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Air

EPA

Arsenic
Non-Ferrous Smelter

Emission Test Report
Kennecott Copper Corporation
Magna, Utah

EMISSION TESTING OF KENNECOTT COPPER SMELTER
MAGNA, UTAH

TO

ENVIRONMENTAL PROTECTION AGENCY
Contract 68-02-2812
Work Assignment 29

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INTRODUCTION

In accordance with the Environmental Protection Agency's program for developing new source performance standards, TRW participated in fugitive emission testing at the Kennecott copper smelter located in Magna, Utah. Testing was performed from October 30 - Novermber 15, 1978.

The testing program was developed to provide arsenic/sulfur dioxide data on the following environmental control systems: matte tapping fugitive emission system, slag tapping fugitive emission system, converter fugitive emission system, acid plant inlet, and concentrate dryer fugitive emission systems.

The matte tapping fugitive emission system operated on an intermittent basis during the loading operation of copper matte from the reactors to the large ladles. The system removed the fugitive air pollutants that were generated during this operation.

The slag tapping fugitive emission system operated on an intermittent basis during the loading of slag from the reactors to the large ladles. This system removed the fugitive emissions generated during the operation.

The converter fugitive emission system is comprised of a hooding system over the converters which removes the fugitive air pollutants that escape the converter ducting system. The acid plant inlet duct (converter ducting system) removes large amounts of air pollutants including sulfur dioxide from the converter process operation and the hot gases enter the sulfuric acid plant. The sulfuric acid plant then converts large amounts of sulfur dioxide into commercial grade sulfuric acid from the process exhaust gases. The converter process operates on a continuous cyclic operation.

The concentrate dryer emission system removes large amounts of moisture and fugitive dust from the rotating concentrate dryers. The emissions are passed through large cyclones and a wet scrubber, then the gases exit through a 150°F stack. The dryer operation works on a continuous basis with the concentrate feed being added as needed.

Testing at the Kennecott copper smelter consisted of the following tests.

Three arsenic/sulfur dioxide tests were performed on the matte tapping fugitive emissions system with the EPA process engineer coordinating the intermittent testing.

At the slag tapping fugitive emission duct, three arsenic/sulfur dioxide tests were conducted with the EPA process engineer coordinating the intermittent sampling.

Testing the converter process operation required three tests to be performed during a given converter cycle. Two tests were performed on the converter fugitive emission system while one test was conducted at the acid plant inlet duct. The two tests conducted at the converter fugitive emission system during the converter cycle consisted of one test being performed during the complete cycle, and a second test being performed only during the converter roll-out segment of the cycle. The tests at the acid plant inlet duct and at the converter fugitive emission system were coordinated under the direction of the EPA process engineer. Three arsenic/sulfur dioxide tests were performed at the acid plant inlet duct and the converter fugitive emission duct (complete cycle test). Two arsenic/sulfur dioxide tests were conducted during the converter roll-out phase of the converter cycle.

This report presents the results of the testing program. The following sections of the report contain: a summary of the results, descriptions of the sampling points, a description of the process, and delineation of the sampling and laboratory analytical procedures. The appendices contain field data, sample calculations and daily activity log.

SECTION 2

SUMMARY AND DISCUSSION OF RESULTS

The results of the testing program are summarized in Tables 1 - 5. The arsenic/sulfur dioxide data for the matte tapping fugitive emission system and slag tapping fugitive emission systems are presented in Tables 1 and 2, respectively. Acid plant inlet arsenic/sulfur dioxide results are given in Table 3. The converter fugitive emission system arsenic/sulfur dioxide results are presented in Tables 4 and 5. Table 4 presents the converter fugitive emissions tests during the complete cycle. The converter roll-out arsenic/sulfur dioxide data are presented in Table 5. Concentrate dryer emissions are reported in Table 6. All process sample analysis data are contained in Table 7.

The field sampling program encountered the following minor problems which are outlined below with respect to individual sampling locations.

During the field sampling at the matte tapping fugitive emission system and the slag tapping fugitive emission system, the sampling program required long days due to the intermittent process operation and days of reduced operation. At the slag tapping fugitive emission duct there were two modifications in the sampling procedure required. Only one port was located on the duct which required that both traverses be performed through the same port utilizing the pythagorean calculations. All equations and distances are shown in figure 3. The sampling train was modified to allow for the two traverses through the single sampling port. A teflon flex line was inserted between the probe and heater box to assist in maneuvering the probe into the proper placement. After the testing the flex line was cleaned with a probe brush and .1N NaOH. The solution was placed in the probe rinse bottle and saved for analysis.

Testing the converter fugitive emission system and the acid plant inlet required TRW personnel to adjust the working schedule to fit the cyclic process operation of the converter unit. Due to lack of space at the converter fugitive emission duct sampling position, TRW was required to utilize the flex lines between the probes and heater boxes on each of the tests. After each test the flex line was cleaned with .1N NaOH and a probe brush. The solution was placed in the probe rinse bottle and saved for analysis.

Weather forced TRW personnel to curtail the field sampling on Friday, November 10, 1978. TRW personnel returned on Monday, November 12, 1978 to complete the field sampling on the concentrate dryer fugitive emission system.

Testing the concentrate dryer fugitive emission system required the test ports to be placed in the fiberglass stack. Due to the working space and the fiberglass stack, TRW utilized the flex line inserted between the probe and the heater box to assist in performing the sampling traverses.

Testing at the concentrate dryer fugitive emission system was performed under low ambient temperature which ranged from $20^{o}F$ to $30^{o}F$.

During the data reduction, the meter volume was back calculated to account for sulfur dioxide that was removed by the three 10% hydrogen peroxide impingers. The back calculation for sulfur dioxide was accomplished in the following order. First, parts per million sulfur dioxide at standard conditions was calculated. Then parts per million was converted to a fraction by dividing by 10^6. This number was added to one and the result multiplied by volume of gas collected through the dry gas meter at standard conditions. The results of multiplication yielded the actual gas volume at standard conditions collected.

TABLE 1 Matte Tapping Arsenic/SO_2 Results

RUN NUMBER	1		2		3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS
I DATE	11/3/78	11/3/78	11/1/78	11/1/78	11/3/78	11/3/78		
II STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	.01	.254	.01	.254	.01	.254	.01	.254
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	25.85	656.59	25.73	653.54	25.85	656.59	25.81	655.57
% CO_2 - Volume % Dry	0	0	0	0	0	0	0	0
% O_2 - Volume % Dry	20.	20.	20.	20.	20.	20.	20.	20.
SO_2 - Volume % Dry	.09	.09	.10	.10	.12	.12	.10	.10
% N_2 - Volume % Dry	79.91	79.91	79.90	79.90	79.88	79.88	79.90	79.90
Ts - Average Stack Temperature °F (°C)	126.3	52.3	110.6	43.7	119.1	48.4	118.7	48.1
% H_2O - % Moisture in Stack Gas, By Volume	1.4	1.4	1.	1.	0	0	.80	.80
As - Stack Area, ft^2 (m^2)	19.635	1.824	19.635	1.824	19.635	1.824	19.635	1.824
Md - Molecular Weight of Stack Gas, Dry Basis	28.84	28.84	28.83	28.83	28.85	28.85	28.84	28.84
Ms - Molecular Weight of Stack Gas, Wet Basis	28.69	28.69	28.72	28.72	28.85	28.85	28.75	28.75
Vs - Stack Gas Velocity, ft/sec, (m/sec)	54.18	16.51	52.42	15.98	47.27	14.41	51.29	15.63
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFM (Nm^3/min)	63829.5	1808.2	61756.0	1749.5	55688.8	1577.6	60424.8	1711.8
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFM (Nm^3/min)	48967.9	1387.2	48644.6	1378.2	43867.9	1242.7	47161.8	1336.0
% EA - Percent Excess Air	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
III TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	25.84	656.34	25.72	653.29	25.84	656.34	25.80	655.32
Dn - Sampling Nozzle Diameter, in. (mm)	.250	6.35	.250	6.35	.250	6.35	.250	6.35
T - Sampling Time, min	69.5	69.5	60.5	60.5	66.5	66.5	65.5	65.5
Vm - Sample Volume, ACF (m^3)	76.73	2.17	58.94	1.67	63.62	1.80	66.43	1.88
Np - Net Sampling Points	24.	24.	24.	24.	24.	24.	24.	24.
Cp - Pitot Tube Coefficient	.84	.84	.84	.84	.84	.84	.84	.84
Tm - Average Meter Temperature °F (°C)	75.7	24.3	71.9	22.2	77.1	25.1	74.9	23.9
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	3.19	81.03	2.93	74.42	2.42	61.47	2.85	72.31
Vlc - Condensate Collected (Impingers and Gel), mls	19.2	19.2	14.6	14.6	0	0	11.3	11.3
ΔP - Stack Velocity Head "H_2O (mmH_2O)	.72	18.29	.69	17.53	.56	14.22	.66	16.68
IV TEST CALCULATIONS								
Vw - Condensed Water Vapor, SDCF (Nm^3)	.90	.03	.69	.02	0	0	.53	.02
Vm - Volume of Gas Sampled at Standard Conditions, DSCF (Nm^3)	65.88	1.87	50.70	1.44	54.37	1.54	56.98	1.62
% H_2O - Percent Moisture, By Volume	1.4	1.4	1.0	1.0	0	0	.80	.80
Ms - Molecular Weight of Stack Gas, Wet Basis	28.69	28.69	28.72	28.72	28.85	28.85	28.75	28.75
Vs - Stack Velocity, ft/sec (m/sec)	51.85	15.80	50.89	15.51	45.72	13.93	49.49	15.08
% I - Percent Isokinetic	107.3	107.3	97.08	97.08	103.5	103.5	102.6	102.6
V ANALYTICAL DATA								
A) Arsenic Front Half								
Probe (mg)		1.058		1.428		3.321		1.9357
Cyclone (mg)								
Filter (mg)		.220		.295		.750		.4217
Arsenic Front Half Total (mg)		1.278		1.723		4.071		2.3573
ppm, (mg/m^3)	.2196	.6848	.3847	1.1996	.8476	2.6431	.4839	1.5092
#/hr, (kg/hr)	.1255	.0570	.2185	.0992	.4341	.1970	.2594	.1177
B) Arsenic - Impinger Collection								
Impinger #1, 2 (mg)		.254		1.148		.738		.7133
ppm, (mg/m^3)	.0436	.1361	.2563	.7993	.1536	.4792	.1512	.4715
#/hr, (kg/hr)	.0250	.0113	.1456	.0661	.0787	.0357	.0831	.0377
Impinger #3,4,5 (mg)								
ppm, mg/m^3)								
#/hr, (kg/hr)								
C) Arsenic - Impinger Total (mg)								
ppm, (mg/m^3)								
#/hr, (kg/hr)								
D) Total Arsenic (mg)		1.5320		2.8710		4.8090		3.0707
ppm, (mg/m^3)	.2632	.8209	.6409	1.9989	1.0011	3.1223	.6351	1.9807
#/hr, (kg/hr)	.1505	.0683	.3641	.1653	.5128	.2328	.3425	.1554
E) Total SO_2 (mg)		4681.46		3742.92		4907.95		4444.11
ppm		941.5505		978.1793		1196.0702		1038.6000
(mg/m^3)		2508.4326		2606.0173		3186.5116		2766.9871
#/hr, (kg/hr)	459.8695	208.7469	474.6541	215.4581	523.3389	237.5574	485.9542	220.5875

TABLE 2 Slag tapping Arsenic/SO_2 Results

RUN NUMBER	1		2		3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS
I DATE	11/1/78	11/1/78	11/2/78	11/2/78	11/3/78	11/3/78		
II STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	.06	1.52	.06	1.52	.06	657.86	0.6	1.52
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	25.75	654.06	25.78	654.81	25.90	1.52	25.81	655.57
% CO_2 - Volume % Dry	0	0	0	0	0	657.86	0	0
% O_2 - Volume % Dry	20.	20.	20.	20.	20.	0	20.	20.
SO_2 - Volume % Dry	.003	.003	.008	.008	.004	.004	.005	.005
% N_2 - Volume % Dry	79.997	79.997	79.992	79.992	79.996	79.996	79.995	79.995
Ts - Average Stack Temperature °F (°C)	72.9	22.7	91.0	32.8	71.4	21.9	78.4	25.8
% H_2O - % Moisture in Stack Gas, By Volume	.3	.3	.9	.9	1.0	1.0	.7	.7
As - Stack Area, ft^2 (m^2)	19.635	1.824	19.635	1.824	19.635	1.824	29.635	1.824
Md - Molecular Weight of Stack Gas, Dry Basis	28.80	28.80	28.81	28.81	28.80	28.80	28.80	28.80
Ms - Molecular Weight of Stack Gas, Wet Basis	28.77	28.77	28.72	28.72	28.69	28.69	28.73	28.73
Vs - Stack Gas Velocity, ft/sec, (m/sec)	43.240	13.179	42.017	12.807	38.788	11.823	41.348	12.603
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFM (Nm^3/min)	50941.0	1443.1	49500.2	1402.3	45696.1	1294.5	48712.4	1380.0
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFM (Nm^3/min)	43307.8	1226.9	40541.4	1148.5	38914.0	1102.4	40921.1	1159.3
% EA - Percent Excess Air	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
III TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	25.69	652.53	25.72	653.29	25.84	656.34	25.75	654.05
Dn - Sampling Nozzle Diameter, in. (mm)	.250	6.35	.309	7.85	.309	7.85	.289	7.35
T - Sampling Time, min	60.	60.	120.	120.	120.	120.	100.	100.
Vm - Sample Volume, ACF (m^3)	47.40	1.34	138.06	3.91	139.37	3.95	108.28	3.07
Np - Net Sampling Points	24.	24.	24.	24.	24.	24.	24.	24.
Cp - Pitot Tube Coefficient	.84	.84	.84	.84	.84	.84	.84	.84
Tm - Average Meter Temperature °F (°C)	74.6	23.7	67.4	19.7	76.0	24.4	72.7	22.6
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	1.89	48.01	4.33	110.0	4.03	102.36	3.47	86.79
Vlc - Condensate Collected (Impingers and Gel), mls	2.7	2.7	23.3	23.3	26.0	26.0	17.3	17.3
ΔP - Stack Velocity Head "H_2O (mmH_2O)	.504	12.80	.460	11.684	.408	10.363	.457	11.616
IV TEST CALCULATIONS								
Vw - Condensed Water Vapor, SDCF (Nm^3)	.13	.00	1.10	.03	1.22	.04	.82	.02
Vm - Volume of Gas Sampled at Standard Conditions, DSCF (Nm^3)	40.40	1.14	120.25	3.41	119.88	3.40	93.51	2.65
% H_2O - Percent Moisture, By Volume	.3	.3	.9	.9	1.0	1.0	.7	.7
Ms - Molecular Weight of Stack Gas, Wet Basis	28.77	28.77	28.72	28.72	28.69	28.69	28.73	28.73
Vs - Stack Velocity, ft/sec (m/sec)	43.240	13.179	42.017	12.807	38.788	11.823	41.348	12.603
% I - Percent Isokinetic	89.9	89.9	93.6	93.6	97.	97.	93.5	93.5
V ANALYTICAL DATA								
A) Arsenic Front Half								
Probe (mg)		.580		.930		.315		.6083
Cyclone (mg)								
Filter (mg)		.210		.065		.085		.1200
Arsenic Front Half Total (mg)		.790		.995		.400		.7283
ppm, (mg/m^3)	.2213	.6903	.093	.2921	.0378	.1178	.1176	.3667
#/hr, (kg/hr)	.1119	.0508	.044	.0201	.0172	.0078	.0578	.0262
B) Arsenic - Impinger Collection								
Impinger #1, 2 (mg)		.147		1.591		.106		.6147
ppm, (mg/m^3)	.0412	.1284	.149	.4670	.0100	.0312	.0670	.2089
#/hr, (kg/hr)	.0208	.0095	.070	.0322	.0045	.0021	.0321	.0146
Impinger #3,4,5 (mg)								
ppm, mg/m^3)								
#/hr, (kg/hr)								
C) Arsenic - Impinger Total (mg)								
ppm, (mg/m^3)								
#/hr, (kg/hr)								
D) Total Arsenic (mg)		.9370		2.5860		.5060		1.3430
ppm, (mg/m^3)	.2625	.8187	.2434	.7591	.0478	.1490	.1846	.5756
#/hr, (kg/hr)	.1327	.0603	.1152	.0523	.0217	.0099	.0899	.0408
E) Total SO_2 (mg)		78.68		768.82		389.47		412.3233
ppm		25.8047		84.7141		43.0470		51.1886
(mg/m^3)		68.7476		225.6910		114.6838		136.3741
#/hr, (kg/hr)	11.1467	5.0598	34.255	15.5496	16.7082	7.5843	20.7035	9.3979

TABLE 3 Acid Plant Inlet Arsenic/SO_2 Results

RUN NUMBER	1		2		3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS
I DATE	11/6/78	11/6/78	11/7/78	11/7/78	11/8/78	11/8/78		
II STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	- .26	-6.60	- .26	-6.60	- .26	-6.60	- .26	-6.60
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	25.72	653.29	25.42	645.67	25.72	653.29	25.62	650.75
% CO_2 - Volume % Dry	0	0	0	0	0	0	0	0
% O_2 - Volume % Dry	20.	20.	20.	20.	20.	20.	20.	20.
SO_2 - Volume % Dry	3.9	3.9	2.4	2.4	3.0	3.0	3.1	3.1
% N_2 - Volume % Dry	76.10	76.10	77.60	77.60	77.0	77.0	76.9	76.9
Ts - Average Stack Temperature °F (°C)	420.8	216.0	476.2	246.8	409.4	209.7	435.5	224.2
% H_2O - % Moisture in Stack Gas, By Volume	5.0	5.0	3.0	3.0	4.0	4.0	4.0	4.0
As - Stack Area, ft^2 (m^2)	19.635	1.824	19.635	1.824	19.635	1.824	19.635	1.824
Md - Molecular Weight of Stack Gas, Dry Basis	30.21	30.21	29.67	29.67	29.88	29.88	29.92	29.92
Ms - Molecular Weight of Stack Gas, Wet Basis	29.60	29.60	29.32	29.32	29.40	29.40	29.44	29.44
Vs - Stack Gas Velocity, ft/sec, (m/sec)	83.19	25.36	81.68	24.90	75.61	23.05	80.16	24.44
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFM (Nm^3/min)	98006.1	2776.4	96227.2	2726.0	89076.1	2523.4	94436.55	2675.3
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFM (Nm^3/min)	47978.1	1359.2	44724.8	1267.0	44643.3	1264.7	45782.1	1297.0
% EA - Percent Excess Air	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
III TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	25.98	659.89	25.68	652.27	25.98	659.89	25.88	657.35
Dn - Sampling Nozzle Diameter, in. (mm)	.180	4.48	.190	4.83	.180	4.48	.183	4.60
T - Sampling Time, min	124.	124.	119.	119.	120.	120.	121.	121.
Vm - Sample Volume, ACF (m^3)	59.71	1.69	57.02	1.62	57.27	1.62	58.00	1.64
Np - Net Sampling Points	24.	24.	24.	24.	24.	24.	24.	24.
Cp - Pitot Tube Coefficient	.84	.84	.84	.84	.84	.84	.84	.84
Tm - Average Meter Temperature °F (°C)	64.2	17.9	74.8	23.8	65.0	18.3	68.0	20.0
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	.69	17.53	.82	20.83	.60	15.24	.70	17.87
Vlc - Condensate Collected (Impingers and Gel), mls	56.2	56.2	32.4	32.4	38.2	38.2	42.3	42.3
ΔP - Stack Velocity Head "H_2O (mmH_2O)	1.16	29.46	1.03	26.16	.98	24.89	1.06	26.84
IV TEST CALCULATIONS								
Vw - Condensed Water Vapor, SDCF (Nm^3)	2.65	.08	1.53	.04	1.80	.05	1.99	.06
Vm - Volume of Gas Sampled at Standard Conditions, DSCF (Nm^3)	50.38	1.43	48.41	1.37	49.57	1.40	49.45	1.40
% H_2O - Percent Moisture, By Volume	5.0	5.0	3.0	3.0	4.0	4.0	4.0	4.0
Ms - Molecular Weight of Stack Gas, Wet Basis	29.60	29.60	29.32	29.32	29.40	29.40	29.44	29.44
Vs - Stack Velocity, ft/sec (m/sec)	83.19	25.36	81.68	24.90	75.61	23.05	80.16	24.44
% I - Percent Isokinetic	97.9	97.9	94.1	94.1	106.9	106.9	99.6	99.6
V ANALYTICAL DATA								
A) Arsenic Front Half								
Probe (mg)		1.100		.700		.290		
Cyclone (mg)								
Filter (mg)		10.000		9.900		6.300		
Arsenic Front Half Total (mg)		11.100		10.600		6.590		9.4300
ppm, (mg/m^3)	2.4938	7.7775	2.4784	7.7294	1.5048	4.6929	2.1590	6.7333
#/hr, (kg/hr)	1.3970	.6341	1.2942	.5875	.7844	.3560	1.1585	.5259
B) Arsenic - Impinger Collection								
Impinger #1, 2 (mg)		7.000		.068		.151		2.4063
ppm, (mg/m^3)	1.5727	4.9047	.0159	.0496	.0345	.1075	.5410	1.6873
#/hr, (kg/hr)	.8810	.3999	.0083	.0038	.0180	.0082	.3024	.1373
Impinger #3,4,5 (mg)								
ppm, mg/m^3)								
#/hr, (kg/hr)								
C) Arsenic - Impinger Total (mg)								
ppm, (mg/m^3)								
#/hr, (kg/hr)								
D) Total Arsenic (mg)		18.1000		10.6680		6.7410		11.8363
ppm, (mg/m^3)	4.0665	12.6822	2.4943	7.7790	1.5392	4.8004	2.7000	8.4205
#/hr, (kg/hr)	2.2780	1.0341	1.3025	.5913	.8023	.3642	1.4610	.6632
E) Total SO_2 (mg)		156011.2		87690.0		113481.2		119060.8
ppm		41031.131		24001.085		30333.385		31788.534
(mg/m^3)		109313.127		63942.512		80812.717		84689.452
#/hr, (kg/hr)	19635.233	8912.9518	10706.778	4860.0898	13506.931	6131.1535	14616.314	6634.7317

TABLE 4 Rollout Converter Fugitive Arsenic/SO_2 Results

RUN NUMBER	1		2		3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS
I DATE	11/6/78	11/6/78	11/8/78	11/6/78				
II STACK PARAMETERS								
PST - STATIC PRESSURE, "HG (MMHG)	- .38	-9.65	- .38	-9.65			- .38	-9.65
PS - STACK GAS PRESSURE, "HG ABSOLUTE (MMHG)	25.52	648.21	25.52	648.21			25.52	648.21
% CO_2 - VOLUME % DRY	-	-	-	-			-	-
% O_2 - VOLUME % DRY	20.	20.	20.	20.			20.	20.
SO_2 - VOLUME % DRY	.03	.03	.05	.05			.04	.04
% N_2 - VOLUME % DRY	79.97	79.97	79.95	79.95			79.96	79.96
TS - AVERAGE STACK TEMPERATURE °F (°C)	100.3	37.9	106.4	41.3			103.4	39.6
% H_2O - % MOISTURE IN STACK GAS, BY VOLUME	1.0	1.0	1.0	1.0			1.0	1.0
AS - STACK AREA, FT^2 (M^2)	22.17	2.06	22.17	2.06			22.17	2.06
MD - MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	28.81	28.81	28.82	28.82			28.82	28.82
MS - MOLECULAR WEIGHT OF STACK GAS, WET BASIS	28.70	28.70	28.71	28.71			28.71	28.71
VS - STACK GAS VELOCITY, FT/SEC, (M/SEC)	78.70	23.99	78.10	23.80			78.40	75.93
QA - STACK GAS VOLUMETRIC FLOW AT STACK CONDITIONS, ACFM (NM^3/MIN)	104686.7	2965.6	103888.6	2943.0			104287.7	2954.3
QS - STACK GAS VOLUMETRIC FLOW AT STANDARD CONDITIONS, DSCFM (NM^3/MIN)	83302.7	2359.9	81777.3	2316.6			82540.0	2338.3
% EA - PERCENT EXCESS AIR	4.7	4.7	4.7	4.7			4.7	4.7
III TEST CONDITIONS								
PB - BAROMETRIC PRESSURE, "HG (MMHG)	25.89	657.61	25.89	657.61			25.89	657.61
DN - SAMPLING NOZZLE DIAMETER, IN. (MM)	.187	4.75	.187	4.75			.187	4.75
T - SAMPLING TIME, MIN	88.	88.	65.	65.			76.5	76.5
VM - SAMPLE VOLUME, ACF (M^3)	74.75	2.12	56.04	1.59			65.40	1.86
NP - NET SAMPLING POINTS	42.	42.	50.	50.			46.	46.
CP - PITOT TUBE COEFFICIENT	.84	.84	.84	.84			.84	.84
TM - AVERAGE METER TEMPERATURE °F (°C)	69.9	21.1	73.6	23.1			71.8	22.1
PM - AVERAGE ORIFICE PRESSURE DROP, "H_2O (MMH_2O)	2.13	54.1	2.10	53.3			2.12	53.7
VLC - CONDENSATE COLLECTED (IMPINGERS AND GEL), MLS	20.1	20.1	7.3	7.3			13.7	13.7
ΔP - STACK VELOCITY HEAD "H_2O (MMH_2O)	1.57	39.88	1.53	38.9			1.55	39.39
IV TEST CALCULATIONS								
VW - CONDENSED WATER VAPOR, SDCF (NM^3)	.95	.03	.34	.01			.65	.02
VM - VOLUME OF GAS SAMPLED AT STANDARD CONDITIONS, DSCF (NM^3)	64.81	1.84	45.45	1.30			55.13	1.57
% H_2O - PERCENT MOISTURE, BY VOLUME	1.0	1.0	1.0	1.0			1.0	1.0
MS - MOLECULAR WEIGHT OF STACK GAS, WET BASIS	28.70	28.70	28.71	28.71			28.71	28.71
VS - STACK VELOCITY, FT/SEC (M/SEC)	78.70	23.99	78.10	23.80			78.40	15.93
% I - PERCENT ISOKINETIC	103.2	103.2	99.8	99.8			101.5	101.5
V ANALYTICAL DATA								
A) ARSENIC FRONT HALF								
PROBE (MG)		.460		1.250				.8550
CYCLONE (MG)								
FILTER (MG)		.330		.340				.3350
ARSENIC FRONT HALF TOTAL (MG)		.790		1.590				1.1900
PPM, (MG/M^3)	.1380	.4303	.3960	1.2349			.2670	.8326
#/HR, (KG/HR)	.1342	.0609	.3781	.1716			.2561	.1163
B) ARSENIC - IMPINGER COLLECTION								
IMPINGER #1, 2 (MG)		.020		.080				.050
PPM, (MG/M^3)	.0035	.0109	.0109	.0621			.0117	.0365
#/HR, (KG/HR)	.0034	.0015	.0190	.0086			.0112	.0051
IMPINGER #3,4,5 (MG)								
PPM, MG/M^3)								
#/HR, (KG/HR)								
C) ARSENIC - IMPINGER TOTAL (MG)								
PPM, (MG/M^3)								
#/HR, (KG/HR)								
D) TOTAL ARSENIC (MG)		.8100		1.6700				1.2400
PPM, (MG/M^3)	.1415	.4412	.4159	1.2971			.2787	.8691
#/HR, (KG/HR)	.1376	.0625	.3971	.1803			.2674	.1214
E) TOTAL SO_2 (MG)		1637.67		1676.45				1657.06
PPM		334.8114		488.7340				411.7727
(MG/M^3)		891.9881		1302.0613				1097.0247
#/HR, (KG/HR)	278.1916	126.2785	398.6437	180.9549			338.4177	153.6167

TABLE 5 Full Cycle Converter Fugitive Arsenic/SO_2 Results

RUN NUMBER	1		2		3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS
I DATE	11/6/78	11/6/78	11/8/78	11/8/78	11/9/78	11/9/78		
II STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	- .38	-9.65	- .38	-9.65	- .38	-9.65	- .38	-9.65
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	25.51	647.95	25.60	650.24	25.61	650.49	25.57	649.56
% CO_2 - Volume % Dry	0	0	0	0	0	0	0	0
% O_2 - Volume % Dry	20	20	20	20	20	20	20	20
% CO - Volume % Dry	.09	.09	.14	.14	.33	.33	.19	.19
% N_2 - Volume % Dry	79.91	79.91	79.86	79.86	79.67	79.67	79.81	79.81
Ts - Average Stack Temperature °F (°C)	104.9	40.5	103.1	39.5	61.3	16.3	89.8	32.1
% H_2O - % Moisture in Stack Gas, By Volume	0	0	.8	.8	1.0	1.0	.6	.6
As - Stack Area, ft^2 (m^2)	22.17	2.06	22.17	2.06	22.17	2.06	22.17	2.06
Md - Molecular Weight of Stack Gas, Dry Basis	28.83	28.83	28.85	28.85	28.92	28.92	28.87	28.87
Ms - Molecular Weight of Stack Gas, Wet Basis	28.83	28.83	28.76	28.76	28.81	28.81	28.80	28.80
Vs - Stack Gas Velocity, ft/sec, (m/sec)	89.32	27.22	85.19	25.97	81.43	24.82	85.31	26.00
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFM (Nm^3/min)	118813.5	3365.8	113319.7	3210.2	108318.2	3068.5	113483.8	3214.8
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFM (Nm^3/min)	94684.1	2682.3	90187.0	2554.9	92967.4	2633.6	92612.8	2623.6
% EA - Percent Excess Air	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
III TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	25.89	657.61	25.98	659.89	25.98	659.89	25.95	659.13
Dn - Sampling Nozzle Diameter, in. (mm)	.187	4.75	.187	4.75	.187	4.75	.187	4.75
T - Sampling Time, min	188.5	188.5	181	181	182.5	182.5	184	184
Vm - Sample Volume, ACF (m^3)	179.91	5.10	168.20	4.76	152.45	4.32	166.85	4.73
Np - Net Sampling Points	72	72	72	72	72	72	72	72
Cp - Pitot Tube Coefficient	.84	.84	.84	.84	.84	.84	.84	.84
Tm - Average Meter Temperature °F (°C)	77.7	25.4	77.4	25.2	56.5	13.6	70.5	21.4
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	2.86	72.60	2.45	62.23	2.60	66.04	2.64	66.96
Vlc - Condensate Collected (Impingers and Gel), mls	0	0	24.6	24.6	30.4	30.4	18.3	18.3
ΔP - Stack Velocity Head "H_2O (mmH_2O)	2.01	51.05	1.84	46.74	1.82	46.23	1.89	48.01
IV TEST CALCULATIONS								
Vw - Condensed Water Vapor, SDCF (Nm^3)	0	0	1.16	.03	1.43	.04	.86	.02
Vm - Volume of Gas Sampled at Standard Conditions, DSCF (Nm^3)	154.05	4.36	144.44	4.09	136.26	3.86	144.92	4.10
% H_2O - Percent Moisture, By Volume	0	0	.8	.8	1.0	1.0	.6	.6
Ms - Molecular Weight of Stack Gas, Wet Basis	28.83	28.83	28.76	28.76	28.81	28.81	28.80	28.80
Vs - Stack Velocity, ft/sec (m/sec)	89.32	27.22	85.19	25.97	81.43	24.82	85.31	26.00
% I - Percent Isokinetic	100.8	100.8	103.3	103.3	93.8	93.8	99.3	99.3
V ANALYTICAL DATA								
A) Arsenic Front Half								
Probe (mg)		2.655		1.100		2.600		2.1183
Cyclone (mg)								
Filter (mg)		.130		.125		1.300		.5183
Arsenic Front Half Total (mg)		2.785		1.225		3.900		2.6367
ppm, (mg/m^3)	.2046	.6382	.0960	.2994	.3240	1.0103	.2082	.6493
#/hr, (kg/hr)	.2262	.1027	.1011	.0459	.3517	.1596	.2263	.1027
B) Arsenic - Impinger Collection								
Impinger #1, 2 (mg)		.615		1.640		1.056		1.1037
ppm, (mg/m^3)	.0452	.1409	.1285	.4008	.0877	.2736	.0871	.2718
#/hr, (kg/hr)	.0500	.0227	.1353	.0614	.0952	.0432	.0935	.0424
Impinger #3,4,5 (mg)								
ppm, mg/m^3)								
#/hr, (kg/hr)								
C) Arsenic - Impinger Total (mg)								
ppm, (mg/m^3)								
#/hr, (kg/hr)								
D) Total Arsenic (mg)		3.4000		2.8650		4.9560		3.7403
ppm, (mg/m^3)	.2498	.7791	.2245	.7002	.4117	1.2839	.2953	.9211
#/hr, (kg/hr)	.2762	.1254	.2364	.1073	.4469	.2028	.3198	.1452
E) Total SO_2 (mg)		10763.42		15803.44		33686.3		20084.4
ppm		925.7729		1449.7063		3275.6750		1883.7181
(mg/m^3)		2466.3987		3862.2364		8726.8926		5018.5093
#/hr, (kg/hr)	874.3011	396.8684	1304.0778	591.9554	3037.4631	1378.7849	1738.6140	789.2029

TABLE 6 Concentrate Dryer Arsenic/SO_2 Results

RUN NUMBER	1		2		3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS
I DATE	11/14/78	11/14/78	11/14/78	11/14/78	11/14/78	11/14/78	11/14/78	11/14/78
II STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	-	-	-	-	-	-	-	-
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	25.98	659.89	25.98	659.89	25.98	659.89	25.98	659.89
% CO_2 - Volume % Dry	-	-	-	-	-	-	-	-
% O_2 - Volume % Dry	20.	20.	20.	20.	20.	20.	20.	20.
SO_2 - Volume % Dry	.06	.06	.07	.07	.07	.07	.07	.07
% N_2 - Volume % Dry	79.94	79.94	79.93	79.93	79.93	79.93	79.93	79.93
Ts - Average Stack Temperature °F (°C)	166.1	74.5	129.3	54.1	118.3	47.9	137.9	58.8
% H_2O - % Moisture in Stack Gas, By Volume	18.1	18.1	18.2	18.2	15.6	15.6	17.3	17.3
As - Stack Area, ft^2 (m^2)	40.34	3.75	40.34	3.75	40.34	3.75	40.34	3.75
Md - Molecular Weight of Stack Gas, Dry Basis	28.82	28.82	28.82	28.82	28.82	28.82	28.82	28.82
Ms - Molecular Weight of Stack Gas, Wet Basis	26.86	26.86	26.85	26.85	27.13	27.13	26.95	26.95
Vs - Stack Gas Velocity, ft/sec, (m/sec)	29.96	9.13	29.37	8.95	29.16	8.89	29.50	8.99
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFM (Nm^3/min)	72515.2	2054.3	71087.2	2013.8	70578.9	1999.4	71393.8	2022.5
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFM (Nm^3/min)	43489.1	1232.0	38676.6	1095.7	47225.4	1337.8	43130.4	1221.8
% EA - Percent Excess Air	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
III TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	25.98	659.89	25.98	659.89	25.98	659.89	25.98	659.89
Dn - Sampling Nozzle Diameter, in. (mm)	.360	9.23	.360	9.23	.360	9.23	.360	9.23
T - Sampling Time, min	90.	90.	90.	90.	90.	90.	90.	90.
Vm - Sample Volume, ACF (m^3)	80.52	2.28	80.55	2.28	80.52	2.28	80.53	2.28
Np - Net Sampling Points	12.	12.	12.	12.	12.	12.	12.	12.
Cp - Pitot Tube Coefficient	.84	.84	.84	.84	.84	.84	.84	.84
Tm - Average Meter Temperature °F (°C)	57.6	14.2	59.9	15.5	47.5	8.61	55.0	12.8
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	2.29	58.17	2.26	57.4	2.31	58.7	2.29	58.09
Vlc - Condensate Collected (Impingers and Gel), mls	337.5	337.5	337.6	337.6	288.0	288.0	321.0	321.0
ΔP - Stack Velocity Head "H_2O (mmH_2O)	.194	4.93	.198	5.03	.201	5.11	.198	5.02
IV TEST CALCULATIONS								
Vw - Condensed Water Vapor, SDCF (Nm^3)	15.89	.45	15.89	.45	13.56	.38	15.11	.43
Vm - Volume of Gas Sampled at Standard Conditions, DSCF (Nm^3)	71.75	2.03	71.46	2.02	73.19	2.07	71.80	2.04
% H_2O - Percent Moisture, By Volume	18.1	18.1	18.2	18.2	15.6	15.6	17.3	17.3
Ms - Molecular Weight of Stack Gas, Wet Basis	26.86	26.86	26.85	26.85	27.13	27.13	26.95	26.95
Vs - Stack Velocity, ft/sec (m/sec)	29.96	9.13	29.37	8.95	29.16	8.89	29.50	8.99
% I - Percent Isokinetic	102.8	102.8	98.4	98.4	96.5	96.5	99.2	99.2
V ANALYTICAL DATA								
A) Arsenic Front Half								
Probe (mg)		.146		2.098		3.915		2.0530
Cyclone (mg)								
Filter (mg)		.004		.042		.470		.1720
Arsenic Front Half Total (mg)		.150		2.140		4.385		2.2250
ppm, (mg/m^3)	.0237	.0738	.3330	1.0571	.6781	2.1149	.3469	1.0819
#/hr, (kg/hr)	.0120	.0055	.1531	.0695	.3739	.1697	.1797	.0816
B) Arsenic - Impinger Collection								
Impinger #1, 2 (mg)		.028		.028		.340		.1320
ppm, (mg/m^3)	.0044	.0138	.0044	.0138	.0526	.1640	.0205	.0639
#/hr, (kg/hr)	.0022	.0010	.0020	.0009	.0290	.0132	.0111	.0050
Impinger #3,4,5 (mg)								
ppm, mg/m^3)								
#/hr, (kg/hr)								
C) Arsenic - Impinger Total (mg)								
ppm, (mg/m^3)								
#/hr, (kg/hr)								
D) Total Arsenic (mg)		.1780		2.1680		4.7250		2.3570
ppm, (mg/m^3)	.0281	.0876	.3434	1.0710	.7307	2.2789	.367[illegible]	1.1458
#/hr, (kg/hr)	.0143	.0065	.1551	.0704	.4029	.1829	.190[illegible]	.0866
E) Total SO_2 (mg)		3216.05		3715.94		4074.50		3668.83
ppm		593.9047		689.0037		737.6298		673.5127
(mg/m^3)		1582.2518		1835.6099		1965.1571		1794.3396
#/hr, (kg/hr)	257.6183	116.9398	265.7966	120.6521	346.4510	157.7172	290.288[illegible]	131.7697

TABLE 7 PROCESS SAMPLE ANALYSIS

SAMPLE	DATE SAMPLED	AS %
Converter 1	11/ 6/78	.009
Converter 2	11/ 6/78	.025
Converter 1	11/ 7/78	.180
Converter 2	11/ 7/78	.082
Converter 1	11/ 8/78	.0463
Converter 2	11/ 8/78	.0436
Furnace Matte	11/ 1/78	.174
Furnace Slag	11/ 1/78	.200
Furnace Matte	11/ 2/78	.0348
Furnace Slag	11/ 2/78	.0292
Furnace Matte	11/ 3/78	.085
Furnace Slag	11/ 3/78	.033
Furnace Concentrate Feed	11/ 2/78	.148
Furnace Concentrate Feed	11/ 3/78	.028
Finished Cu Anode	11/ 7/78	.049
Finished Cu Anode	11/ 8/78	.077
Concentrate before dryer	11/ 9/78	.043
Concentrate after dryer	11/ 9/78	.047
Concentrate before dryer	11/14/78 am	.017
Concentrate after dryer	11/14/78 am	.014
Concentrate before dryer	11/14/78 pm	.014
Concentrate after dryer	11/14/78 pm	.017
Dryer Cyclone Scrubber Water	11/ 9/78	18. ppm
Dryer Cyclone Scrubber Water	11/14/78 am	5.9ppm
Dryer Cyclone Scrubber Water	11/14/78 pm	2.5ppm

SECTION 4

LOCATION OF SAMPLING POINTS

Matte Tapping Fugitive Emission Ducts

Matte tapping fugitive emissions were collected through two ducts at the smelter. One duct evacuated fumes from the ladle area which was below the floor where tapping personnel worked, while the other duct carried fumes away from the tap hole area located above the floor. The two ducts ran parallel in a vertical direction to the roof which was approximately 120 feet above the ground. A crossover duct running diagonally connected the vertical ducts on the lower part of the vertical run. This crossover duct contained a damper that allowed all of the emissions to flow through only one of the two vertical ducts and although ports were installed on both vertical ducts above the roof, the damper in the crossover pipe routed all the emissions through a single vertical duct during the test. Drawings related to this site show dual ductwork, however, only one duct had flow during testing, and the matte tapping summary sheets show data for this duct only.

Samples from the single vertical matte tapping fugitive emission duct were taken above the roof approximately 120 feet above the ground. Sampling ports were located at a 90^{o} angle to each other to allow for horizontal traverses during sampling. The nearest upstream flow disturbance was located greater than 8 diameters away from the sampling location. Twenty four traverse points were selected with twelve points on each traverse. Figure 1 is a schematic of the sampling location.

Slag Tapping Fugitive Emission Duct

Slag tapping fugitive emission samples were taken through a 60" vertical duct located approximately 120 feet above the ground. One sampling port was utilized for both horizontal traverses during sampling. The nearest upstream flow disturbance was located more than 8 duct diameters from the sampling position. The nearest downstream disturbance was a bend located 8' away from the sampling location. Twenty-four traverse points were selected with twelve points on each traverse. Figure 2 is a diagram of this sampling location.

Acid Plant Inlet

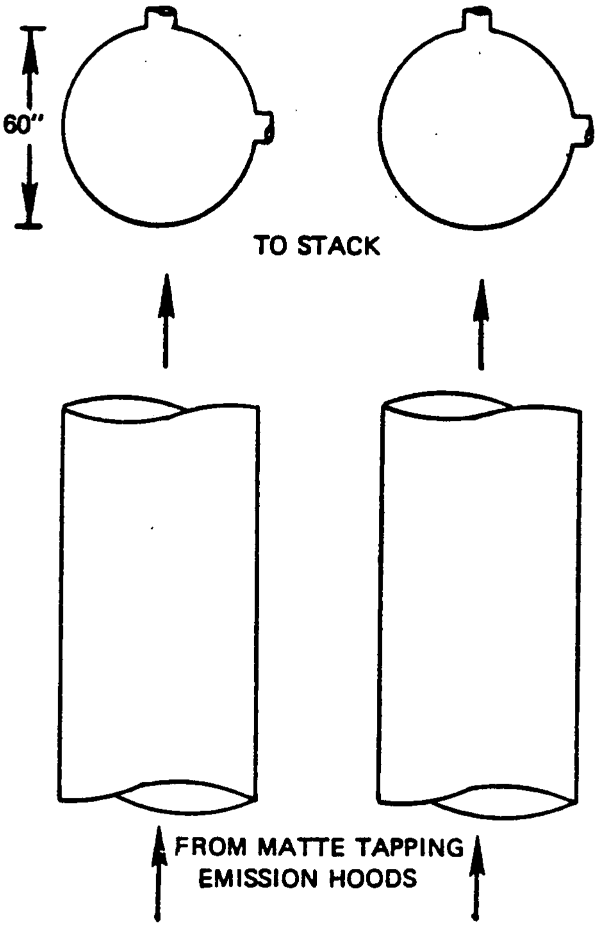
Acid plant inlet samples were taken through a 60" horizontal duct located approximately 8 feet above the ground. The sampling ports on the top and side of the duct allowed for vertical and horizontal traverses. The nearest upstream flow disturbance was greater than 8 diameters away from the sampling position. The nearest downstream disturbance was located 1½ duct diameters away from the sampling position. Twenty-four traverse points were selected with twelve points on each traverse. Figure 5 is a schematic of the sampling location.

Converter Fugitive Emission Duct

Converter fugitive emission samples were taken through a 38" X 84" rectangular vertical duct located approximately 60 feet from the ground. Six sampling ports were evenly spaced across the 84" face of the duct that allowed for horizontal sampling. The nearest downstream flow disturbance was located approximately 5 feet (1 duct diameter equivalent) away from the sampling position. The nearest upstream disturbance was a bend located approximately 20 feet (4.75 duct diameter equivalent) away from the sampling points. Figure 6 is a schematic of this sampling location

Concentrate Dryer Stack

Concentrate dryer Fugitive samples were taken through a 84" diameter vertical fiberglass duct located approximately 110 feet above the ground. Two sampling ports placed at right angles allowed for horizontal traverses during sampling. The nearest downstream disturbance was the stack exit which was 40 feet (6 duct diameters) from the sampling points. The nearest upstream disturbance was two ducts entering the stack 56 feet (8 duct diameters) away from the sampling position. Figure 8 is a schematic of the concentrate dryer fugitive emission duct.



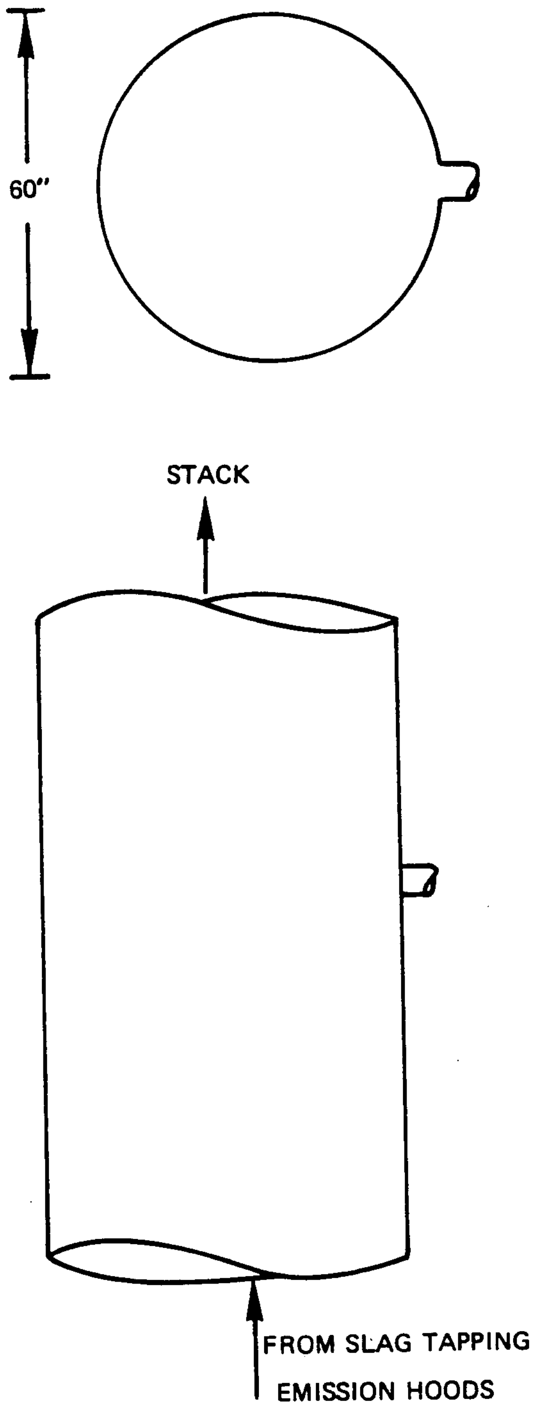
TRAVERSE POINT LOCATIONS

TRAVERSE POINT LOCATIONS	FRACTION OF STACK I.D.	DISTANCE FROM INSIDE WALL (IN)
1	.021	1.28
2	.067	4.02
3	.118	7.09
4	.177	10.64
5	.250	15.00
6	.356	21.34
7	.644	38.66
8	.750	45.00
9	.823	49.36
10	.882	52.91
11	.933	55.98
12	.979	58.72

Figure 1. Matte tapping.

TRAVERSE POINT LOCATIONS

TRAVERSE POINT LOCATIONS	FRACTION OF STACK I.D.	DISTANCE FROM INSIDE WALL (IN)
1	.021	1.28
2	.067	4.02
3	.118	7.09
4	.177	10.64
5	.250	15.00
6	.356	21.34
7	.644	38.66
8	.750	45.00
9	.823	49.36
10	.882	52.91
11	.933	55.98
12	.979	58.72

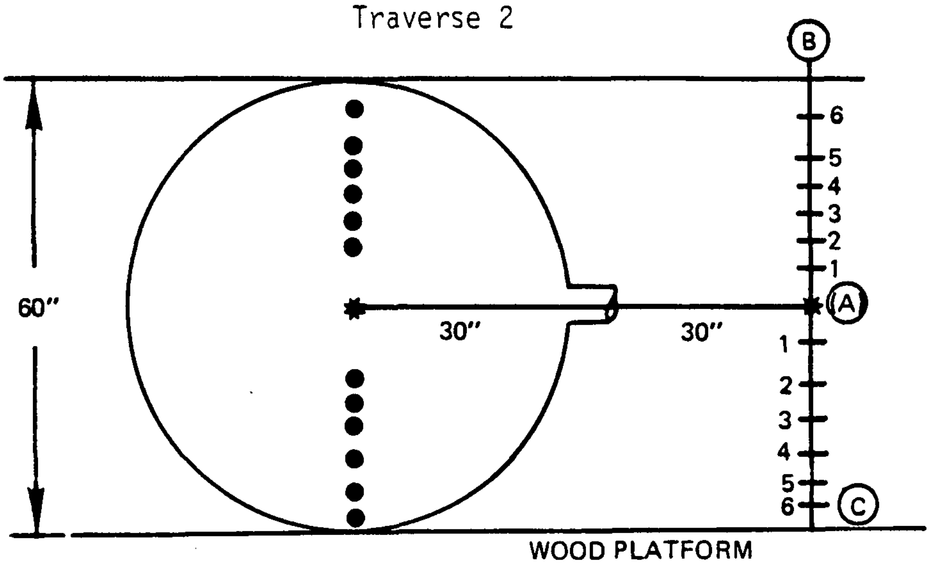


SLAG TAPPING

Figure 2. Slag tapping.

Figure 3. Slag tapping fugitive emission duct traverse point location procedure.

Traverse 2



1. Points are marked on the wood platform as illustrated above. Note that 30" distance from the line marked on the wood platform and sampling port is the same as the radius of the duct.

2. Points marked on each line (AC) and (AB) from the center point A.

Point	Distance "
(AB)1	8.66
(AB)2	15.00
(AB)3	19.36
(AB)4	22.92
(AB)5	25.98
(AB)6	28.74
AC 1	8.66
AC 2	15.00
AC 3	19.36
AC 4	22.92
AC 5	25.98
AC 6	28.94

3. During Sampling

Point	Probe distance In Stack	Probe must intersect the line at the following points
1	41.55	AC 6
2	36.69	AC 5
3	37.75	AC 4
4	35.72	AC 3
5	33.54	AC 2
6	31.22	AC 1
7	31.22	AB 1
8	33.54	AB 2
9	35.72	AB 3
10	37.75	AB 4
11	39.69	AB 5
12	41.55	AB 6

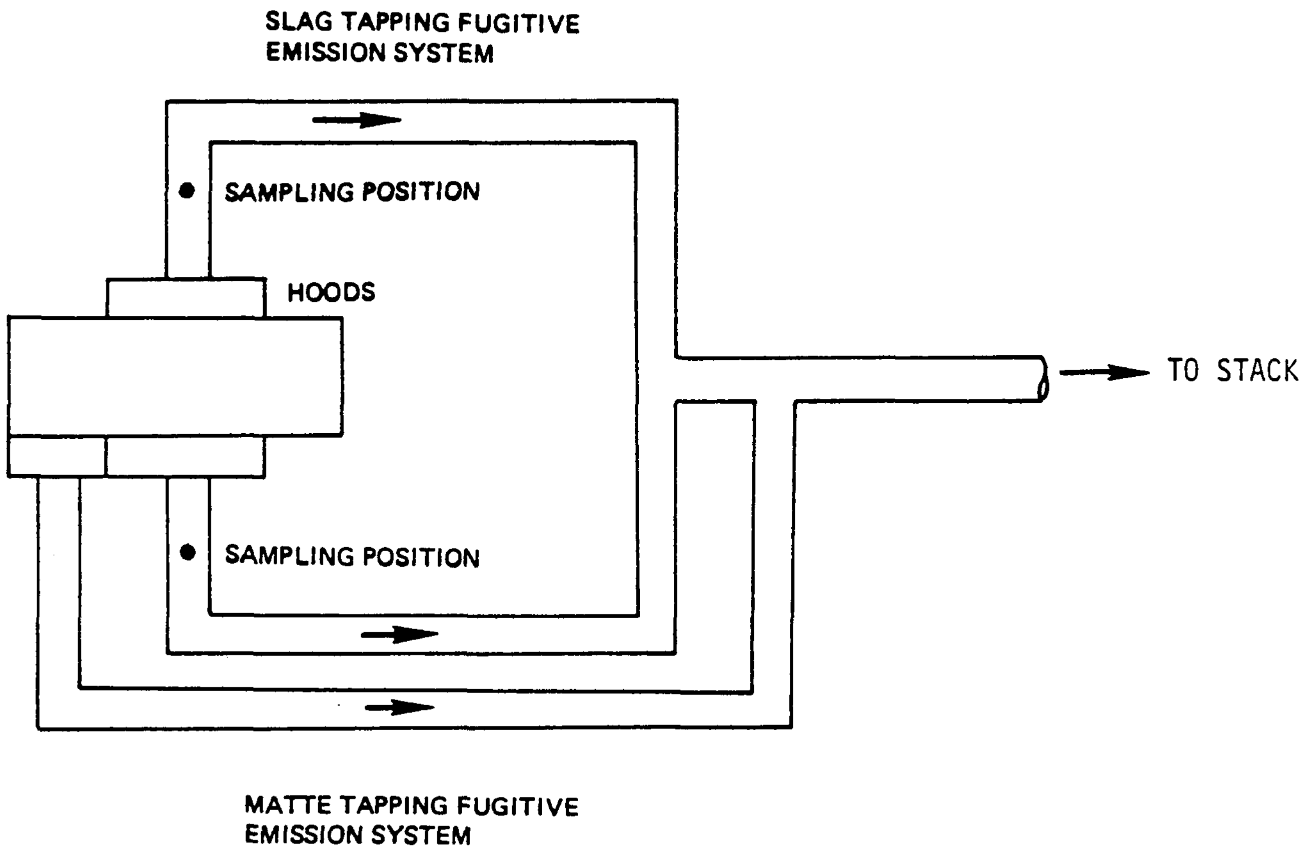
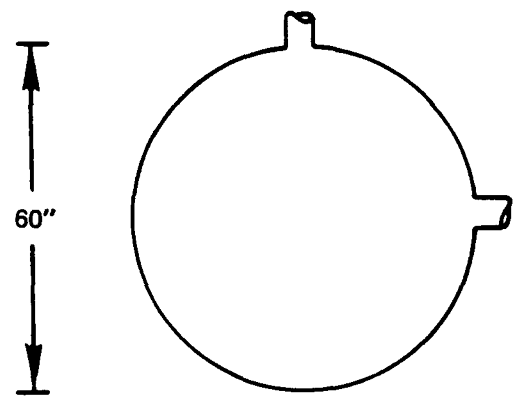


Figure 4. Plant schematic - The matte tapping and slag tapping fugitive emission systems.

TRAVERSE POINT LOCATIONS

TRAVERSE POINT LOCATIONS	FRACTION OF STACK I.D.	DISTANCE FROM INSIDE WALL (IN)
1	.021	1.28
2	.067	4.02
3	.118	7.09
4	.177	10.64
5	.250	15.00
6	.356	21.34
7	.644	38.66
8	.750	45.00
9	.823	49.36
10	.882	52.91
11	.933	55.98
12	.979	58.72



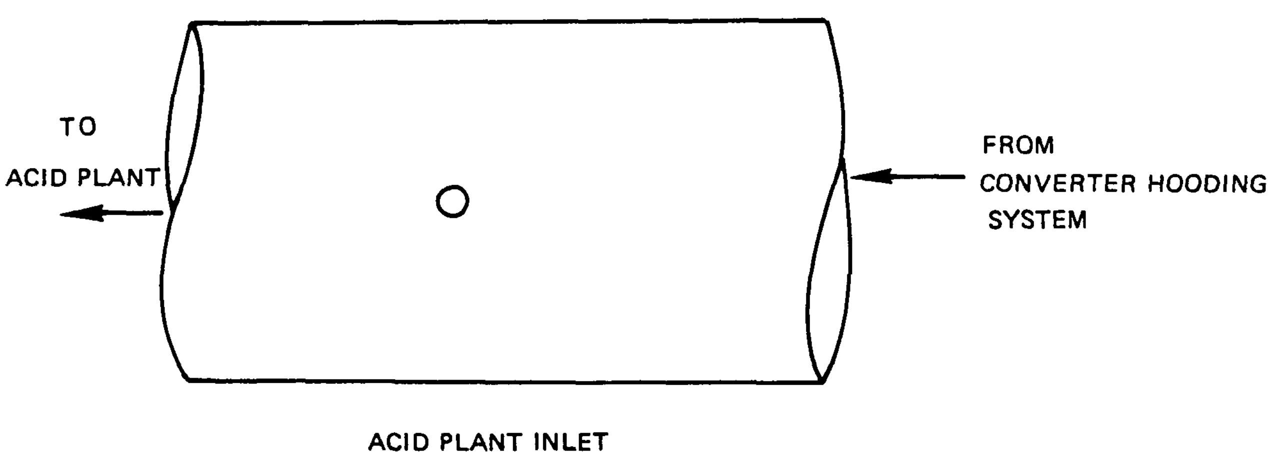


Figure 5. Acid plant inlet.

TRAVERSE POINT	FRACTION OF DUCT I.D.	DISTANCE FROM INSIDE WALL (IN)
1	.044	1.66
2	.146	5.56
3	.296	11.24
4	.704	26.76
5	.854	32.44
6	.956	36.34

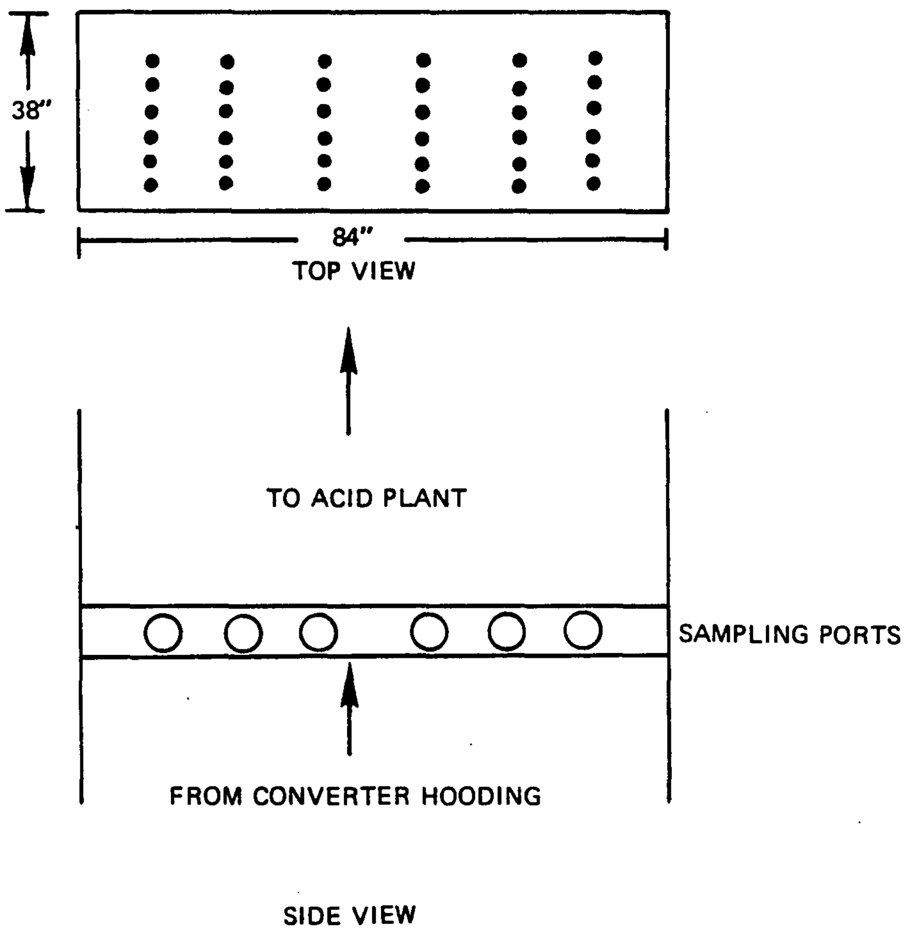


Figure 6. Converter fugitive emission system.

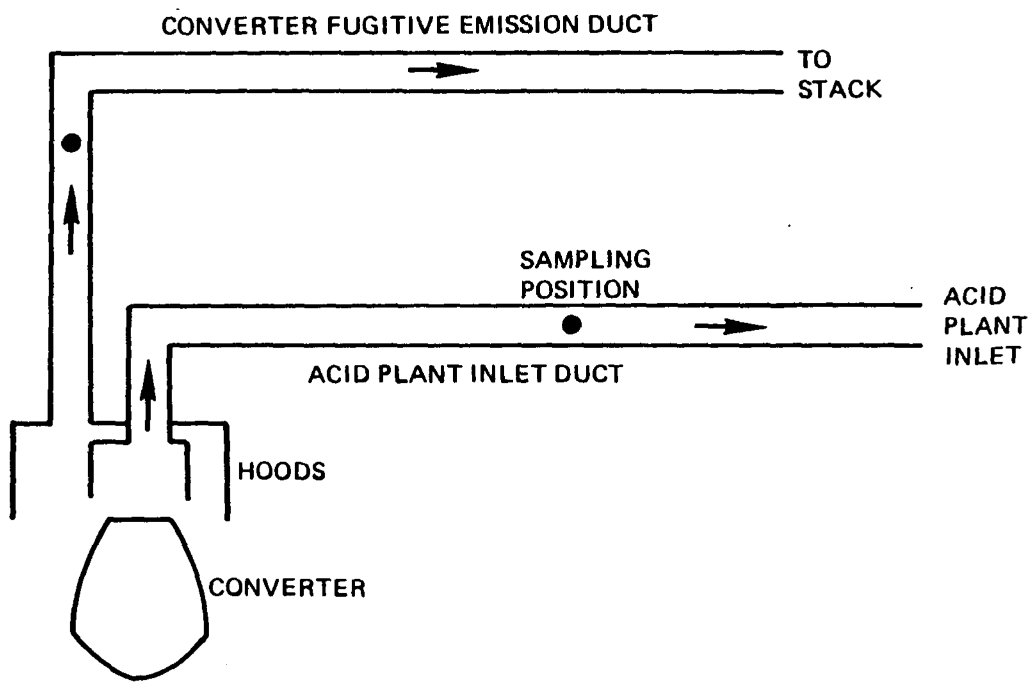
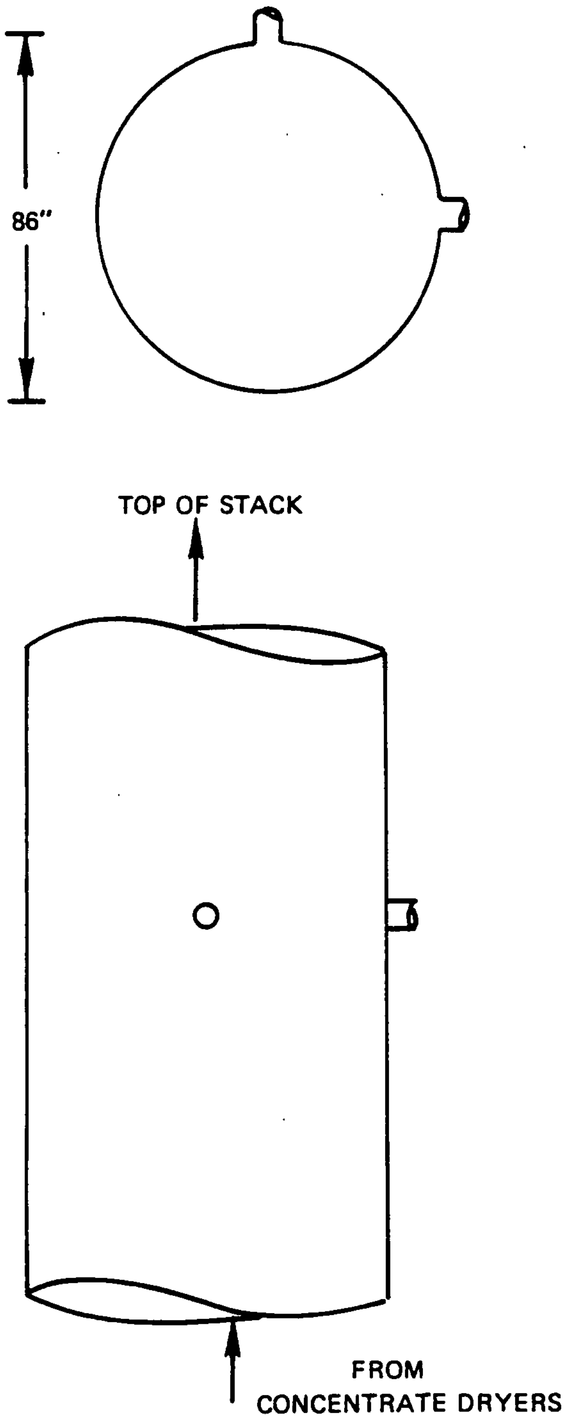


Figure 7. Plant schematic - converter fugitive emission system.



TRAVERSE POINT LOCATIONS

TRAVERSE POINT LOCATIONS	FRACTION OF STACK I.D.	DISTANCE FROM INSIDE WALL (IN)
1	.044	3.75
2	.146	12.59
3	.296	25.45
4	.704	60.55
5	.854	73.41
6	.956	82.25

CONCENTRATE DRYER STACK

Figure 8. Concentrate dryer stack.

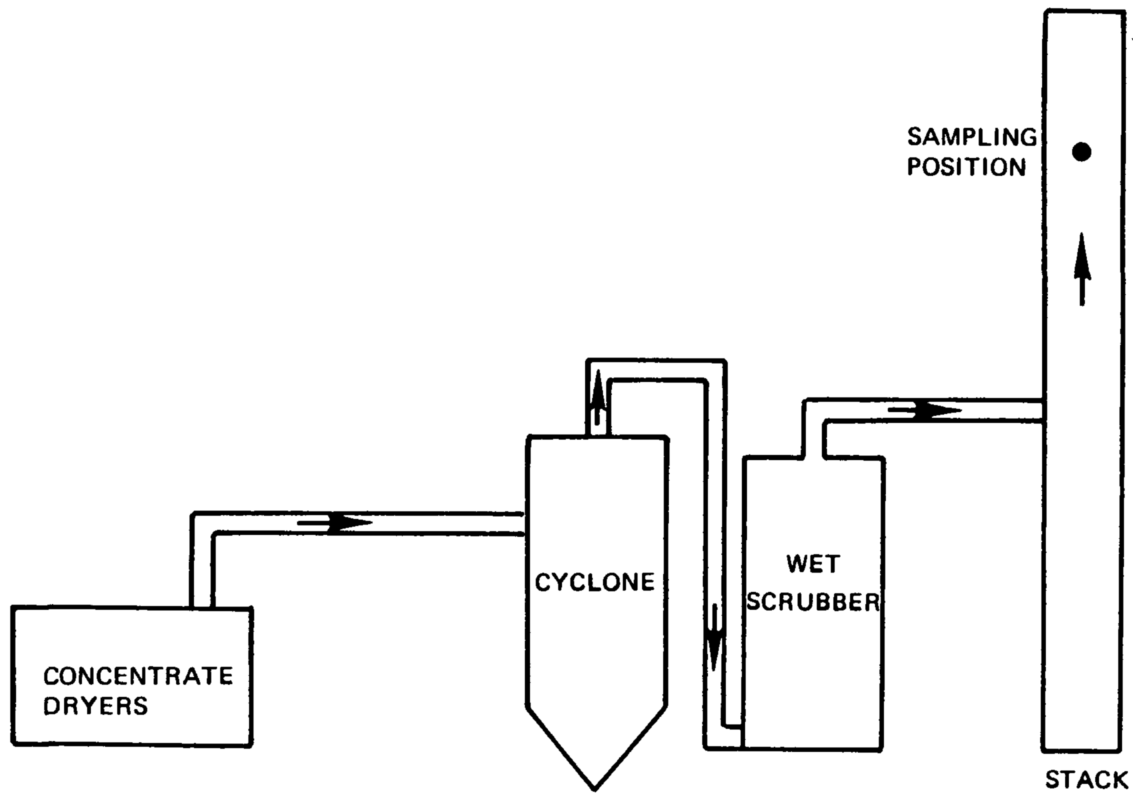


Figure 9. Plant schematic - concentrate dryer fugitive emission system

SECTION 5

SAMPLING AND ANALYTICAL PROCEDURE

A) Arsenic/Sulfur Dioxide Sampling

The sampling train used for arsenic/sulfur dioxide collection consists of an EPA Method 5 train modified by adding two additional impingers in series to the four used in the Method 5 train. The first two impingers contained 150 mls of distilled water each, third, fourth and fifth impingers contained 150 mls of 10% hydrogen peroxide each. The sixth impinger contained 250 grams of silica gel.The Arsenic/sulfur dioxide sampling train schematic is presented in Figure 10.

Before each test a velocity traverse of the stack was done to determine the average stack temperature and velocity pressure. The velocity traverse was done according to EPA Methods 1 and 2. A grab sample of the stack gas was taken and analyzed with a thermal conductivity detector gas chromatograph for CO_2, O_2, N_2, and CO. Before the first test at each location the moisture content of the gas stream was estimated by either condensation in impingers as in EPA Method 4, or by wet and dry bulb thermometer if the stack gas temperature was below 120°F.

The arsenic/sulfur dioxide samples were taken at traverse points at the center of equal areas within the stack. The number of traverse points was determined by the number of duct diameters upstream and downstream from the nearest flow disturbances. The sampling rate was adjusted to isokinetic conditions using a nomograph which had been set based on the preliminary velocity traverse data, and moisture estimate.

The sampling time per traverse point was 3-10 minutes depending upon the sampling location. Leak checks of the sampling train were done at the beginning of each test, just before the sampling port change, and at the end of the test. At the end of each test the sampling train was inspected for cracked or broken glassware, and to assure that the filter remained intact.

Sample Recovery

The sampling nozzle and probe liner were rinsed with 0.1N NaOH and brushed out with a nylon bristle brush with a teflon tubing handle. The remainder of the sampling train was removed to the mobile laboratory. The front half of the filter and connecting glassware were rinsed with 0.1N NaOH and this rinse was added to the nozzle and probe rinse. The filter was removed from the filter holder and placed in a Polyethylene container,

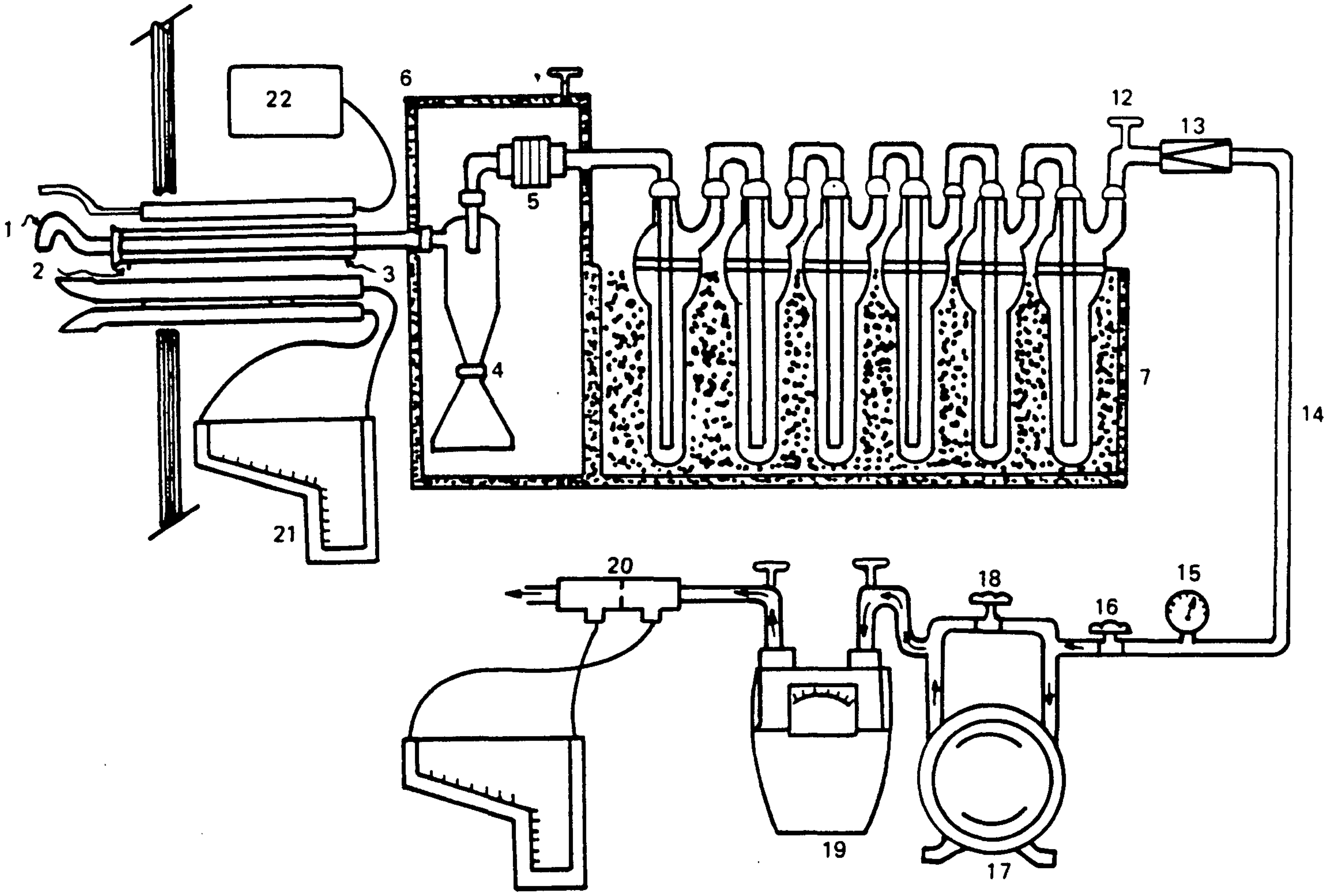


Figure 10. Arsenic sulfur dioxide sampling train.

KEY

1. Calibrated Nozzle
2. Heated Probe
3. Reverse Type Pitot
4. Cyclone Assembly
5. Filter Holder
6. Heated Box
7. Ice Bath with Impingers
12. Thermometer
13. Check Valve
14. Vacuum Line
15. Vacuum Gauge
16. Main Valve
17. Air Tight Pump
18. By-Pass Valve
19. Dry Test Meter
20. Orifice
21. Pitot Manometer
22. Thermometer

Which was labeled and sealed. The first two impinger solutions were measured and placed in a glass sample container along with a 0.1N NaOH rinse of the impingers. The contents of the third, fourth and fifth impingers were measured and placed in a separate glass sample container along with a distilled water rinse of the impingers. The silica gel in the sixth impinger was weighed to the nearest 0.5 gram, and regenerated.

B) Analysis

Sulfur Dioxide Analysis

The samples were analyzed for sulfur dioxide by taking an aliquot of the hydrogen peroxide impinger solutions and titrating with barium perchlorate solution and thorin indicator as described in EPA Method 6 (Determination of Sulfur Dioxide Emissions from Stationary Sources).

Arsenic Analysis

1. Filter- Warm filter and loose particulate matter with 50ml 0.1N NaOH for about 15 minutes. Add 10ml concentrated HNO_3 and bring to boil for 15 minutes. Filter solution through No. 41 Whatman paper and wash with hot water. Evaporate filtrate, cool, redissolve in 5ml of 1:1 HNO_3, transfer to a 40ml volumetric flask and dilute.

2. Probe Wash and Impinger Solutions-These should be combined and a 100ml sample withdrawn. Add 10ml concentrated HNO_3 and evaporate to a few milliliters. Redissolve with 5ml 1:1 HNO_3 and dilute to 50mls. A reagent blank should be carried through the same procedure. The resulting blank solution should be used in the dilution of standards to matrix match samples and standards.

3. All the samples prepared above should be screened by air/acetylene flame. The filter samples may require dilution with 0.8N HNO_3. Impinger solutions containing more than 26 mg/l of arsenic should be diluted since linearity decreases dramatically above that level.

Since an entrained hydrogen flame provides about five times as much sensitivity as the air/acetylene flame, a matrix check of a sample in a hydrogen flame should be carried out by the method of standard additions, and compared with a value obtained from matrix matched standards in a hydrogen flame. If values are comparable ($\pm5\%$) the air entrained hydrogen flame may be used.

Due to high concentrations of copper on the filter an air/acetylene flame should always be used to dissociate any AsCu compounds stable in the cooler hydrogen flame.

4. For samples below the 1 mg/l level, hydride generation is necessary. An appropriate aliquot of digested sample in 0.8N HNO_3 containing less than about 10 μg of arsenic is chosen (some screening may be necessary). Five

mls of concentrated $H_2 SO_4$ is added to the sample which is then placed on a hot plate until SO_3 fumes fill the flask. A reduction in volume to about 5ml or less may be necessary. This step removes HNO_3 which causes a violent reaction when the reducing agent is added resulting in poor reproducibility and lowered sensitivity by producing I_2, NO_2 and possible other species.

One ml of 30% KI and 1ml of 30% $SnCl_2$ are added to the sample, the former to act as a catalyst in hydride formation and the latter to reduce all the arsenic to As^{+3}. The sample is then diluted to about 15ml and 15ml of concentrated HCL is added. Powdered Zn (or $NaBH_4$) is then added, the reaction vessel is immediately closed and the nitrogen or argon carrier flow initiated. A peak should be produced within a few seconds.