Background Report Reference

AP-42 Section Number: 12.20

Background Chapter: 4

Reference Number: 64

Title: Emissions Stack Testing at McDonnell Douglas, Torrance, CA

Engineering Science

November 1986

REJECT

ELECTROPLATING
REF. 4-64

Enclosure 3 - Reference C

✓ 1986 test used deionized H_2O - Analysis for ± 20% difference between inlet & outlet ~~flows~~ flows
High variation between total and hex chrome.
Used colorimetric method for hex chrome. We used H_2O & saw no difference

Had same problem with ratio of hex to total as seen in other reports. Table 4 gives efficiencies Hex and total are very close but the efficiencies are more a reflection of conversion efficiency than hex chrome removal.

✓ No data from lab on quantities of hex chrome captured. Computer data for calculation but no catch

✓ There are, of course, no analysis of tank or scrubber water samples.

✓ We assume that AA graphite furnace was used for analysis

While we may use total Cr number for efficiency, how will this effect the standard.

Ratio $\frac{\text{Hex Cr}}{\text{Total Cr}} \times 100 = \%$ Hex Cr

Vary from 15.3% Hex to 73.2%

See Back

Insufficient data to draw conclusions. No data showing catches. No computer data for raw data reduction.

The meter volumes could be calculated from the field data sheets - no moisture recovery - must take their word for it.

WA01602

ENCLOSURE 3
REFERENCE C

EMISSIONS STACK TESTING AT McDONNELL DOUGLAS, TORRANCE, CALIFORNIA

Source Tested:

Etching Tank Scrubber (Tank 193, Bldg. 2)
Anodizing Tank Scrubber (Tank 195, Bldg. 2)

Date Tested:

October 1 and 3, 1986

Prepared for

LATHAM AND WATKINS
ATTORNEYS AT LAW
555 South Flower Street
Los Angeles, California 90071

Revised

November 12, 1986

Prepared by

ENGINEERING-SCIENCE
75 N. Fair Oaks Avenue
P.O. Box 7107
Pasadena, California 91109

ES ENGINEERING-SCIENCE

WA01602

EMISSIONS STACK TESTING AT McDONNELL DOUGLAS, TORRANCE, CALIFORNIA

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SAMPLING SUMMARY SHEET

PLANT _____ LOCATION _____

SAMPLED SOURCE _____

Run	Date	N_p	(3) Y_m	(4) ΔH	(5) P Bar.	(6) V_m	(7) T_m	(8) V_m Std.	(9) %	(10) P_{st}	17 P_s	(18) T_s	(19) VP	(20) V_w	21 $V_{w_{gas}}$	22 %M	23 M_d

Run	(24) CO_2	(25) O_2	26 N_2	(27) CO	(28) ___	29 MW_d	30 MW	(31) $C_p\sqrt{\Delta P_s(T_s + 460)}$	(32)	(33) T_t	(34) D_n	35 V_s	(36) D_s	(37) Area	38 ACFM	(39) DSCFM	40 %I

$$V_m \text{ Std.} = Y_m \frac{17.64 \times V_m \left(P \text{ Bar.} + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

$$V_{w_{gas}} = 0.0471\ V_w$$

$$MW_d = \%CO_2 \times .44 + (\%O_2 \times .32) + (\%CO + \%N_2) \times .28 + \left(\%\text{Other} \times \frac{\text{Mol. wt.}}{100}\right)$$

$$MW = MW_d \times M_d + 18(1 - M_d)$$

$$V_s = 85.49 \times C_p \sqrt{\Delta P_s (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{0.09450 \times (T_s + 460) \times V_m \text{ Std.}}{V_s \times T_t \times P_s \times M_d \times A_n}$$

$$\%M = \frac{100 \times V_{w_{gas}}}{V_m \text{ Std.} + V_{w_{gas}}}$$

$$M_d = \frac{100 - \%M}{100}$$

$$P_s = P \text{ Bar.} + \frac{P_{st}}{13.6}$$

N_p = Total No. of Sampling points

Y_m = Meter Box Correction Factor

ΔH = Average Orifice Pressure Drop, inches H_2O

P Bar. = Barometric Pressure, Inches Hg, Absolute

V_m = Volume of Dry Gas at Meter Conditions, DCF

T_m = Average Meter Temperature, °F.

V_m Std. = Volume of Dry Gas at STP, DSCF[a]

% = Per Cent other gas removed before Dry Gas Meter

P_{st} = Static Pressure of Stack Gas, inches H_2O

P_s = Stack Gas Pressure, inches Hg.

T_s = Average Stack Temperature, °F

VP = Vapor Pressure of H_2O At Stack Temperature

V_w = Total H_2O Collected in Impingers and Silica Gel

$V_{w_{gas}}$ = Volumn of water vapor collected at STP, SCF[b]

%M = Per Cent Moisture by volume

M_d = Mole Fraction of Dry Gas

$\%CO_2$ = Volume % Dry

$\%O_2$ = Volume % Dry

$\%N_2$ = Volume % Dry

%CO = Volume % Dry

MW_d = Molecular Weight of Stack Gas Dry Basis

MW = Molecular Weight of Stack Gas, Wet Basis

C_p = Pitot Tube Coefficient

$\sqrt{\Delta P (T_s + 460)}$ Is determined by averaging the square root of the product of the velocity head (ΔP) and the absolute stack temperature from each sampling point.

T_t = Net time of test in minutes

D_n = Sampling Nozzle Diameter, inches

A_n = Area of Nozzle opening, ft^2.

V_s = Stack Gas Velocity at Stack Conditions, Feet per second.

D_s = Diameter of Stack, inches

Area = Area of duct in ft^2

ACFM = Actual Cubic Feet per minute

DSCFM = Dry Standard Cubic Feet per minute

%I = Per Cent Isokinetic

[a] Dry Standard Cubic Feet @ 68°F, 29.92 in. Hg.

[b] Standard Conditions @ 68°F. 29.92 in. Hg.

SUMMARY OF EMISSIONS

PLANT McDonnell-Douglas LOCATION Torrance, Calif.

SAMPLED SOURCE Tank 193, Building 2

RUN	DATE	(1) V_m Std.	(2) DSCFM
Sampler ON	1OCT86		22024
Sampler OFF	1OCT86		22026
Outlet 1	30CT86		22052
Outlet 2	30CT86		23231

Inlet

FRONT HALF MILLIGRAMS						
PROBE	CYCLONE	FILTER	(3) TOTAL	Total PPM	(4) BACK HALF	5 FRONT + BACK TOTAL
				27.19×10^{-3}		19.91×10^{-3}
				24.7×10^{-3}		4.19×10^{-3}
				51.06×10^{-3}		34.43×10^{-3}
				2.71×10^{-3}		1.55×10^{-3}

Hex

CONCENTRATIONS

FRONT HALF Total				
RUN	Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr
		.058786	.00485	
		.053448	.004141	
		.111426	.009122	
		.005860	.000510	
		6	7	8	9

BACK HALF Hex			
Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr
	.043029	.00355	
	.009066	.000748	
	.074461	.006151	
	.003355	.000292	
	10	17	18	19

TOTAL			
Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr
20	21	22	23

Remarks:

```
            XEQ "PPM=LBS"
DSCF/M ?
       22,024.00    RUN
MOL WT ?
            52.00    RUN

PPM ?
            .02719    RUN
 LB/HR = 4.85E-3

PPM ?
            .01991    RUN
 LB/HR = 3.55E-3

PPM ?
```

```
            XEQ "PPM=LBS"
DSCF/M ?
       22,026.00    RUN
MOL WT ?
            52.00    RUN

PPM ?
            .0247    RUN
 LB/HR = 4.41E-3

PPM ?
            .00419    RUN
 LB/HR = 7.48E-4

PPM ?
```

```
            XEQ "PPM=LBS"
DSCF/M ?
     22,052.00000    RUN
MOL WT ?
       52.000000    RUN

PPM ?
            .051060    RUN
 LB/HR = 0.009122

PPM ?
            .034430    RUN
 LB/HR = 0.006151
```

```
            XEQ "PPM=LBS"
DSCF/M ?
       23,231.00    RUN
MOL WT ?
            52.00    RUN

PPM ?
            .00271    RUN
 LB/HR = 5.10E-4

PPM ?
            .00155    RUN
 LB/HR = 2.92E-4

PPM ?
```

```
PPM ?
```

Sparger ON

```
            XEQ "CONVT"
DSCFM ?
     22,024.00000    RUN
LB/HR?
            .004850    RUN
 MG/MMM = 0.058786
            XEQ "CONVT"
DSCFM ?
     22,024.00000    RUN
LB/HR?
            .003550    RUN
 MG/MMM = 0.043029
```

Sparger OFF

```
            XEQ "CONVT"
DSCFM ?
     22,026.00000    RUN
LB/HR?
            .004410    RUN
 MG/MMM = 0.053448
            XEQ "CONVT"
DSCFM ?
     22,026.00000    RUN
LB/HR?
            .000748    RUN
 MG/MMM = 0.009066
```

```
            XEQ "CONVT"
DSCFM ?
```

Outlet 1

```
     22,052.00000    RUN
LB/HR?
            .009122    RUN
 MG/MMM = 0.110426
            XEQ "CONVT"
DSCFM ?
     22,052.00000    RUN
LB/HR?
            .006151    RUN
 MG/MMM = 0.074461
```

Outlet 2

```
DSCFM ?
     23,231.00000    RUN
LB/HR?
            .000510    RUN
 MG/MMM = 0.005860
            XEQ "CONVT"
DSCFM ?
     23,231.00000    RUN
LB/HR?
            .000292    RUN
 MG/MMM = 0.003355
```

SUMMARY OF EMISSIONS

PLANT McDonnell-Douglas LOCATION Torrence, Calif

SAMPLED SOURCE Tank 193, Building 2

RUN	DATE	(1) V_m Std.	(2) DSCFM
sparger ON	10CT86		12546
Sparger OFF	10CT86		12531

FRONT HALF MILLIGRAMS

PROBE	CYCLONE	FILTER	(3) TOTAL	Total PPM	(4) BACK HALF	5 FRONT + BACK TOTAL	Hex
				22.2×10^{-3}			3.38×10^{-3}
				23.0×10^{-3}	"		3.78×10^{-3}

CONCENTRATIONS Hex

Total

FRONT HALF

RUN	Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr
			.02256	
			.02335	
	6	7	8	9

BACK HALF

Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr
		.000344	
		.000381	
10	17	18	19

TOTAL

Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr
20	21	22	23

Remarks:

SAMPLING SUMMARY SHEET

PLANT _____ LOCATION _____

SAMPLED SOURCE _____

Run	Date	N_p	(3) Y_m	(4) ΔH	(5) P Bar.	(6) V_m	(7) T_m	(8) V_m Std.	(9) %	(10) P_{st}	17 P_s	(18) T_s	(19) VP	(20) V_w	21 $V_{w_{gas}}$	22 %M	23 M_d

Run	(24) CO_2	(25) O_2	26 N_2	(27) CO	(28) ___	29 MW_d	30 MW	(31) $C_p\sqrt{\Delta P_s(T_s + 460)}$	(32)	(33) T_t	(34) D_n	35 V_s	(36) D_s	(37) Area	38 ACFM	(39) DSCFM	40 %I

$$V_{m\ Std.} = V_m \frac{17.64 \times V_m \left(P\ Bar. + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

$$V_{w_{gas}} = 0.0471\ V_w$$

$$MW_d = \%CO_2 \times .44 + (\%O_2 \times .32) + (\%CO + \%N_2) \times .28 + \left(\%Other \times \frac{Mol.\ wt.}{100}\right)$$

$$MW = MW_d \times M_d + 18(1 - M_d)$$

$$V_s = 85.49 \times C_p \sqrt{\Delta P_s (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{0.09450 \times (T_s + 460) \times V_{m\ Std.}}{V_s \times T_t \times P_s \times M_d \times A_n}$$

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m\ Std.} + V_{w_{gas}}}$$

$$M_d = \frac{100 - \%M}{100}$$

$$P_s = P\ Bar. \pm \frac{P_{st}}{13.6}$$

N_p = Total No. of Sampling points

Y_m = Meter Box Correction Factor

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$\%CO_2$ = Volume % Dry

$\%O_2$ = Volume % Dry

$\%N_2$ = Volume % Dry

%CO = Volume % Dry

MW_d = Molecular Weight of Stack Gas Dry Basis

MW = Molecular Weight of Stack Gas, Wet Basis

C_p = Pitot Tube Coefficient

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DSCFM = Dry Standard Cubic Feet per minute

%I = Per Cent Isokinetic

[a] Dry Standard Cubic Feet @ 68°F, 29.92 in. Hg.

[b] Standard Conditions @ 68°F. 29.92 in. Hg.

Sparger ON

```
                XEQ "PPM=LBS"
 DSCF/M ?
      12,546.00000     RUN
 MOL WT ?
         52.000000     RUN

 PPM ?
              .022200  RUN
 LB/HR = 0.002256

 PPM ?
              .003380  RUN
 LB/HR = 0.000344

 PPM ?
```

Sparger OFF

```
                XEQ "PPM=LBS"
 DSCF/M ?
      12,531.00000     RUN
 MOL WT ?
         52.000000     RUN

 PPM ?
              .023000  RUN
 LB/HR = 0.002335

 PPM ?
              .003780  RUN
 LB/HR = 0.000384

 PPM ?
```

Sparger ON

```
                XEQ "CONVT"
 DSCFM ?
      12,546.00000     RUN
 LB/HR?
              .022560  RUN
 MG/MMM = 0.480023
                XEQ "CONVT"
 DSCFM ?
      12,546.00000     RUN
 LB/HR?
              .000344  RUN
 MG/MMM = 0.007320
```

SPARGER OFF

```
                XEQ "CONVT"
 DSCFM ?
      12,531.00000     RUN
 LB/HR?
              .002335  RUN
 MG/MMM = 0.049743
                XEQ "CONVT"
 DSCFM ?
      12,531.00000     RUN
 LB/HR?
              .000384  RUN
 MG/MMM = 0.008180
```

REPORT OF STACK TESTING
AT McDONNELL DOUGLAS

INTRODUCTION

On October 1 and 3, 1986, personnel from Engineering-Science (ES), Pasadena, California, conducted air pollution testing at the McDonnell Douglas facility in Torrance, California. The purpose of the tests was to determine the chromium emissions from etching tank 193 and anodizing tank 195 scrubbers (Bldg. 2). The testing program was coordinated by Mr. Ken Svoboda of McDonnell Douglas.

On October 1, the inlet to the Etching and Anodizing Tank Scrubbers was tested with the air sparger both on and off. On October 3, the inlet and outlet to the Anodizing Tank Scrubber were tested simultaneously. The ES testing team was comprised of Messrs. Rolando Rosario (team leader), Ron Diaz, Paul Farmanian, and Ms. Cammie Mok.

TEST METHODS

The chromium runs were conducted proportionally. The sampling train consisted of a Teflon probe connected to four impingers in series. The first two impingers were each charged with 100 milliliters of deionized water, the third impinger was dry, and the fourth contained about 400 grams of indicating silica gel. The first, third, and fourth impingers were straight tube Greenburg-Smith impingers and the second was an orifice tip Greenburg-Smith impinger.

RESULTS

The results of the testing program are summarized in Tables 1 through 4. Additional supporting data are presented in the Appendix. Additionally, a discussion of the determination of hexavalent chromium emissions is included in the Appendix.

TABLE 1

SUMMARY OF VOLUMETRIC FLOW DATA
ETCHING TANK SCRUBBER (Tank 193, Bldg. 2)
ANODIZING TANK SCRUBBER (Tank 195, Bldg. 2)

McDonnell Douglas

October 1, 1986

Parameter	Etching Tank Scrubber Inlet Sparger On	Etching Tank Scrubber Inlet Sparger Off	Anodizing Tank Scrubber Inlet Sparger On	Anodizing Tank Scrubber Inlet Sparger Off
Velocity (FPS)	30.19	30.26	41.10	41.14
Volumetric Flow				
ACFM	13,187	13,218	23,279	23,302
DSCFM	12,546	12,531	22,024	22,026
Stack Temperature (°F)	70	73	72	73
Moisture Content (%)	1.65	1.44	1.83	1.73

TABLE 2

SUMMARY OF VOLUMETRIC FLOW DATA
ANODIZING TANK SCRUBBER (Tank 195, Bldg. 2)

McDonnell Douglas

October 3, 1986

Parameter	Anodizing Tank Scrubber Inlet	Anodizing Tank Scrubber Outlet
Velocity (FPS)	41.17	50.32
Volumetric Flow		
ACFM	23,319	24,576
DSCFM	22,052	23,231
Stack Temperature (°F)	71	71
Moisture Content (%)	1.39	1.43

TABLE 3

SUMMARY OF EMISSIONS DATA
ETCHING TANK SCRUBBER (Tank 193, Bldg. 2)
ANODIZING TANK SCRUBBER (Tank 195, Bldg. 2)

McDonnell Douglas

October 1, 1986

Parameter	Etching Tank Scrubber Inlet Sparger On	Etching Tank Scrubber Inlet Sparger Off	Anodizing Tank Scrubber Inlet Sparger On	Anodizing Tank Scrubber Inlet Sparger Off
Total Chromium				
ppm	22.2×10^{-3}	23.0×10^{-3}	27.19×10^{-3}	24.7×10^{-3}
lbs/hr	2.29×10^{-3}	2.37×10^{-3}	4.92×10^{-3}	4.47×10^{-3}
Chromium +6				
ppm	3.38×10^{-3}	3.78×10^{-3}	19.91×10^{-3}	4.19×10^{-3}
lbs/hr	0.35×10^{-3}	0.39×10^{-3}	3.6×10^{-3}	0.76×10^{-3}
	15.3% Cr^{+6}	16.5% Cr^{+6}	73.2% Cr^{+6}	17% Cr^{+6}

TABLE 4

SUMMARY OF VOLUMETRIC FLOW DATA
ANODIZING TANK SCRUBBER (Tank 195, Bldg. 2)

McDonnell Douglas

October 3, 1986

Parameter	Anodizing Tank Scrubber Inlet	Anodizing Tank Scrubber Outlet
Total Chromium		
ppm	51.06×10^{-3}	2.71×10^{-3}
lbs/hr	9.25×10^{-3}	0.52×10^{-3}
		14.38%
Chromium +6		
ppm	34.43×10^{-3}	1.55×10^{-3}
lbs/hr	6.24×10^{-3}	0.30×10^{-3}
		75.1%
	67.5% Hex	57.7%

ENGINEERING-SCIENCE, ARCADIA, CALIFORNIA

PLANT: MCDONNEL DOUGLASS
SOURCE: SCRUBBER #1 INLET
DATE: 10-1-86
RUN #: SPARGER ON

FLOW DATA

STACK LENGTH (INCHES)	32.875
STACK WIDTH (INCHES)	31.675
STACK CROSS-SECTIONAL AREA (SQUARE FT)	7.28
BAROMETRIC PRESSURE (INCHES MERCURY)	29.5
OXYGEN CONTENT (%)	20.8
CARBON DIOXIDE (%)	0
MOISTURE CONTENT (%)	1.65
STACK TEMPERATURE (DEG F)	70
STACK STATIC PRESSURE (INCHES WATER)	-1.3
VELOCITY PRESSURE (SQ RT INCHES WATER DELTA P)	.53
PITOT TUBE CORRECTION FACTOR	.84
VELOCITY (FEET PER SEC)	30.19
EXHAUST GAS FLOW RATE (ACFM)	13187
EXHAUST GAS FLOW RATE (DSCFM)	12546

POLLUTANT DATA

PARAMETER: TOTAL CHROMIUM
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	22.2×10^{-3}
EMISSION RATE (LBS/HR)	2.29×10^{-3}

PARAMETER: CHROMIUM +6
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	3.38×10^{-3}
EMISSION RATE (LBS/HR)	$.35 \times 10^{-3}$

ENGINEERING-SCIENCE, ARCADIA, CALIFORNIA

PLANT: MCDONNEL DOUGLASS
SOURCE: SCRUBBER #1 INLET
DATE: 10-1-86
RUN #: SPARGER OFF

FLOW DATA

STACK LENGTH (INCHES)	32.875
STACK WIDTH (INCHES)	31.875
STACK CROSS-SECTIONAL AREA (SQUARE FT)	7.28
BAROMETRIC PRESSURE (INCHES MERCURY)	29.5
OXYGEN CONTENT (%)	20.8
CARBON DIOXIDE (%)	0
MOISTURE CONTENT (%)	1.44
STACK TEMPERATURE (DEG F)	73
STACK STATIC PRESSURE (INCHES WATER)	-1.3
VELOCITY PRESSURE (SQ RT INCHES WATER DELTA P)	.53
PITOT TUBE CORRECTION FACTOR	.84
VELOCITY (FEET PER SEC)	30.26
EXHAUST GAS FLOW RATE (ACFM)	13218
EXHAUST GAS FLOW RATE (DSCFM)	12531

POLLUTANT DATA

PARAMETER: TOTAL CHROMIUM
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	23 $\times 10^{-3}$
EMISSION RATE (LBS/HR)	2.37 $\times 10^{-3}$

PARAMETER: CHROMUIM +6
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	3.78 $\times 10^{-3}$
EMISSION RATE (LBS/HR)	.39 $\times 10^{-3}$

ENGINEERING-SCIENCE, ARCADIA, CALIFORNIA

PLANT: MCDONNEL DOUGLASS
SOURCE: SCRUBBER #2 INLET
DATE: 10-1-86
RUN #: SPARGER ON

FLOW DATA

STACK LENGTH (INCHES)	37.875
STACK WIDTH (INCHES)	35.875
STACK CROSS-SECTIONAL AREA (SQUARE FT)	9.44
BAROMETRIC PRESSURE (INCHES MERCURY)	29.5
OXYGEN CONTENT (%)	20.8
CARBON DIOXIDE (%)	0
MOISTURE CONTENT (%)	1.83
STACK TEMPERATURE (DEG F)	72
STACK STATIC PRESSURE (INCHES WATER)	-1.4
VELOCITY PRESSURE (SQ RT INCHES WATER DELTA P)	.72
PITOT TUBE CORRECTION FACTOR	.84
VELOCITY (FEET PER SEC)	41.1
EXHAUST GAS FLOW RATE (ACFM)	23279
EXHAUST GAS FLOW RATE (DSCFM)	22024

POLLUTANT DATA

PARAMETER: TOTAL CHROMIUM
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	27.19	$\times 10^{-3}$
EMISSION RATE (LBS/HR)	4.92	$\times 10^{-3}$

PARAMETER: CHROMIUM +6
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	19.91	$\times 10^{-3}$
EMISSION RATE (LBS/HR)	3.6	$\times 10^{-3}$

ENGINEERING-SCIENCE, ARCADIA, CALIFORNIA

PLANT: MCDONNEL DOUGLASS
SOURCE: SCRUBBER #2 INLET
DATE: 10-2-86
RUN #: INLET

FLOW DATA

STACK LENGTH (INCHES)	37.875
STACK WIDTH (INCHES)	35.875
STACK CROSS-SECTIONAL AREA (SQUARE FT)	9.44
BAROMETRIC PRESSURE (INCHES MERCURY)	29.3
OXYGEN CONTENT (%)	20.8
CARBON DIOXIDE (%)	0
MOISTURE CONTENT (%)	1.39
STACK TEMPERATURE (DEG F)	71
STACK STATIC PRESSURE (INCHES WATER)	-1.3
VELOCITY PRESSURE (SQ RT INCHES WATER DELTA P)	.72
PITOT TUBE CORRECTION FACTOR	.84
VELOCITY (FEET PER SEC)	41.17
EXHAUST GAS FLOW RATE (ACFM)	23319
EXHAUST GAS FLOW RATE (DSCFM)	22052

POLLUTANT DATA

PARAMETER: TOTAL CHROMIUM
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	51.06×10^{-3}
EMISSION RATE (LBS/HR)	9.25×10^{-3}

PARAMETER: CHROMIUM +6
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	34.43×10^{-3}
EMISSION RATE (LBS/HR)	6.24×10^{-3}

ENGINEERING-SCIENCE, ARCADIA, CALIFORNIA

PLANT: MCDONNEL DOUGLASS
SOURCE: SCRUBBER #2 INLET
DATE: 10-1-86
RUN #: SPARGER OFF

FLOW DATA

STACK LENGTH (INCHES)	37.875
STACK WIDTH (INCHES)	35.875
STACK CROSS-SECTIONAL AREA (SQUARE FT)	9.44
BAROMETRIC PRESSURE (INCHES MERCURY)	29.5
OXYGEN CONTENT (%)	20.8
CARBON DIOXIDE (%)	0
MOISTURE CONTENT (%)	1.73
STACK TEMPERATURE (DEG F)	73
STACK STATIC PRESSURE (INCHES WATER)	-1.4
VELOCITY PRESSURE (SQ RT INCHES WATER DELTA P)	.72
PITOT TUBE CORRECTION FACTOR	.84
VELOCITY (FEET PER SEC)	41.14
EXHAUST GAS FLOW RATE (ACFM)	23302
EXHAUST GAS FLOW RATE (DSCFM)	22026

POLLUTANT DATA

PARAMETER: TOTAL CHROMIUM
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	24.7 $\times 10^{-3}$
EMISSION RATE (LBS/HR)	4.47 $\times 10^{-3}$

PARAMETER: CHROMIUM +6
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	4.19 $\times 10^{-3}$
EMISSION RATE (LBS/HR)	.76 $\times 10^{-3}$

ENGINEERING-SCIENCE, ARCADIA, CALIFORNIA

PLANT: MCDONNEL DOUGLASS
SOURCE: SCRUBBER #2 OUTLET
DATE: 10-3-86
RUN #: OUTLET

FLOW DATA

STACK LENGTH (INCHES)	36.75
STACK WIDTH (INCHES)	30.25
STACK CROSS-SECTIONAL AREA (SQUARE FT)	8.14
BAROMETRIC PRESSURE (INCHES MERCURY)	29.3
OXYGEN CONTENT (%)	20.8
CARBON DIOXIDE (%)	0
MOISTURE CONTENT (%)	1.43
STACK TEMPERATURE (DEG F)	71
STACK STATIC PRESSURE (INCHES WATER)	-1.3
VELOCITY PRESSURE (SQ RT INCHES WATER DELTA P)	.88
PITOT TUBE CORRECTION FACTOR	.84
VELOCITY (FEET PER SEC)	50.32
EXHAUST GAS FLOW RATE (ACFM)	24576
EXHAUST GAS FLOW RATE (DSCFM)	23231

POLLUTANT DATA

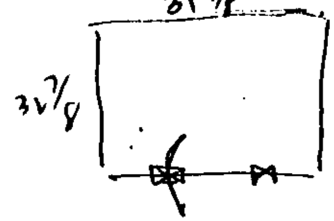
PARAMETER: TOTAL CHROMIUM
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	2.71×10^{-3}
EMISSION RATE (LBS/HR)	$.52 \times 10^{-3}$

PARAMETER: CHROMIUM +6
MOLECULAR WEIGHT=52

CONCENTRATION (PPM)	1.55×10^{-3}
EMISSION RATE (LBS/HR)	$.3 \times 10^{-3}$

I-O DATA



SCHEMATIC OF TRAVERSE POINT LAYOUT

PLANT Mc 17
DATE 10-1-86
SAMPLING LOCATION SCRUBBER #1
SAMPLE TYPE
RUN NUMBER 1
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s) ——
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

CONDITION W/ SPARGER ON

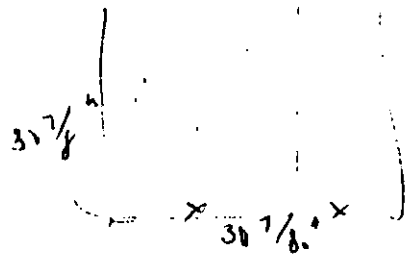
READ AND RECORD ALL DATA EVERY 10 MINUTES FIX! 180 only

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1045	124.049	.772	.75	.75	63	80		2		
	10	1055	130.6			.75		80		2		
	20	1105	137.0			.75		82		2		
	30	1115	140.3	.772		.75	72	82		2		
	40	1125	146.0			.75		87				
	50	1135	151.7			.75		90		2		
	60	1145	156.2	.773		.75	73	90				
	70	1155	162.6			.75		90		2		
	80	1205	168.5			.75		90		2		
	90	1215	173.9			.75		90		2		
	100	1225	178.1			.75		90		2		
	110	1235	184.4	.772		.75		90				
	120	1245	188.5			.75		90		2		
	130	1255	194.2[illegible]			.75		90		2		
	140	1305	201.0			.75		90		2		
	150	1315	204.8	.772		.75		90		2		
	160	1325	210.4			.75		90		2		
	170	1335	215.6					90		2		
	180	1345	220.931	END								
			96.882	$\sqrt{\ }$ = .852			70	90			33.2	

COMMENTS:

F. .D DATA

PLANT MCD TORRANCE
DATE 10-1-86
SAMPLING LOCATION SC # 1
SAMPLE TYPE
RUN NUMBER 2
OPERATOR RL
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s) -1.3
FILTER NUMBER (s)



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER 3
METER $\Delta H_@$ 1.93 1.0V
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

CONDITION SPARGER OFF

READ AND RECORD ALL DATA EVERY 10 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0	1355	221.095	.27	.75	.75	73	82		✓		
	10	1405	226.1			.75		82		✓		
	20	1415	231.8			.75	73	82		✓		
	30	1425	238.3			.75						
	40	1435	242.0			.75	73	82		2"		
	50	1445	247.3			.75		88				
	60	1455	253.2			.75	73					
	70	1505	258.5			.75		86		2"		
	80	1515	264.0			.75	73					
	90	1525	269.8			.75		88		2"		
	100	1535	274.1			.75						
	110	1545										
	120	1555	285.6			.75	73	88		2"		
	130	1605	291.1			.75		88		2"		
	140	1615	296.7			.75				2"		
	150	1625	301.7			.75		86		2"		
	160	1635	307.4			.75				2"		
161	~~170~~ 164		1646 307.158	END RUN								
	~~180~~ 165					END	RUN					
			8.063	1=.5V		.75	73	87			95.7	

COMMENTS:

-1 O_2 = w.8%

-2 O_2 = w.8%

.D DATA

PLANT: Mc D
DATE: 10-1-96
SAMPLING LOCATION: SCRUBBER #2 INLET
SAMPLE TYPE:
RUN NUMBER:
OPERATOR:
AMBIENT TEMPERATURE:
BAROMETRIC PRESSURE:
STATIC PRESSURE, (P_s):
FILTER NUMBER (s):

PROBE LENGTH AND TYPE:
NOZZLE I.D.:
ASSUMED MOISTURE, %:
SAMPLE BOX NUMBER:
METER BOX NUMBER:
METER $\Delta H_@$:
C FACTOR:
PROBE HEATER SETTING:
HEATER BOX SETTING:
REFERENCE Δp:

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 10 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	10:45	746.789	.55	.75	.75	72	81		3		
	10	10.55	751.5		.75	.75	73	83				
	20	11:05	756.1		.75	.75	70	86		3		
	30	11:15	760.8		.75	.75		81				
	40	1125	766.0			.75		88				
	50	1135	770.1			.75	72	88				
	60	1145	775.2			.75	73	88				
70		1155	780.6			.75	73	88		3		
80		1205	784.6			.75						
90		1215	789.3			.75						
100		1225	794.1			.75						
110		1235	798.9			.75				3		
120		1245	803.6			.75						
130		1255	808.4			.75	73			3		
140		1305	812.1			.75						
150		1315	817.9			.75						
160		1325	822.7			.75						
170		1335	827.9			.75						
180		1345	832.299			.75						
			85.4	.55		.75	71	84			33.3	
				$\bar{p}$ = .74								

COMMENTS:

F. ..J DATA

PLANT McD
DATE 10-1-86
SAMPLING LOCATION Scrubber #2 INLET
SAMPLE TYPE
RUN NUMBER V
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER 2A
METER BOX NUMBER 2
METER $\Delta H_@$ 1.99 1.03
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 10 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	1355 0	832.351		.75	.75	74	83		2		
	1405 10	837.9			.75	72					
	1415 20	842.1			.75	72			2		
	1425 30	846.9			.75	72					
	1435 40	851.6			.75	73			2		
	1445 50	856.4			.75	73	83				
-	1455 60	861.2			.75	76	84		2		
	70 1505	866.0			.75	73	84		2		
	80 1515	870.9			.75	73	83				
	90 1525	875.6			.75	73	82		2		
	100 1535	880.4			.75	73	82				
	110 1545	885.3			.75	73	82		2		
	120 1555	890.1			.75	73	82				
	130 1605	894.8			.75	73	82				
	140 1615	899.6			.75	73	82		2		
	150 1625	904.5			.75	72	82				
	160 1635	909.355									
	170 1645										
	180 1655										
		7504	1.74	.75		73	83			96.7	

COMMENTS:

F .D DATA

PLANT MCDONNELL DOUGLAS
DATE 10-3-96
SAMPLING LOCATION SCRUBBER #2 INLET
SAMPLE TYPE METHOD 5
RUN NUMBER 1
OPERATOR C.MOK
AMBIENT TEMPERATURE 75
BAROMETRIC PRESSURE 29.5
STATIC PRESSURE, (P_g) –
FILTER NUMBER (s) N/A

PROBE LENGTH AND TYPE STAINLESS/TEFLON TUBING
NOZZLE I.D. _____
ASSUMED MOISTURE, % _____
SAMPLE BOX NUMBER _____
METER BOX NUMBER 2A
METER $\Delta H_@$ 1.71 / 1.6 = 1.03
C FACTOR _____
PROBE HEATER SETTING _____
HEATER BOX SETTING _____
REFERENCE Δp _____

SCHEMATIC OF TRAVERSE POINT LAYOUT
SUPER DIAMETER = 35 7/8" x 37 7/8"

READ AND RECORD ALL DATA EVERY 10 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F			
	0 11:00	41.425		0.75	0.75	71		63			
	10 11:10	46.12		0.75	0.75	74		81			
	20 11:20	51.13		0.75	0.75	73		83			
★	30 11:30	56.07		0.75	0.75	73		83	9		
	40 12:40	61.1		0.75	0.75	78		90	9		
	50 12:50	65.69		0.75	0.75	76		92	9		
	60 13:00	70.4		0.75	0.75				9		
	70 13:10	75.55		0.75	0.75	73		94	9		
	80 13:20	80.04		0.75	0.75				9		
	90 13:30	84.72		0.75	0.75	78		93	9		
	100 13:40	89.34		0.75	0.75				9		
	110 13:50	94.12		0.75	0.75	71		94	9		
	120 14:00	98.933		0.75	0.75				9		
	TT = 120 min	V_m = 57.508	$\sqrt{\Delta p}$ = .72	ΔH =	0.75	T_s = 74	T_m =	86	9"	16.8 °C	

COMMENTS: ★ pump shut off at 11:31 (V_m = 56.705) per request of client. Pump turned back on at 12:31.

PRELIMINARY VELOCITY TRAVERSE

PLANT TURNER
DATE 10-2-86
LOCATION
STACK I.D.
BAROMETRIC PRESSURE, in. Hg
STACK GAUGE PRESSURE, in. H_2O 1.3
OPERATORS

TRI-ACID
#1 STD 37 7/8 × 31 7/8

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	.15	63
2	.17	↓
3	.15	↓
4	.15	
5	.17	
6	.15	
1	.4	63
2	.3	↓
3	.25	
4	.27	↓
5	.3	
6	.35	
	$\sqrt{\Delta p}$ = .416	63
	LOW	HIGH
AVERAGE		

1. ANODIZE TANK

SCHEMATIC OF TRAVERSE POINT LAYOUT

Scrubber #2 35 7/8" × 37 7/8"

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	.55	63
2	.52	63
3	.52	70
4	.57	70
5		
6		
1	.45	70
2	.45	70
3	.40	70
4	.30	70
5	.35	70
6		
$\sqrt{\Delta p}$'s = (87)#	CAN'T READ W/ STD.	
1.3 PS		
AVERAGE		

37 7/8
35 7/8

EPA (Dur) 233
4/72

| .D DATA

PLANT McD + D
DATE 10-3-86
SAMPLING LOCATION scrubber #2 outlet
SAMPLE TYPE
RUN NUMBER 1
OPERATOR RON DIAZ
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s) –
FILTER NUMBER (s) NONE

PROBE LENGTH AND TYPE TEFLON TUBING
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER 3
METER $\Delta H_@$ 1.93/8=1.02
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

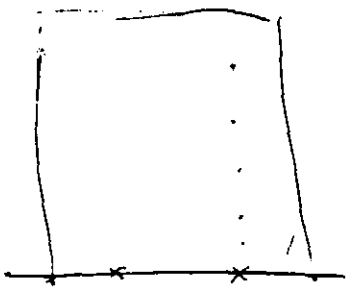
READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	10:55	309.491	.77	1.0	1.0	68		78	1"		
	10	1105	314.9		1.0	1.0	68		82			
	20	1115	320.4		1.0	1.0				1"		
	30	1125	325.9		1.0	1.0	68		82			
	40	1131 stop	329.691 start 12:30									
	50	1240	334.9		1.0	1.0	71		82	1"		
	60	1250	340.4		1.0	1.0	71		82	1"		
	70	1300	345.9		1.0	1.0						
	80	1310	351.8		1.0	1.0	74		83	1"		
	90	1320	356.9		1.0	1.0			84	1		
	100	1330	362.4		1.0	1.0	73		84	1		
	120	1340	367.9		1.0	1.0						
	130	1350	373.7		1.0	1.0	73		84	1"		
	140	1400	378.936									
	TT= 120min		Vm= 69.445	VΔp= .88	ΔH=	1.0	Ts= 71		Tm= 82		wg	

COMMENTS:

PRELIMINARY VELOCITY TRAVERSE

PLANT McDonnel Douglas
DATE 10-1-86
LOCATION SCRUBBER # 1 (TRI-REND) INLET
STACK I.D. 31 7/8 x 52 3/8
BAROMETRIC PRESSURE, in. Hg
STACK GAUGE PRESSURE, in. H_2O -1.3
OPERATORS RJ2 / RJD



SCHEMATIC OF TRAVERSE POINT LAYOUT

INLET

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	.28	70
2	.30	70
3	.27	70
4	.23	70
5	.30	70
6	.32	70
$\sqrt{\Delta p_s}$	.534	
$V_s =$	$85.49\ C_p \sqrt{\frac{T_s}{M_s P_s}} \sqrt{\Delta p_s}$	
=	$85.49 \cdot .84 \sqrt{\frac{530}{29.4}} \cdot .534$	
=	30.4 fps	
Q_{scfm} =	$V_s A \times 60 \frac{sec}{min}$	
=	$30.4 \frac{31.875 \times 52.375}{144} \times 60$	
AVERAGE	= 13,273 acfm	

EPA (Dur) 233
4/72

= 12 551 dscfm

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	.27	70
2	.30	
3	.27	70
4	.21	
5	.28	70
6	.34	
AVERAGE		

PRELIMINARY VELOCITY TRAVERSE

PLANT McDonnell Douglas

DATE 10-1-92

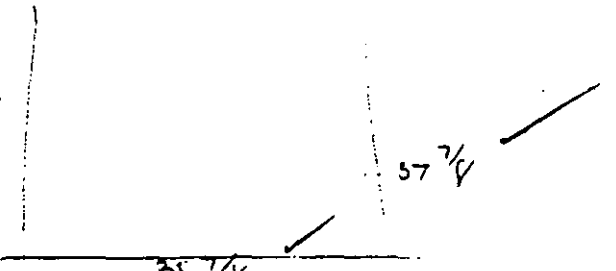
LOCATION SCRUBBER # 2 (MODIZE) INLET

STACK I.D. 37 7/8

BAROMETRIC PRESSURE, in. Hg 24.5

STACK GAUGE PRESSURE, in. H_2O

OPERATORS



SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	.55	73
2	.55	
3	.56	73
4	.57	
5	.49	
6	.45	71
$\sqrt{\Delta p_{avg}}$	.71	
$V_s = 85.49\ C_p \sqrt{\frac{T_s}{M_s P_s}} \sqrt{P_s}$		
$= 85.49\ (.84) \sqrt{\frac{533}{29.44}}$		.71
$= 41.6$ fpm		
$Q_{mm^2} = V_s A \times 60$		
$= 41.6 \cdot \frac{35.875 \times 37.875}{144} \times 60$		
$= 41.6 \times 9.44 \times 60$		
AVERAGE	$= 23{,}326$ acfm	

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	.52	71
2	.55	
3	.55	
4	.53	
5	.48	
6	.45	
AVERAGE		

EPA (Dur) 233
4/72

$Q_{scfm} = 23{,}326 \left(\frac{530}{533}\right)\left(\frac{24.5}{29.92}\right)$

$= 19{,}057$ dscfm

PRELIMINARY VELOCITY TRAVERSE

PLANT MCDONNEL DOUGLAS
DATE 10-3-86
LOCATION SCRUBBER 2 OUTLET
STACK I.D.
BAROMETRIC PRESSURE, in. Hg
STACK GAUGE PRESSURE, in. H_2O
OPERATORS CM/RD

width $38\frac{6}{8}$" 38.75
$30\frac{1}{4}$" 30.25

SCHEMATIC OF TRAVERSE POINT LAYOUT

O_2 21%, CO_2 0%.

A

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	0.60	70
2	0.90	69
3	1.0	70
4	1.0	63
5	1.4	63
6	1.2	63
1	0.65	63
2	0.92	70
3	1.0	70
4	1.1	70
5	1.6	70
6	1.1	70
AVERAGE		

B

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	0.25	70
2	0.36	63
3	0.60	70
4	0.66	70
5	0.68	70
6	0.84	70
	$\sqrt{\Delta p_s}$ =	.87
		68 °F
1	0.27	70
2	0.37	63
3	0.62	70
4	0.65	70
5	0.65	70
6	0.80	70
	$\sqrt{\Delta p_s}$ = .88	
		69 °F
AVERAGE		

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The Determination of Hexavalent Chromium Emissions using a Diphenylcarbazide Colorimetric Method

SAMPLE ANALYSIS

The EPA Method 5 sampling trains were recovered in the laboratory. The probe wash and impinger solutions were combined, diluted to 500 mls and stored at room temperature. These samples were analyzed for hexavalent chromium within 24 hours after sampling following the procedure below.

The analytical procedure consisted of three steps. The initial step consisted of digesting the samples with an alkaline solution of sodium hydroxide and anhydrous sodium carbonate. The digested samples were then filtered. The second step involved reacting the digested and filtered samples with the diphenylcarbazide solution to produce the characteristic red-violet color which allowed the colorimetric determination of hexavalent chromium. The third step consisted of analyzing the reacted samples spectrophotometrically.

The samples were prepared for analysis by an initial digestion and filtration step. A 50 ml aliquot of each sample was taken and combined with approximately 40 mls of the digesting solution. This mixture was heated to near boiling with constant stirring for thirty minutes and then allowed to cool. After the solution had cooled, it was filtered through a 47-mm diameter, 3.0-μm pore size Zefluor filter. The filtered solution was then transferred quantitatively into a 100 ml volumetric flask and diluted to the mark. A deionized water blank was prepared for analysis in the same manner.

Then the samples were reacted with a diphenylcarbazide solution. A 50 ml aliquot of the digested and filtered sample was transferred to another 100 ml volumetric flask and diluted with approximately 20 mls of deionized water. The pH of each sample was adjusted to 2 ± 0.5 with the dropwise addition of ~~a~~ 10% (v/v) H_2SO_4 ~~solution~~. Two mls of the diphenylcarbazide solution were added to each volumetric flask which was then diluted to the mark. This step was also carried out for seven calibration standards prepared from a standard potassium dichromate stock solution. The seven calibration standard solutions, ranging in concentration from 0 ug Cr^{+6} to 100 ug Cr^{+6}, were used to obtain the spectrophotometric calibration factor, Kc. The samples and calibration standard solutions were allowed to stand for 15 minutes to allow full color development.

After full color development, the samples and calibration standard solutions were analyzed spectrophotometrically at the predetermined optimum wavelength.

EMISSION CALCULATIONS

~~The Seven Calibrations~~

The spectrophotometric calibration factor, Kc, was calculated from the absorbance values obtained by the spectrophotometric measurement of the seven calibration standard solutions. The spectrophotometric Calibration Factor, Kc, was calculated using the following equation:

$$K_c = 15 \quad \frac{A_1 + 2A_2 + 5A_3 + 10A_4 + 15A_5 + 20A_6}{A_1^2 + A_2^2 + A_3^2 + A_4^2 + A_5^2 + A_6^2}$$

Where:

K_c = calibration factor
A_1 = absorbance of the 5 ug Cr^{+6} standard
A_2 = " " " 10 ug Cr^{+6} "
A_3 = " " " 25 ug Cr^{+6} "
A_4 = " " " 50 ug Cr^{+6} "
A_5 = " " " 75 ug Cr^{+6} "
A_6 = " " " 100 ug Cr^{+6} "

The total ug Cr^{+6} in each sample, m, was calculated using the following equation:

$$m = \frac{500\ K_c\ A\ F}{V_a}$$

where 500 = volume in ml of total sample
A = absorbance of sample
F = dilution factor (if required)
V_a = volume in ml of aliquot analyzed (50)