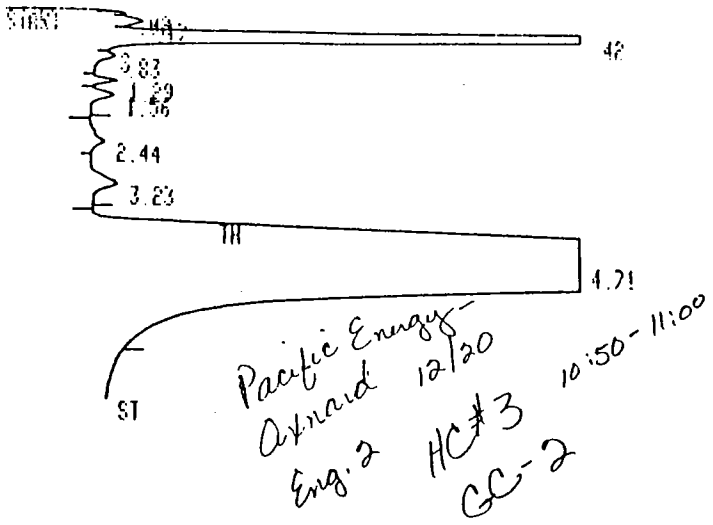


RUN # 916 DEC/27/90 14:58:59

AREA%

	RT	AREA	TYPE	AR/HT	AREA%
~~C1~~	~~0.16~~	~~22515~~	~~PH~~	~~0.112~~	~~0.157~~
C1	0.41	5426700	SHB	0.105	37.760
	~~0.75~~	~~0~~	~~D BP~~	~~0.000~~	~~0.000~~
~~C2~~	~~1.21~~	~~30881~~	~~PP~~	~~0.105~~	~~0.215~~
C2	1.48	43787	PB	0.158	0.305
C3	2.44	40148	BB	0.237	0.279
C4	3.29	76669	PB	0.245	0.534
C5	4.93	8730700	PB	0.879	60.751

TOTAL AREA= 1.4371E+07
MUL FACTOR= 1.0000E+00

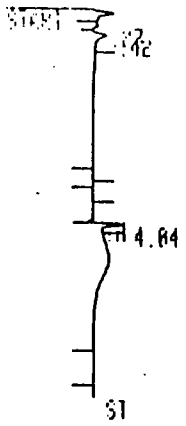


RUN # 917 DEC/27/90 15:30:08

AREA%

	RT	AREA	TYPE	AR/HT	AREA%
	~~0.02~~	~~13774~~	~~BV~~	~~0.054~~	~~0.064~~
	~~0.17~~	~~81168~~	~~VH~~	~~0.165~~	~~0.375~~
C1	0.42	6160000	SHB	0.111	28.469
	~~0.83~~	~~7609~~	~~D BP~~	~~0.052~~	~~0.035~~
	~~1.29~~	~~35002~~	~~D PV~~	~~0.100~~	~~0.162~~
C3	1.56	47014	VB	0.149	0.217
C4	2.44	47029	PP	0.234	0.217
C5	3.23	86707	PB	0.244	0.401
C6	4.71	1.5160E+07	PB	0.893	70.060

TOTAL AREA= 2.1638E+07
MUL FACTOR= 1.0000E+00



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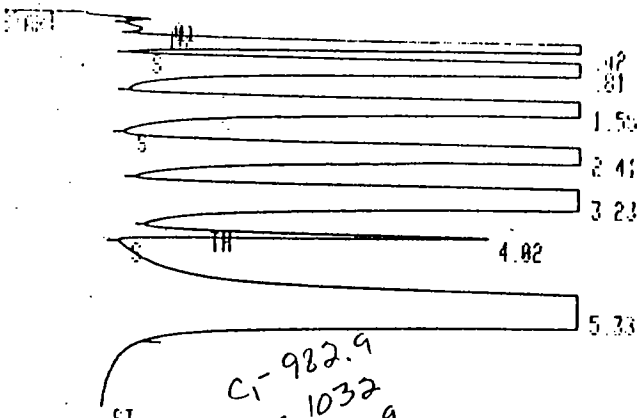
RUN # 924 DEC/27/90 17:39:14

RT	AREA	TYPE	AR/HT	AREA%
0.23	5029	D BP	0.093	8.322
0.42	26995	PB	0.137	44.754
4.04	28295	D BB	0.070	46.909

TOTAL AREA= 60319
MUL FACTOR= 1.0000E+00

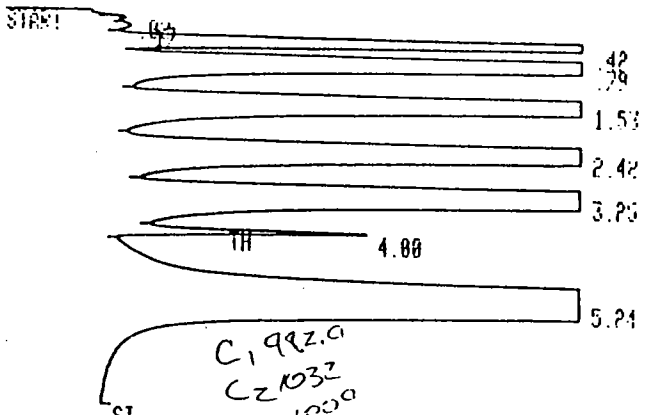


RUN # 910 DEC/27/90 12:00:41

AREA%

	RT	AREA	TYPE	AR/HT	AREA%
	~~0.01~~	~~12678~~	~~D BP~~	~~0.041~~	~~0.013~~
	~~0.18~~	~~23782~~	~~PH~~	~~0.105~~	~~0.025~~
C_1	0.42	5629500	SHB	0.107	5.870
C_2	0.81	1.0833E+07	SPH	0.147	11.294
C_3	1.55	1.5519E+07	SHB	0.160	16.181
C_4	2.41	1.9725E+07	SPH	0.167	20.566
C_5	3.23	2.2083E+07	SHB	0.204	23.025
	4.02	447450	DTBB	0.088	0.467
C_6	5.33	2.1638E+07	BB	0.384	22.560

TOTAL AREA= 9.5910E+07
MUL FACTOR= 1.0000E+00



RUN # 919 DEC/27/90 16:21:01

AREA%

	RT	AREA	TYPE	AR/HT	AREA%
	0.02	12794	D BV	0.058	~~0.013~~
	~~0.17~~	~~46108~~	~~VH~~	~~0.154~~	~~0.048~~
C_1	0.42	5146300	SHH	0.103	5.296
C_2	0.79	1.1123E+07	SHH	0.150	11.445
C_3	1.53	1.5933E+07	SHH	0.165	16.396
C_4	2.42	2.0154E+07	SHH	0.173	20.739
C_5	3.25	2.2504E+07	ISHP	0.206	23.157
	4.00	287730	DTBP	0.086	0.296
C_6	5.24	2.1973E+07	TPV	0.375	22.611

TOTAL AREA= 9.7179E+07
MUL FACTOR= 1.0000E+00

HYDROCARBON EMISSIONS TESTING
METHODS AND EQUATIONS

REF: EPA METHOD 18; FID ANALYSIS

SAMPLING PROCEDURES:

The sample was drawn via evacuated cannister through a stainless steel/teflon probe into a tedlar bag. Each sample bag was evacuated three (3) times, and then filled.

ANALYTICAL PROCEDURES:

The contents of the tedlar bag are analyzed by gas chromatography. The gas chromatograph is calibrated with an appropriate standard for each carbon #, before and after each set of samples are analyzed. The sample is speciated by carbon #-C1, C2, C3, C4, C5, and C6+ backflush.

SYMBOL IDENTIFICATION:

i = carbon #; i = 1 to 6+
s = refers to standard for that carbon #
Rx_i = response factor for C_i
MW = molecular weight - g/mole
DSCFM = Average volume flow rate of unit tested

EQUATIONS

$$Rx_i = \frac{ppm\,std}{Area_s} \qquad Rx_i = \frac{Area\,std}{ppm\,std}$$

$$Sample\ ppm_i = \frac{1}{Rx_i} \times Area_i$$

$$Sample\ ppm\ (as\ C_1) = Sample\ ppm \times \#\ of\ Carbons$$

$$\frac{lbs}{hr_i} = ppm_i \times MW_i \times DSCFM \times 1.581 \times 10^{-7}$$

$$Total\ non\text{-}methane\ \frac{lbs}{hr} = \sum_{2}^{6+} \frac{lbs}{hr_i}$$

Note 1: If $\frac{lbs}{hr}$ *as methane is required, MW will equal* 16.0 (*MW of methane*)

Note 2: # of carbons: ethane = 2; propane = 3; etc...

FUEL ANALYSIS

COMPANY: PACIFIC ENERGY
UNIT : OXNARD LANDFILL ENGINE #2
DATE : 12-20-90
REPORT : 62-372

DSCFM CALCULATIONS

SCFM = 733.0

FOLLOWING VALUES FOR GROSS MMBTU/CF AND 'F' FACTOR @ 60' F
TAKEN FROM 'EPA F-FACTOR FOR FUEL GAS' SHEET
LAB #2048-2
AVERAGED % O2 TAKEN FROM ORSAT ANALYSIS

0.000413 = MMBtu/CF % O2 = 9.1
9920.553 = DSCF/MMBTU

DSCF/MIN= 733.0 SCF/MIN *0.000413 MMBTU/CF*9920.5 DSCF/MMBTU

=3000.8 DSCF/MIN @ 0 % O2

DSCFM @ 9.1 % O2 = 3000.8 DSCF/MIN* (20.9/ (20.9 - 9.10

= 5315.00 DSCFM @ 9.1 % O2

COMPANY: PACIFIC ENERGY
UNIT : OXNARD LANDFILL ENGINE #2
DATE : 12-20-90
REPORT : 62-372

PACIFIC GAS: #2048-2

EPA "F" FACTOR FOR NATURAL GAS

FUEL COMPONENT	C	H	EXPANSION FACTOR	COMPONENT MOLE %	EXHAUST DSCF (0)/ SCF FUEL
METHANE	1	4	8.57	40.87	3.502559
ETHANE	2	6	15.25	0	0
PROPANE	3	8	21.92	0	0
(ISO-BUTANE)	4	10	28.6	0	0
NORM-BUTANE	4	10	28.6	0	0
(ISO-PENTANE)	5	12	35.28	0	0
NORM-PENTANE	5	12	35.28	0	0
HEXANE +	6	14	41.95	0	0
AIR (N2+02)	--	--	1	26.96	0.2696
CO2	--	--	1	32.17	0.3217
H2S	--	--	6.68	0	0
			TOTAL	100.00	4.093859

4.093859	DSCF EXHAUST PER SCF OF FUEL GAS AT ZERO % OXYGEN
371.5491	NET BTU/SCF OF FUEL GAS
412.6643	GROSS BTU/SCF OF FUEL GAS
9920.553	DSCF/MMBTU (EPA "F" FACTOR @ 60'F & ZERO % OXYGEN)
10071.62	DSCF/MMBTU (EPA "F" FACTOR @ 68'F & ZERO % OXYGEN)

PACIFIC GAS TECHNOLOGY

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805/324-1317
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GAS ANALYSIS BY CHROMATOGRAPH

PETROCHEM ENVIRONMENTAL SERVICES
3207 Antonino Avenue
Bakersfield, CA 93388

SAMPLED: DECEMBER 20, 1990
SUBMITTED: DECEMBER 28, 1990
REPORTED: DECEMBER 28, 1990

Attention: Faythe Blythe

LAB # 2048-2

Sample ID : PACIFIC ENERGY
OXNARD LANDFILL
ENGINE #2, #8

CUSTOMER NUMBER : 01208

CUSTOMER
JOB NUMBER: 62-372

ANALYZED GAS	MOLE %	WT %	CHONS WT %	
OXYGEN	4.43	4.98	CARBON	30.84
NITROGEN	22.53	22.19	HYDROGEN	5.79
CARBON DIOXIDE	32.17	49.78	OXYGEN	41.18
HYDROGEN	ND	0.00	NITROGEN	22.19
CARBON MONOXIDE	ND	0.00	SULFUR	0.00
		0.00		
METHANE	40.87	23.05		
ETHANE	ND	0.00		
PROPANE	ND	0.00		
iso-BUTANE	ND	0.00		
n-BUTANE	ND	0.00		
iso-PENTANE	ND	0.00		
n-PENTANE	ND	0.00		
HEXANE +	ND	0.00		

SPECIFIC GRAVITY * : 0.982

* CALCULATED ACCORDING TO :

HYDROGEN SULFIDE : ppm
(Draeger)

ASTM D-3588

TOTAL * DRY : 411
BTU/cu ft

WET : 407

PACIFIC GAS TECHNOLOGY

4200 Easton Drive - Suite 5
Bakersfield, California 93309
805/324-1317
Fax: 805/324-2746

GAS ANALYSIS BY CHROMATOGRAPH

PETROCHEM ENVIRONMENTAL SERVICES
3207 Antonino Avenue
Bakersfield, CA 93388

SAMPLED: DECEMBER 21, 1990
SUBMITTED: DECEMBER 28, 1990
REPORTED: DECEMBER 28, 1990

Attention: Faythe Blythe

LAB = 2048

Sample ID : PACIFIC ENERGY
OXNARD LANDFILL
ENGINE #2, #7

CUSTOMER NUMBER : 01208

CUSTOMER
JOB NUMBER: 62-372

NOT USED DO TO HIGH O2 CONTENT

ANALYZED GAS

	MOLE %	WT %	CHONS	WT %
OXYGEN	11.18	12.32	CARBON	17.63
NITROGEN	46.20	44.58	HYDROGEN	3.10
CARBON DIOXIDE	20.30	30.77	OXYGEN	34.70
HYDROGEN	ND	0.00	NITROGEN	44.58
CARBON MONOXIDE	ND	0.00	SULFUR	0.00
		0.00		
METHANE	22.32	12.33		
ETHANE	ND	0.00		
PROPANE	ND	0.00		
iso-BUTANE	ND	0.00		
n-BUTANE	ND	0.00		
iso-PENTANE	ND	0.00		
n-PENTANE	ND	0.00		
HEXANE +	ND	0.00		

SPECIFIC GRAVITY * : 1.002

* CALCULATED ACCORDING TO :

HYDROGEN SULFIDE : ppm
(Draeger)

ASTM D-3588

TOTAL * DRY : 226
BTU/cu ft

WET : 222

F-FACTOR FOR GASEOUS FUELS

Ref: 1) Code of Federal Regulations 40 CFR 60.45
2) Handbook of Chemistry and Physics; CRC Press

The F-Factor is the ratio of the total exhaust volume (DSCF°) produced by the stoichiometric combustion of 1 SCF of the gaseous fuel and the Btu content of the same 1 SCF of gaseous fuel.

$$EPA\ F\ Factor = F\ \frac{DSCF°}{MMBtu} = 10^6 \times \frac{\frac{DSCF°}{SCF\ fuel}}{\frac{Btu}{SCF\ fuel}}$$

STOICHIOMETRIC COMBUSTION OF HYDROCARBONS:

The exhaust volume concentration of each fuel gas component is determined by the general equation for the stoichiometric combustion of a gaseous hydrocarbon.

C_xH_y in air:

$$C_xH_y + air \rightarrow x\ CO_2 + \frac{y}{2}\ H_2O + 3.785\ (x + \frac{y}{4})\ N_2$$

$$C_{xH_y} + (x + \frac{y}{4})\ (O_2 + 3.785\ N_2) \rightarrow x\ CO_2 + \frac{y}{2}\ H_2O + 3.785\ (x + \frac{y}{4})\ N_2$$

Therefore, for each mole (or standard cubic foot) of each fuel gas component C_xH_y, there will be:

1) $x + \frac{y}{2} + 3.785\ (x + \frac{y}{4})$ *moles (or SCF) of "wet" exhaust flow*

2) $x + 3.785\ (x + \frac{y}{4})$ *moles (or DSCF) of "dry" exhaust flow*

OR

1 SCF of C_xH_y produces $4.785x + 0.946y$ DSCF° flue gas

where: x = # of carbon atoms in component C_xH_y
y = # of hydrogen atoms in component C_xH_y

If non-combustible components such as N_2, O_2, or CO_2 are present in the gaseous fuel, these will not participate in the combustion process.

1 SCF Non-combustible component produces 1 SCF° flue gas.

STOICHIOMETRIC COMBUSTION OF HYDROCARBONS (con't)...

Hydrogen (H_2) combustion proceeds according to the reaction:

$$1\ H_2 + \frac{1}{2}\ (O_2 = 3.785\ N_2) \rightarrow 1\ H_2O + 1.893\ N_2$$

Carbon Monoxide (CO) combustion in air proceeds according to the reaction:

$$CO + air \rightarrow CO_2 + N_2\ (stoichiometric\ combustion)$$

$$1\ CO + \frac{1}{2}\ (O_2 + 3.785\ N_2) \rightarrow 1\ CO_2 + 1.893\ N_2$$

1 SCF CO produces 2.893 DSCF° flue gas

The total exhaust gas volume at stoichiometric combustion (zero % excess O_2) is the summation of the individual component's contribution. The actual total exhaust gas volume is greater and depends on the % O_2 in the exhaust gas.

$$Actual\ DSCF = DSCF°\ (@\ stoichiometric\ combustion) \times \frac{20.9}{20.9 - \%\ O_2\ in\ exhaust\ gas}$$

BTU HEATING CONTENT OF GASEOUS FUELS:

The Btu/SCF of the gaseous fuel is determined either by actual measurement of a sample combustion in a calorimeter or from a summation of the known heating value of the components multiplied by the mole fraction of the components.

ORSAT ANALYSIS

PETRO
CHEM
ENVIRONMENTAL
SERVICES

Client: PACIFIC ENERGY - OXNARD.
Date : 12-20-90
Unit :
Job # :

ORSAT ANALYSIS
%O2, CO2, N2

Run #	% O2	% CO2	% N2
SAMPLE # 4	9.6	9.9	
SAMPLE # 5	8.6	10.1	
average	9.1	10.0	