

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY CONTROL

STAPPA/ALAPCO

2.5

#122

11/04/86

60

BR 2.2
#60
4.0

SOURCE TEST REPORT

NAME : Erie Sewer Authority, Erie, Pennsylvania

PROCESS/SOURCE TESTED : Sludge Incinerator No. 1

TEST NO. : 1881A 1881B

TEST DATE : 7/14/81 7/14/81

POLLUTANT SAMPLED : Particulate Heavy Metals

ACTUAL EMISSIONS : 0.009 gr/dscf (corrected to 12% CO₂) See Page 11

ALLOWABLE EMISSIONS : 0.10 gr/dscf (corrected to 12% CO₂) N.A.



TEST CONDUCTED BY : Richard D. Roller

REPORT PREPARED BY : Richard D. Roller

REPORT APPROVED BY : L. Blaine DeHaven

L. Blaine DeHaven 9/23/81

**ERIE SEWER AUTHORITY
ERIE, PENNSYLVANIA**

PROCESS DESCRIPTION

The Erie Sewer Authority operates two identical Eimco BSP multiple hearth sludge incinerators at their Erie facility. These incinerators are used to incinerate both human and industrial waste. Each furnace has a design feed rate of 22,500 lbs./hr. of wet filter cake. The normal feed rate is approximately 15,000 lbs./hr. per incinerator. Each incinerator was designed with 11 hearths. Hearths 3, 4, and 5 are each equipped with four natural gas-fired burners while hearths 7 and 9 are equipped with two burners. Test Nos. 1881A and B were conducted in the scrubber exhaust stack of Incinerator Unit No. 1.

Through a series of preliminary and secondary treatments consisting of settling tanks, aeration tanks, flotation thickeners, and chemical additives, the solids content of the sludge has been increased from 1% upon arrival at the plant to approximately 6% prior to being introduced to the three vacuum filters. These vacuum filters remove excess moisture and the resultant filter cake has now been increased to a solids content of approximately 16%. The concentrated sludge is pumped to an opening located at the top of the incinerator and is distributed onto the first hearth through a flap gate feeder. The sludge is moved by a rotating system of rakes towards an opening along the outside wall of the incinerator where it falls to the second hearth. These rakes are equipped with a cooling airchannel to prevent melting at high temperatures. The cooling air is provided by a Clarage Model 40 NH forced draft fan. Approximately 30% of the air in this totally enclosed system is recirculated onto the eighth and tenth hearths of the incinerator where it is reutilized as drying air. The remainder of the cooling air is exhausted through the warm air exhaust stack. The sludge is then raked towards an opening at the center of the second hearth. This reversal process continues with each hearth until the resultant ash reaches the eleventh hearth. The ash is screw conveyed to a hopper from which it is vacuum pumped to the ash silo. The ash is then trucked to off plant sites where it is used for such purposes as soil conditioning and in landfills.

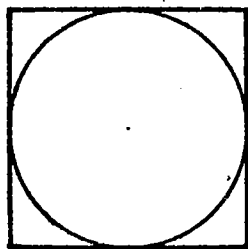
Combustion air for the burners is provided by a North American forced draft fan rated at 7,500 cfm. Additional combustion air may be provided by a Clarage Model 66 NH forced draft fan. The hot flue gases travel countercurrent to the sludge flow and pass through 6 afterburners having a total heat input of 55,000 BTU/hr. These afterburners are rarely used. After the afterburners, the gases split with a portion being ducted through a waste heat recovery boiler and the remainder being bypassed. The percentage of the flow being bypassed is dependent upon the facility's steam need. The separate flue gas streams are then rejoined prior to being drawn through a precooler, an ARCO venturi scrubber, and an ARCO two stage impingement tray by a Clarage XL 229 induced draft fan rated at 22,000 cfm at 30 in. Hg. The total water usage is approximately 1,300 gpm and the pressure drop across the system is approximately 20 in. H₂O. From the fan the flue gases are ducted to the atmosphere through a 38 inch diameter stack having a discharge point approximately 75 feet above grade.

A process flow diagram is shown in Figure I.

TEST DATA SUMMARY

Test No.....	1881A	1881B
Test Date.....	7/14/81	7/14/81
No. of Traverse Points/Sampling Points.....	16/16	16/16
Stack or Duct Area at Sampling Plane (sq ft).....A	7.88	7.88
Barometric Pressure (preliminary traverse) (in. Hg).....Pbp	29.35	29.35
(sample traverse) (in. Hg).....Pbs	29.35	29.35
Condensate Volume (ml).....Vlc	80.8	89.0
Avg. Pressure Drop at Orifice (in. WG).....DH	1.8	1.7
Avg. Meter Temperature (deg F).....Tm	105	103
Volume of Water Vapor Condensed (scf).....Vwc	3.8	4.2
Volume of Gas Sampled (dscf).....Vms	45.6	46.4
Total Sample Time (min).....e	80.0	80.0
Moisture in Gas Stream (%).....Bws	7.7	7.7
Dry Molecular Wt. (preliminary traverse) (lb/lb-mole)....Mdp	29.62	29.62
(sample traverse) (lb/lb-mole).....Mos	29.30	29.32
Molecular Wt. (preliminary traverse) (lb/lb-mole).....Msp	28.72	28.72
(sample traverse) (lb/lb-mole).....Mss	28.43	28.45
Pitot Tube Coefficient (preliminary traverse).....Cpp	0.860	0.860
(sample traverse).....Cps	0.860	0.833
Average Corrected Velocity (preliminary traverse) (fps)...Vsp	34.1	34.1
(sample traverse) (fps).....Vss	33.6	32.9
Stack Static Pressure (in. WG).....Pg	0.14	0.14
Average Stack Temperature (preliminary traverse) (deg F)..Tsp	122	122
(sample traverse) (deg F).....Tss	123	126
Volumetric Flow Rate (preliminary traverse) (dscfm).....Qsp	13,300	13,300
(sample traverse) (dscfm).....Qss	13,100	12,700
Sample Nozzle Diameter (in.).....Dn	0.254	0.254
Percent Isokinetic Sampling (%).....I	97.7	102.6
Weight Collected (gm).....Mn	0.0210	NA
Pollutant Concentration (gr/dscf) (Actual).....Cs	0.007	NA
Allowable Pollutant Concentration (gr/dscf) (Corrected to 12% CO2)	0.10	NA
Pollutant Mass Emission Rate (lb/hr) (Actual).....E	0.8	NA
Allowable Mass Emission Rate (lb/hr).....	NA	NA
Pollutant Concentration (ppm).....C	NA	NA
Allowable Pollutant Concentration (ppm).....	NA	NA
Heat Input To Combustion Unit (mm btu/hr).....HI	NA	NA
Pollutant Mass Emission Rate (lb/mm btu).....E'	NA	NA
Allowable Mass Emission Rate (lb/mm btu).....	NA	NA
Pollutant Concentration (gr/dscf) (Corrected to 12% CO2).....	0.009	NA

SAMPLING LOCATION INFORMATION



Distance from wall to point (in.):

1. 1 1/4	4. 12 5/16	7. 34	10.
2. 4	5. 25 11/16	8. 36 3/4	11.
3. 7 3/8	6. 30 5/8	9.	12.

Flue configuration: 38 INCH I.D. Area: 7.88 sq.ft.
Port location: APPROXIMATELY 5 FT. UPSTREAM OF THE SCRUBBER EXHAUST STACK EXIT
No. of ports: 2 PORTS @ 90 DEGREES

Test No. 1881A

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SAMPLING TRAIN

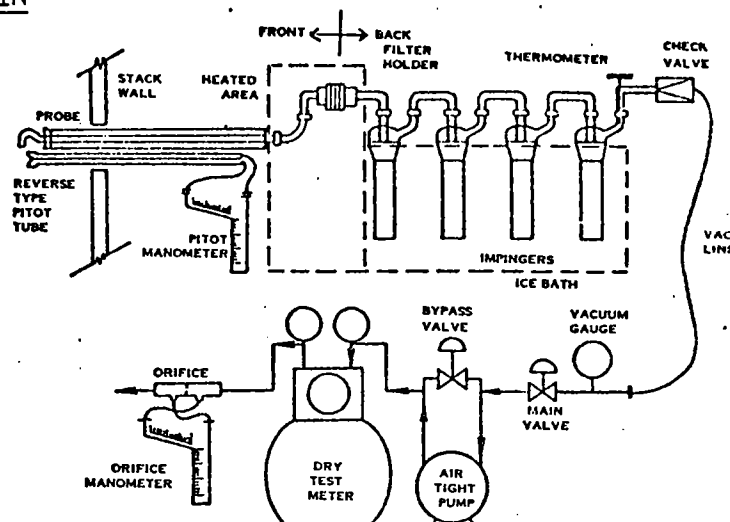
Nozzle No. B-4 (Dn = 0.254 in.)

Sample Box No. 528

Probe No. 472 (Cps = 0.860)

Module No. 503

Impinger Solution: DISTILLED WATER



LABORATORY RESULTS

SAMPLE WEIGHTS (PARTICULATE)

TRAIN COMPONENT	INSOLUBLE wt.(gm)	SOLUBLE wt.(gm)
Front Half	0.0006	0.0068
Filter #50806	0.0101	
Filter #		
Filter #		
Back Half	0.0035	0.0272*
Subtotals	0.0142	0.0340
Total Less *		0.0210 gm

CONDENSATE (ml)

IMPINGER NO.	FINAL	INITIAL
1(H2O)	209.0	150.0
2(H2O)	162.0	150.0
3(H2O)	152.0	150.0
4		
5		
Silica Gel	343.5	335.7
TOTAL (Vlc)		80.8 ml

GAS ANALYSIS

	PRELIM.	SAMPLING
%CO	0.0	0.0
%CO2	6.5	4.7
%O2	14.5	13.7
%N2	79.0	81.6

CONDENSATE VOLUME

$$V_{wc} = 0.0474 \times V_{lc}$$

$$V_{wc} = 0.0474 \times 80.8 = 3.8 \text{ SCF}$$

MOISTURE BY VOLUME

$$B_{ws} = \frac{V_{wc}}{V_{wc} + V_{ms}}$$

$$B_{ws} = \frac{3.8}{3.8 + 45.6} = 7.7\%$$

DRY MOLECULAR WEIGHT

$$M_d = (\%CO \times 0.28) + (\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 \times 0.28)$$

$$M_{dp} = (0.0 \times 0.28) + (6.5 \times 0.44) + (14.5 \times 0.32) + (79.0 \times 0.28) = 29.62$$

$$M_{ds} = (0.0 \times 0.28) + (4.7 \times 0.44) + (13.7 \times 0.32) + (81.6 \times 0.28) = 29.30$$

MOLECULAR WEIGHT

$$M_s = (B_{ws} \times 18.00) + (M_d \times (1 - B_{ws}))$$

$$M_{sp} = (0.077 \times 18.00) + (29.62 \times (1 - 0.077)) = 28.72$$

$$M_{ss} = (0.077 \times 18.00) + (29.30 \times (1 - 0.077)) = 28.43$$

Test No. 1881B

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SAMPLING TRAIN

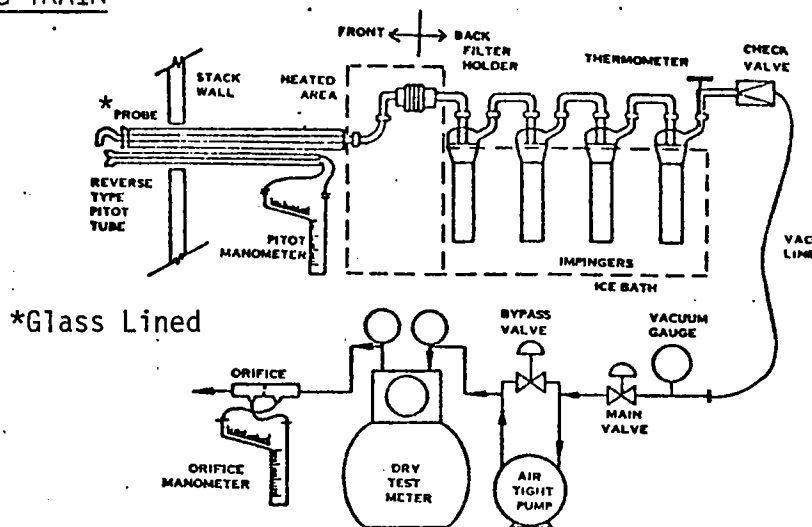
Nozzle No. B-2 (Dn = 0.254 in.)

Sample Box No. 526

Probe No. 475 (Cps = 0.833)

Module No. 503

Impinger Solution: 0.1 N Nitric Acid



LABORATORY RESULTS

SAMPLE WEIGHTS (HEAVY METALS)

TRAIN COMPONENT	INSOLUBLE wt.(gm)	SOLUBLE wt.(gm)
Front Half		
Filter #50803		
Filter #		
Filter #		
Filter #		
Back Half		
Subtotals		
Total		

See Page 11

CONDENSATE (ml)

IMPINGER NO.	FINAL	INITIAL
1	222.0	150.0
2	156.0	150.0
3	154.0	150.0
4		
5		
Silica Gel	383.3	376.3
TOTAL (Vlc)		89.0 ml

GAS ANALYSIS

	PRELIM.	SAMPLING
%CO	0.0	0.0
%CO2	6.5	4.8
%O2	14.5	13.8
%N2	79.0	81.4

CONDENSATE VOLUME

$$V_{wc} = 0.0474 \times V_{lc}$$

$$V_{wc} = 0.0474 \times 89.0 = 4.2 \text{ SCF}$$

MOISTURE BY VOLUME (from test number 1881A)

$$B_{ws} = \frac{V_{wc}}{V_{wc} + V_{ms}}$$

$$B_{ws} = 7.7\%$$

DRY MOLECULAR WEIGHT

$$M_d = (\%CO \times 0.28) + (\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 \times 0.28)$$

$$M_{dp} = (0.0 \times 0.28) + (6.5 \times 0.44) + (14.5 \times 0.32) + (79.0 \times 0.28) = 29.62$$

$$M_{ds} = (0.0 \times 0.28) + (4.8 \times 0.44) + (13.8 \times 0.32) + (81.4 \times 0.28) = 29.32$$

MOLECULAR WEIGHT

$$M_s = (B_{ws} \times 18.00) + (M_d \times (1 - B_{ws}))$$

$$M_{sp} = (0.077 \times 18.00) + (29.62 \times (1 - 0.077)) = 28.72$$

$$M_{ss} = (0.077 \times 18.00) + (29.32 \times (1 - 0.077)) = 28.45$$

Erie Sewer Authority
Erie, Pennsylvania

Incinerator Unit No. 1
Test No. 1881B 7/14/81

<u>Element</u>	<u>Total Weight Collected (10⁻⁶ gms.)</u>	<u>Emissions (gms./hr.)</u>
Cobalt	1.5	0.02
Manganese	25.5	0.44
Copper	118.0	2.03
Chromium	49.5	0.85
Nickel	73.5	1.26
Zinc	251.0	4.32
Lead	486.0	8.36
Cadmium	1324.5	22.78
Aluminum	0.0	0.0
Beryllium	0.0	0.0
Antimony	0.0	0.0
Tin	0.0	0.0
Asbestos	0.0	0.0

All metals were analyzed using flame atomic absorption.

Example Calculation:

$$E = (Mn/Vms)(Qsp)(60 \text{ min./hr.})$$

Where:

E = Emission, gms./hr.

Mn = Weight Collected, gms.

Vms = Volume of Gas Collected, dscf

Qsp = Volumetric Flow Rate (preliminary traverse), dscfm

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY AND NOISE CONTROL

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PROCESS DATA

DATE 7/14/81

TEST NUMBER 1881A and B

NAME OF FIRM

Erie Sewer Authority, Erie, Pennsylvania

DESCRIPTION OF EQUIPMENT TESTED AND OPERATION COVERED IN TEST

Eimco BSP Multiple Hearth Sludge Incinerator No. 1

SAMPLING STATION LOCATION

Approximately 5 feet upstream of the scrubber exhaust stack exit

LENGTH OF PROCESS CYCLE Continuous TIME CYCLE BEGINS _____ ENDS _____
1881A: 11:05 a.m. 12:29 p.m.
TIME OF TEST: BEGINS 1881B: 1:10 p.m. ENDS 2:32 p.m. CYCLE COVERAGE Complete

RAW MATERIAL CHARGED DURING THIS TIME:

MATERIAL Sludge

MATERIAL _____

MATERIAL _____

MATERIAL _____

MATERIAL _____

FUEL CHARGED Natural Gas

TOTAL POUNDS _____

Test No.	1881A	1881B
WT(LBS.)	20,160*	19,680*

WT(LBS.) _____

WT(LBS.) _____

WT(LBS.) _____

WT(LBS.) _____

ft.³ 16,600 17,940

WT(LBS.) _____

COLLECTION EQUIPMENT TYPE

Arco venturi scrubber
Arco two stage impingement tray

PLANT OFFICIAL AND TITLE

Mr. Alois Zasada, Chief, Bureau of Sewers

ADDITIONAL COMMENTS

*Approximate value based upon operator's data recorded between 9:00 a.m. and 2:00 p.m.

During Test Nos. 1881A and 1881B the solids content of the sludge leaving the vacuum
filters was approximately 15.0 and 16.0%, respectively.

Erle Sewer Authority
Erle, Pennsylvania

Process Data

Test Nos. 1881A and B 7/14/81
Incinerator Unit No. 1

TEMPERATURES, OF

Time	Hearth 1	Hearth 2	Hearth 3	Hearth 4	Hearth 5	Hearth 6	Hearth 7	Hearth 8	Hearth 9	Hearth 10	Hearth 11	Shaft Air Outlet	Afterburner Outlet	Venturi Outlet	Scrubber Outlet
11:00 AM	808	896	1056	1113	1483	1590	1391	1430	1330	839	154	369	386	147	102
11:10	807	893	1053	1094	1466	1560	1394	1418	1337	870	156	367	384	147	102
11:20	807	884	1058	1097	1457	1568	1397	1418	1340	862	154	365	386	148	102
11:30	799	878	1041	1082	1443	1589	1416	1440	1335	851	153	363	387	148	103
11:40	805	894	1074	1128	1555	1594	1423	1446	1338	775	157	362	386	147	102
11:50	817	904	1118	1178	1516	1507	1351	1383	1332	869	165	364	379	144	101
12:00 N	824	917	1132	1196	1532	1501	1338	1358	1329	879	149	366	385	146	101
12:10	838	929	1141	1204	1541	1509	1335	1344	1328	898	142	368	390	147	101
12:20	856	956	1196	1267	1511	1496	1336	1338	1322	887	139	372	395	146	101
12:30	927	1063	1406	1475	1527	1488	1317	1326	1327	905	139	379	411	147	102
1:10	820	904	1119	1193	1469	1455	1249	1286	1314	875	132	373	390	145	100
1:20	817	905	1103	1176	1512	1486	1288	1307	1323	886	134	371	387	146	101
1:30	806	891	1073	1140	1555	1575	1321	1334	1323	907	135	368	386	145	102
1:40	798	879	1056	1122	1540	1669	1355	1377	1335	897	136	366	381	146	102
1:50	788	869	1044	1106	1518	1700	1363	1376	1337	888	138	363	381	146	101
2:00	782	856	1034	1096	1490	1693	1381	1394	1335	871	138	361	378	149	103
2:10	767	840	1000	1050	1373	1530	1410	1435	1332	823	139	357	379	148	105
2:20	762	836	981	1042	1328	1467	1424	1464	1341	744	144	354	372	153	105
2:30	798	879	1058	1110	1414	1587	1676	1548	1417	1030	161	355	383	154	107

Erie Sewer Authority
Erie, Pennsylvania

Process Data

Test Nos. 1881A and B 7/14/81
Incinerator Unit No. 1

PRESSURES, IN. W.C.											WATER FLOW RATES			CO2 READING PERCENT*
Time	Auxiliary Air	Shaft Cooling Air	Afterburner Outlet	Venturi Pressure Drop	Incinerator I.D. Fan Inlet	Incinerator I.D. Fan Outlet	Hearth No. 11	Precooler	Venturi		Spray			
										Implingement Tray				
11:00 AM	2.6	6.5	0.155	8.0	18.0	39	0.16	84	225	960	20			
11:10	2.6	6.6	0.155	8.0	18.0	38	0.17	84	225	960	21	9.0,9.0		
11:20	2.6	6.5	0.155	8.0	18.5	38	0.15	84	223	955	21	8.5,9.5		
11:30	2.6	6.5	0.155	8.1	18.0	38	0.15	84	227	955	21	11.0,10.0		
11:40	2.7	6.5	0.155	8.0	18.0	38	0.17	84	225	958	21	10.0,10.0		
11:50	2.6	6.5	0.155	8.0	18.0	38	0.19	84	227	971	21	8.5,9.0		
12:00 N	2.6	6.5	0.155	8.0	18.0	38	0.17	85	227	972	22	8.5,9.0		
12:10	2.6	6.5	0.155	8.0	18.0	38	0.16	84	224	965	21	9.0,10.0		
12:20	2.6	6.5	0.115	8.0	18.5	38	0.16	84	225	967	21	11.0,12.0		
12:30	2.6	6.5	0.115	8.0	18.5	38	0.16	84	224	967	20			
1:10	2.6	6.5	0.115	8.0	18.0	38	0.16	84	222	948	21			
1:20	2.6	6.5	0.115	8.0	18.0	38	0.16	84	224	950	20			
1:30	2.6	6.5	0.115	8.0	18.0	38	0.16	84	220	950	20			
1:40	2.6	6.5	0.115	7.9	18.0	38	0.16	84	220	940	20			
1:50	2.6	6.5	0.115	7.9	18.0	38	0.16	84	220	948	20			
2:00	2.6	6.5	0.115	8.0	18.5	38	0.15	84	218	940	20			
2:10	2.6	6.5	0.115	8.0	18.0	38	0.14	85	220	942	20			
2:20	2.7	6.5	0.115	8.4	18.0	38	0.15	85	218	940	21			
2:30	2.6	6.5	0.115	8.5	18.5	38	0.12	84	219	939	20			

*These readings were obtained using a fyrite analyzer at the outlet of the incinerator and were used to correct the emission concentration to 12% CO₂.