Oregon

EMCOTEK CORPORATION — EMISSION CONTROL TECHNOLOGY

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(29.)

August 4, 1989

Mr. K. Steven Mackey
Department of Environmental Quality
811 SW Sixth Avenue
Portland, OR 97204-1390

State of Oregon
DEPARTMENT OF ENVIRONMENTAL QUALITY
RECEIVED
AUG 08 1989
AIR QUALITY CONTROL

Subject: Source Testing Bio-Waste. File No. 18-0083
(Our Ref. No. 523)

Dear Mr. Mackey:

As agreed in June at the time you granted two full days of source test operation, enclosed is the complete set of test results. This work was done by AmTest on June 16 and 17, 1989.

There were five tests of scrubber inlet (a measure of how the incinerator was performing) and five tests of scrubber outlet. In each test, both Particulate and HCl were measured. So, by comparing inlet and outlet for the same test, you can judge scrubber performance. Removal of HCl was 99.9% or higher in every test.

One point to note is that not all scrubber outlet particulate is necessarily soot and ash. AmTest measured the water insolubles (soot and ash) in each outlet catch, and got the results marked at the bottom of the outlet sheets. The remainder of the particle emission is presumably water-soluble salts, most of which were created during acid gas neutralization by sodium base in the scrubber.

We at **EMCOTEK** would appreciate any comments you have on these results, or decisions you arrive at as a result of this work, so we can continue to help you improve Oregon's air quality.

Sincerely,

Hank Marschall

H.L. Marschall
Manager, Process Applications

METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AN TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	BSM-IN1	LAB #:	910020
CLIENT:	BIOMASTE MANAGEMENT	START TIME:	13:05 O'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	14:05 O'CLOCK
SAMPLE SITE:	SCRUBBER INLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 16, 1989		
RUN #:	1 METHOD 5/HCL		
OPERATORS:	GRENTHOER/WIDMEYER		
CONTACT:	E MUNDY		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G	NET WT. OF H2O G.		
444.4	382.9	61.5	PITOT Cp:	0.80
474.3	451.4	22.9	NOZZLE DIA INCHES:	0.750
323.2	320.0	3.2	NOZZLE AREA FT^2:	0.0031
751.9	742.3	9.6	STACK DIA. INCHES:	36.00
TOTAL H2O GAIN:		97.2	STACK AREA FT^2:	7.069
TOTAL VOLUME (SCF)		4.58	METER TEMP. DEG F:	103.5
PERCENT MOISTURE:		13.27	BAROM. PRES. "HG:	26.06
Bws:		0.1327	STATIC PRES. "H2O:	-0.30
			STACK PRES. "HG:	26.04
			ORIFICE PRES "H2O:	1.050
			METER PRES. "HG:	26.14

INIT. METER VOLUME	937.771		
FINAL METER VOLUME	975.056	AVERAGE % CO2:	9.8
VOLUME SAMPLED:	37.285	AVERAGE % O2:	8.3
STD VOLUME (DSCF):	29.909	AVERAGE PPM CO:	606
STD VOLUME (DSCM):	0.847	STACK GAS MW. DRY:	29.90
Y FACTOR:	0.98	STACK GAS MW. WET:	28.32

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
POINT OF	0.015	1719	POINT OF	0.015	1719
AVERAGE	0.015	1657	AVERAGE	0.015	1657
VELOCITY	0.015	1777	VELOCITY	0.015	1777
	0.015	1677		0.015	1677
	0.015	1761		0.015	1761
	0.015	1882		0.015	1882

PERCENT ISOKINETICS:	104 %	
STACK TEMPERATURE:	1745.5 DEG. F.	2205.5 DEG. R.
AVERAGE VELOCITY HEAD:	0.015 " OF H20	
STACK GAS VELOCITY:		14.49 FT/SEC.
STACK GAS AIR FLOW:	6143.7 ACF/MIN.	1110.1 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.497 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.072 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.569 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		1302.7 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.697 GR/DSCF
POLLUTANT MASS EMISSION RATE:		5.42 LB/HR

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER:	#90-219
TARE WEIGHT OF FILTER IN GRAMS:	0.6010
FINAL WEIGHT OF FILTER IN GRAMS:	1.2543
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.6533
BEAKER NUMBER:	#89-693
TARE WEIGHT OF BEAKER IN GRAMS:	79.4551
FINAL WEIGHT OF BEAKER IN GRAMS:	79.7662
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.3111
VOLUME OF ACETONE IN MILLILITERS:	200.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0004
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.9640

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE

TARE WEIGHT OF BEAKER IN GRAMS:	70.1296
FINAL WEIGHT OF BEAKER IN GRAMS:	70.1548
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0252
TOTAL VOLUME OF WATER IN MILLILITERS:	299.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	97.2
NET VOLUME OF WATER FOR BLANK IN MLS.:	201.8
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0004

"Cx" SECTION - HYDROCARBON EXTRACTION

TARE WEIGHT OF BEAKER IN GRAMS:	70.5408
FINAL WEIGHT OF BEAKER IN GRAMS:	70.5474
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0066
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS:	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002

"D" SECTION - ACETONE RINSE OF CONDENSER

TARE WEIGHT OF BEAKER IN GRAMS:	64.7351
FINAL WEIGHT OF BEAKER IN GRAMS:	64.8438
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.1087
TOTAL VOLUME OF ACETONE IN MIL.LITERS:	125.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0003
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.1397
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	1.1037

CHLORIDE AS HCL

MILLILITERS OF SOLUTION:	299
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	5880
CHLORIDE CONCENTRATION (MG/DSCM):	2075.0
TOTAL CHLORIDE AS HCL IN SAMPLE (PPM):	1369.0
CHLORIDE EMISSION RATE (LBS/HR):	8.6

METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AM TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	BWH-LN2	LAB #:	910021
CLIENT:	BIOWASTE MANAGEMENT	START TIME:	08:38)'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	09:38)'CLOCK
SAMPLE SITE:	SCRUBBER INLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 17, 1989		
RUN #:	2-METHOD 5/HCL		
OPERATORS:	GUENTHOER/WIDMEYER		
CONTACT:	E. MURDY		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G.	NET WT. OF H2O G.
547.7	452.3	95.4
486.2	468.5	17.7
323.9	320.9	3.0
816.0	805.4	10.6
TOTAL H2O GAIN:		126.7
TOTAL VOLUME (SCF)		5.96
PERCENT MOISTURE:		14.56
Bws:		0.1456

PITOT Cp:	0.80
NOZZLE DIA (INCHES):	0.750
NOZZLE AREA FT^2:	0.0031
STACK DIA. (INCHES:	36.00
STACK AREA FT^2:	7.069
METER TEMP. DEG F:	92.8
BARON. PRES. "HG:	26.06
STATIC PRES. "H2O:	-0.30
STACK PRES. "HG:	26.04
ORIFICE PRES "H2O:	1.400
METER PRES. "HG:	26.16

INIT. METER VOLUME	975.577
FINAL METER VOLUME	1018.338
VOLUME SAMPLED:	42.761
STD VOLUME (DSCF):	35.000
STD VOLUME (DSCM):	0.991
Y FACTOR:	0.98

AVERAGE % CO2:	10.9
AVERAGE % O2:	6.9
AVERAGE PPM CO:	268
STACK GAS MW. DRY:	30.02
STACK GAS MW. WET:	28.27

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
POINT OF AVERAGE VELOCITY	0.02	1607	POINT OF AVERAGE VELOCITY	0.02	1607
	0.02	1594		0.02	1594
	0.02	1548		0.02	1548
	0.02	1547		0.02	1547
	0.02	1525		0.02	1525
	0.02	1540		0.02	1540

PERCENT ISOKINETICS:	102 %	
STACK TEMPERATURE:	1560.2 DEG. F.	2020.2 DEG. R.
AVERAGE VELOCITY HEAD:	0.020 " OF H2O	
STACK GAS VELOCITY:		16.02 FT/SEC.
STACK GAS AIR FLOW:	6795.7 ACF/MIN.	1320.6 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.182 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.014 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.196 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		448.3 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.216 GR/DSCF
POLLUTANT MASS EMISSION RATE:		2.22 LB/HR

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER:	#90-209
TARE WEIGHT OF FILTER IN GRAMS:	0.6027
FINAL WEIGHT OF FILTER IN GRAMS:	0.8422
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.2395
BEAKER NUMBER:	#89-694
TARE WEIGHT OF BEAKER IN GRAMS:	81.2709
FINAL WEIGHT OF BEAKER IN GRAMS:	81.4440
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.1731
VOLUME OF ACETONE IN MILLILITERS:	250.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0005
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.4121

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE	
TARE WEIGHT OF BEAKER IN GRAMS:	68.7772
FINAL WEIGHT OF BEAKER IN GRAMS:	68.7871
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0099
TOTAL VOLUME OF WATER IN MILLILITERS:	322.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	126.7
NET VOLUME OF WATER FOR BLANK IN MLS.:	195.3
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0004
"Cx" SECTION - HYDROCAREON EXTRACTION	
TARE WEIGHT OF BEAKER IN GRAMS:	64.7089
FINAL WEIGHT OF BEAKER IN GRAMS:	64.7153
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0064
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS:	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002
"D" SECTION - ACETONE RINSE OF CONDENSER	
TARE WEIGHT OF BEAKER IN GRAMS:	71.2102
FINAL WEIGHT OF BEAKER IN GRAMS:	71.2270
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0168
TOTAL VOLUME OF ACETONE IN MILLILITERS:	90.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0002
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.0324
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.4445

CHLORIDE AS HCL

MILLILITERS OF SOLUTION:	322
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	7040
CHLORIDE CONCENTRATION (MG/DSCM):	2286.3
TOTAL CHLORIDE AS HCL IN SAMPLE (PPM):	1508.5
CHLORIDE EMISSION RATE (LBS/HR):	11.3

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METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AM TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	BAM-1N3	LAB #:	910022
CLIENT:	BIOMASTE MANAGEMENT	START TIME:	10:55 O'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	11:55 O'CLOCK
SAMPLE SITE:	SCRUBBER INLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 17, 1989		
RUN #:	3-METHOD 5/HCL		
OPERATORS:	QUENTMOER/WIDMEYER		
CONTACT:	E. MUNDY		

FINAL WT. OF H2O G.	INIT. WT. OF H2O G.	NET WT. OF H2O G.
519.2	415.3	103.9
478.1	451.3	26.8
323.2	319.5	3.7
800.9	790.4	10.5
TOTAL H2O GAIN:		144.9
TOTAL VOLUME (SCF)		6.82
PERCENT MOISTURE:		16.43
Bws:		0.1643

INIT. METER VOLUME	18.877
FINAL METER VOLUME	62.394
VOLUME SAMPLED:	43.517
STD VOLUME (DSCF):	34.690
STD VOLUME (DSCM):	0.983
Y FACTOR:	0.98

PITOT Cp:	0.80
NOZZLE DIA INCHES:	0.750
NOZZLE AREA FT^2:	0.0031
STACK DIA. INCHES:	36.00
STACK AREA FT^2:	7.069
METER TEMP. DEG F:	107.6
BAROM. PRES. "HG:	26.06
STATIC PRES. "H2O:	-0.30
STACK PRES. "HG:	26.04
ORIFICE PRES "H2O:	1.400
METER PRES. "HG:	26.16

AVERAGE % CO2:	10.0
AVERAGE % O2:	8.1
AVERAGE PPM CO:	58
STACK GAS MW. DRY:	29.92
STACK GAS MW. WET:	27.96

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
POINT OF	0.02	1778	POINT OF	0.02	1778
AVERAGE	0.02	1631	AVERAGE	0.02	1631
VELOCITY	0.02	1692	VELOCITY	0.02	1692
	0.02	1800		0.02	1800
	0.02	1759		0.02	1759
	0.02	1694		0.02	1694

PERCENT ISOKINETICS:	107 %	
STACK TEMPERATURE:	1725.7 DEG. F.	2185.7 DEG. R.
AVERAGE VELOC TY HEAD:	0.020 " OF H2O	
STACK GAS VELOCITY:		16.76 FT/SEC.
STACK GAS AIR FLOW:	7107.0 ACF/MIN.	1248.6 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.178 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.008 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.186 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		426.6 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.224 GR/DSCF
POLLUTANT MASS EMISSION RATE:		2.00 LB/HR

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER:	#90-220
TARE WEIGHT OF FILTER IN GRAMS:	0.6035
FINAL WEIGHT OF FILTER IN GRAMS:	0.8268
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.2233
BEAKER NUMBER:	#89-695
TARE WEIGHT OF BEAKER IN GRAMS:	66.2762
FINAL WEIGHT OF BEAKER IN GRAMS:	66.4539
NET WEIGHT OF PART C. MATTER IN GRAMS:	0.1777
VOLUME OF ACETONE IN MILLILITERS:	200.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PART C. DUE TO ACETONE IN GMS.:	0.0004
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.4006

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE	
TARE WEIGHT OF BEAKER IN GRAMS:	101.4356
FINAL WEIGHT OF BEAKER IN GRAMS:	101.4474
NET WEIGHT OF PART C. MATTER IN GRAMS:	0.0118
TOTAL VOLUME OF WATER IN MILLILITERS:	334.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	144.9
NET VOLUME OF WATER FOR BLANK IN MLS.:	189.1
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PART C. DUE TO WATER IN GRAMS:	0.0004
"Cx" SECTION - HYDROCARBONS EXTRACTION	
TARE WEIGHT OF BEAKER IN GRAMS:	71.3784
FINAL WEIGHT OF BEAKER IN GRAMS:	71.3799
NET WEIGHT OF PART C. MATTER IN GRAMS:	0.0015
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PART C. DUE TO CH2Cl2 IN GRAMS:	0.0002
"D" SECTION - ACETONE RINSE OF CONDENSER	
TARE WEIGHT OF BEAKER IN GRAMS:	70.1870
FINAL WEIGHT OF BEAKER IN GRAMS:	70.1930
NET WEIGHT OF PART C. MATTER IN GRAMS	0.0060
TOTAL VOLUME OF ACETONE IN MILLILITERS:	95.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PART C. DUE TO ACETONE IN GMS.:	0.0002
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS	0.0186
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.4192

CHLORIDE AS HCL

MILLILITERS OF SOLUTION:	334
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	6460
CHLORIDE CONCENTRATION (MG/DSCM):	2195.6
TOTAL CHLORIDE AS HCL IN SAMPLE (PPM)	1448.6
CHLORIDE EMISSION RATE (LBS/HR):	10.3

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METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AN TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	BSM-1M4	LAB #:	910023
CLIENT:	BIOWASTE MANAGEMENT	START TIME:	13:20 O'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	14:20 O'CLOCK
SAMPLE SITE:	SCRUBBER INLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 17, 1989		
RUN #:	4-METHOD 5/HCL		
OPERATORS:	GLENTROER/MIDMEYER		
CONTACT:	E. MANDY		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G	NET WT. OF H2O G.
485.2	381.1	105.1
537.0	486.9	52.1
325.5	320.8	5.7
864.8	853.7	11.1
TOTAL H2O GAIN:		174.0
TOTAL VOLUME (SCF)		8.19
PERCENT MOISTURE:		16.58
Bws:		0.1658

INIT. METER VOLUME	62.744
FINAL METER VOLUME	115.107
VOLUME SAMPLED:	52.363
STD VOLUME (DSCF):	41.216
STD VOLUME (DSCM):	1.168
Y FACTOR:	0.98

PITOT Cp:	0.80
NOZZLE DIA (INCHES):	0.750
NOZZLE AREA FT^2:	0.0031
STACK DIA. INCHES:	36.00
STACK AREA FT^2:	7.069
METER TEMP. DEG F:	115.8
BAROM. PRES. "HG:	26.06
STATIC PRES. "H2O:	-0.30
STACK PRES. "HG:	26.04
ORIFICE PRES "H2O:	2.000
METER PRES. "HG:	26.21

AVERAGE % CO2:	9.2
AVERAGE % O2:	9.1
AVERAGE PPM CO:	789
STACK GAS MW. DRY:	29.84
STACK GAS MW. WET:	27.87

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
POINT OF AVERAGE VELOCITY	0.03	1667	POINT OF AVERAGE VELOCITY	0.03	1667
	0.03	1665		0.03	1665
	0.03	1563		0.03	1563
	0.03	1652		0.03	1652
	0.03	1564		0.03	1564
	0.03	1607		0.03	1607

PERCENT ISOKINETICS:	101 %	
STACK TEMPERATURE:	1619.7 DEG. F.	2079.7 DEG. R.
AVERAGE VELOCITY HEAD:	0.030 " OF H20	
STACK GAS VELOCITY:		20.05 FT/SEC.
STACK GAS AIR FLOW:	8504.4 ACF/MIN.	1567.5 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.119 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.005 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.125 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		284.9 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.162 GR/DSCF
POLLUTANT MASS EMISSION RATE:		1.67 LB/HR

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER:	#90-223
TARE WEIGHT OF FILTER IN GRAMS:	0.6120
FINAL WEIGHT OF FILTER IN GRAMS:	0.8009
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.1889
BEAKER NUMBER:	#89-696
TARE WEIGHT OF BEAKER IN GRAMS:	65.3974
FINAL WEIGHT OF BEAKER IN GRAMS:	65.5272
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.1298
VOLUME OF ACETONE IN MILLILITERS:	300.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0006
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.3181

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE

TARE WEIGHT OF BEAKER IN GRAMS:	99.6081
FINAL WEIGHT OF BEAKER IN GRAMS:	99.6174
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0093
TOTAL VOLUME OF WATER IN MILLILITERS:	369.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	174.0
NET VOLUME OF WATER FOR BLANK IN MLS.:	195.0
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0004

"Cx" SECTION - HYDROCARBON EXTRACTION

TARE WEIGHT OF BEAKER IN GRAMS:	69.8401
FINAL WEIGHT OF BEAKER IN GRAMS:	69.8431
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0030
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS:	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002

"D" SECTION - ACETONE RINSE OF CONDENSER

TARE WEIGHT OF BEAKER IN GRAMS:	66.7615
FINAL WEIGHT OF BEAKER IN GRAMS:	66.7645
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0030
TOTAL VOLUME OF ACETONE IN MILLILITERS:	80.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0002
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.0146
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.3327

CHLORIDE IS HCL

MILLILITERS OF SOLUTION:	369
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	7710
CHLORIDE CONCENTRATION (MG/DSCM):	2436.6
TOTAL CHLORIDE AS HCL IN SAMPLE (PPM):	1607.6
CHLORIDE EMISSION RATE (LBS/HR):	14.3

5

METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AN TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	BWM-1M5	LAB #:	910024
CLIENT:	BIOWASTE MANAGEMENT	START TIME:	15:35 O'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	16:35 O'CLOCK
SAMPLE SITE:	SCRUBBER INLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 17, 1989		
RUN #:	5-METHOD 5/HCL		
OPERATORS:	GUENTHNER/MIDMEYER		
CONTACT:	E. MURDY		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G	NET WT. OF H2O G.
518.8	416.2	102.6
482.2	449.8	32.4
324.9	320.4	4.5
755.6	745.7	9.9
TOTAL H2O GAIN:		149.4
TOTAL VOLUME (SCF)		7.03
PERCENT MOISTURE:		16.58
Bws:		0.1658

INIT. METER VOLUME	115.588
FINAL METER VOLUME	160.735
VOLUME SAMPLED:	45.147
STD VOLUME (DSCF):	35.379
STD VOLUME (DSCM):	1.002
Y FACTOR:	0.98

PITOT Cp:	0.80
NOZZLE DIA INCHES:	0.750
NOZZLE AREA FT^2:	0.0031
STACK DIA. INCHES:	36.00
STACK AREA FT^2:	7.069
METER TEMP. DEG F:	117.4
BAROM. PRES. "HG:	26.06
STABIC PRES. "H2O:	-0.30
STACK PRES. "HG:	26.04
ORIFICE PRES "H2O:	1.410
METER PRES. "HG:	26.16

AVERAGE % CO2:	9.7
AVERAGE % O2:	8.5
AVERAGE PPM CO:	19
STACK GAS MW. DRY:	29.89
STACK GAS MW. WET:	27.92

SAMPLE POINT	VELOCITY " OF H20	TEMPERATURE DEGREES F.
POINT OF AVERAGE VELOCITY	0.02	1679
	0.02	1702
	0.02	1775
	0.02	1680
	0.02	1729
	0.02	1685

SAMPLE POINT	VELOCITY " OF H20	TEMPERATURE DEGREES F.
POINT OF AVERAGE VELOCITY	0.02	1679
	0.02	1702
	0.02	1775
	0.02	1680
	0.02	1729
	0.02	1685

PERCENT ISOKINETICS:	109 %	
STACK TEMPERATURE:	1708.3 DEG. F.	2168.3 DEG. R.
AVERAGE VELOCITY HEAD:	0.020 " OF H20	
STACK GAS VELOCITY:		16.70 FT/SEC.
STACK GAS AIR FLOW:	7084.4 ACF,MIN.	1258.8 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.238 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.006 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.243 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		556.7 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.301 GR/DSCF
POLLUTANT MASS EMISSION RATE:		2.61 LB/HR

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER:	#90-224
TARE WEIGHT OF FILTER IN GRAMS:	0.6076
FINAL WEIGHT OF FILTER IN GRAMS:	0.7929
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.1853
BEAKER NUMBER:	#89-697
TARE WEIGHT OF BEAKER IN GRAMS:	65.5314
FINAL WEIGHT OF BEAKER IN GRAMS:	65.8919
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.3605
VOLUME OF ACETONE IN MILLILITERS:	250.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0005
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.5453

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE

TARE WEIGHT OF BEAKER IN GRAMS:	98.4385
FINAL WEIGHT OF BEAKER IN GRAMS:	98.4473
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0088
TOTAL VOLUME OF WATER IN MILLILITERS:	339.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	149.4
NET VOLUME OF WATER FOR BLANK IN MLS.:	189.6
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0004

"CX" SECTION - HYDROCARBON EXTRACTION

TARE WEIGHT OF BEAKER IN GRAMS:	68.2771
FINAL WEIGHT OF BEAKER IN GRAMS:	68.2785
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0014
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS:	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002

"B" SECTION - ACETONE RINSE OF CONDENSER

TARE WEIGHT OF BEAKER IN GRAMS:	70.6250
FINAL WEIGHT OF BEAKER IN GRAMS:	70.6282
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0032
TOTAL VOLUME OF ACETONE IN MILLILITERS:	100.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0002
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.0127
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.5580

CHLORIDE AS HCL

MILLILITERS OF SOLUTION:	369
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	7710
CHLORIDE CONCENTRATION (MG/DSCM):	2838.6
TOTAL CHLORIDE AS HCL IN SAMPLE (PPM):	1872.8
CHLORIDE EMISSION RATE (LBS/HR):	13.3

METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AM TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	RUN-OUT1	LAB #:	910025
CLIENT:	BL WASTE MANAGEMENT	START TIME:	13:05 O'CLOCK
LOCATION:	BLUNATH FALLS, OR	STOP TIME:	14:08 O'CLOCK
SAMPLE SITE:	SCRUBBER OUTLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 16, 1989		
RUN #:	1 - METHOD 5/HCL		
OPERATORS:	KLEINTHOER/MIDMEYER		
CONTACT:	B. MURDY		

FINAL WT. OF H2O G.	INIT WT. OF H2O G.	NET WT. OF H2O G.
782.2	599.5	182.9
769.7	573.0	196.7
730.5	463.1	267.4
846.3	798.6	47.7
TOTAL H2O GAIN:		694.7
TOTAL VOLUME (CC):		32.70
PERCENT MOISTURE:		46.01
Bws:		0.4601

PITOT Cp:	0.82
NOZZLE DIA INCHES:	0.506
NOZZLE AREA FT^2	0.0014
STACK DIA. INCHES:	22.75
STACK AREA FT^2:	2.823
METER TEMP. DEG F:	75.2
BAROM. PRES. "HG:	26.06
STATIC PRES. "H2O:	0.01
STACK PRES. "HG:	26.06
ORIFICE PRES "H2O:	0.786
METER PRES. "HG:	26.12

INIT. METER VOLUME	164.300
FINAL METER VOLUME	209.168
VOLUME SAMPLED:	44.868
STD VOLUME (DSCM):	38.369
STD VOLUME (DSCM):	1.087
Y FACTOR:	0.993

AVERAGE % CO2:	9.8
AVERAGE % O2:	8.3
AVERAGE PPM CO:	606
STACK GAS MW. DRY:	29.90
STACK GAS MW. WET:	24.42

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
M 1	0.065	170	M 1	0.050	171
2	0.065	169	2	0.050	172
3	0.065	170	3	0.055	165
4	0.065	170	4	0.065	170
5	0.065	162	5	0.065	163
6	0.065	169	6	0.065	168
7	0.060	168	7	0.065	171
8	0.075	165	8	0.070	172
9	0.065	168	9	0.070	171
10	0.060	165	10	0.070	170
11	0.065	170	11	0.065	166
12	0.065	169	12	0.065	171

PERCENT ISOKINETICS:	110 %	
STACK TEMPERATURE:	168.5 DEG. F.	628.5 DEG. R.
AVERAGE VELOCITY HEAD:	0.064 " OF H2O	
STACK GAS VELOCITY:		17.60 FT/SEC.
STACK GAS AIR FLOW:	2980.9 ACF/MIN.	1177.5 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.045 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.001 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.046 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		104.7 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.056 GR/DSCF
POLLUTANT MASS EMISSION RATE:		0.46 LB/HR

Insolubles 30% of this, or 0.0168 gr/dscf.

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER:	#125-1086
TARE WEIGHT OF FILTER IN GRAMS:	0.7820
FINAL WEIGHT OF FILTER IN GRAMS:	0.8570
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0750
BEAKER NUMBER:	#89-698
TARE WEIGHT OF BEAKER IN GRAMS:	67.4121
FINAL WEIGHT OF BEAKER IN GRAMS:	67.4487
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0366
VOLUME OF ACETONE IN MILLILITERS:	78.0
WT /VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0002
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.1114

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE

TARE WEIGHT OF BEAKER IN GRAMS:	66.9607
FINAL WEIGHT OF BEAKER IN GRAMS:	66.9634
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0027
TOTAL VOLUME OF WATER IN MILLILITERS:	854.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	694.7
NET VOLUME OF WATER FOR BLANK IN MLS.:	159.3
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0003

"C1" SECTION - HYDROCARBON EXTRACTION

TARE WEIGHT OF BEAKER IN GRAMS:	65.6924
FINAL WEIGHT OF BEAKER IN GRAMS:	65.6926
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0002
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS:	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002

"D" SECTION - ACETONE RINSE OF CONDENSER

TARE WEIGHT OF BEAKER IN GRAMS:	72.2286
FINAL WEIGHT OF BEAKER IN GRAMS:	72.2287
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0001
TOTAL VOLUME OF ACETONE IN MILLILITERS:	80.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0002
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.0024
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.1138

CHLORIDE AS HCL

MILLILITERS OF SOLUTION:	854
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	3.6
CHLORIDE CONCENTRATION (MG/DSCM):	2.83
TOTAL CHLORIDE AS HCL IN SAMPLE (PPM):	1.87
CHLORIDE EMISSION RATE (LBS/HR):	0.01

METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AN TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	RUN-OUT2	LAB #:	910026
CLIENT:	BIOMASTE MANAGEMENT	START TIME:	08:37 O'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	09:39 O'CLOCK
SAMPLE SITE:	SCRUBBER OUTLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 17, 1989		
RUN #:	2-METHOD 5/HCL		
OPERATORS:	GUENTHER/MIDMEYER		
CONTACT:	E. MUNDY		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G.	NET WT. OF H2O G.
794.8	589.6	205.2
862.1	588.4	273.7
1500.1	1053.5	446.6
772.2	750.2	22.0
TOTAL H2O GAIN:		947.5
TOTAL VOLUME (SCF)		44.60
PERCENT MOISTURE:		44.94
Bws:		0.4494

INIT. METER VOLUME	209.632
FINAL METER VOLUME	272.968
VOLUME SAMPLED:	63.336
STD VOLUME (DSCF):	54.650
STD VOLUME (DSCM):	1.548
Y FACTOR:	0.993

PITOT Cp:	0.82
NOZZLE DIA INCHES:	0.506
NOZZLE AREA FT^2:	0.0014
STACK DIA. INCHES:	22.75
STACK AREA FT^2:	2.823
METER TEMP. DEG F:	71.7
BARON. PRES. "HG:	26.06
STATIC PRES. "H2O:	0.01
STACK PRES. "HG:	26.06
ORIFICE PRES "H2O:	1.647
METER PRES. "HG:	26.18
AVERAGE % CO2:	10.9
AVERAGE % O2:	6.9
AVERAGE PPM CO:	268
STACK GAS MW. DRY:	30.02
STACK GAS MW. WET:	24.62

SAMPLE POINT	VELOCITY "H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY "H2O	TEMPERATURE DEGREES F.
# 1	0.11	169	# 1	0.150	171
2	0.13	169	2	0.135	170
3	0.13	170	3	0.150	170
4	0.16	170	4	0.150	163
5	0.13	166	5	0.160	167
6	0.16	170	6	0.160	170
7	0.16	170	7	0.160	166
8	0.16	166	8	0.180	169
9	0.18	169	9	0.180	168
10	0.16	166	10	0.140	166
11	0.15	170	11	0.140	170
12	0.15	170	12	0.140	165

PERCENT ISOKINETICS:	100 %	
STACK TEMPERATURE:	168.3 DEG. F.	628.3 DEG. R.
AVERAGE VELOCITY HEAD:	0.151 " OF H2O	
STACK GAS VELOCITY:		26.92 FT/SEC.
STACK GAS AIR FLOW:	4559.7 ACF/MIN.	1837.7 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.035 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.002 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.037 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		84.4 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.041 GR/DSCF
POLLUTANT MASS EMISSION RATE:		0.58 LB/HR

Insolubles 47% of this or 0.0016 gr/dscf

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER: #125-1084	
TARE WEIGHT OF FILTER IN GRAMS:	0.7889
FINAL WEIGHT OF FILTER IN GRAMS:	0.9088
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.1199
BEAKER NUMBER: #89-699	
TARE WEIGHT OF BEAKER IN GRAMS:	68.3862
FINAL WEIGHT OF BEAKER IN GRAMS:	68.3909
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0047
VOLUME OF ACETONE IN MILLILITERS:	70.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0001
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.1245

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE

TARE WEIGHT OF BEAKER IN GRAMS:	65.9825
FINAL WEIGHT OF BEAKER IN GRAMS:	65.9882
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0057
TOTAL VOLUME OF WATER IN MILLILITERS:	1010.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	947.5
NET VOLUME OF WATER FOR BLANK IN MLS.:	62.5
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0001

"Cx" SECTION - HYDROCARBON EXTRACTION

TARE WEIGHT OF BEAKER IN GRAMS:	62.0112
FINAL WEIGHT OF BEAKER IN GRAMS:	62.0114
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0002
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS:	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002

"D" SECTION - ACETONE RINSE OF CONDENSER

TARE WEIGHT OF BEAKER IN GRAMS:	70.5715
FINAL WEIGHT OF BEAKER IN GRAMS:	70.5725
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0010
TOTAL VOLUME OF ACETONE IN MILLILITERS:	180.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0004
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.0063
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.1307

CHLORIDE AS HCl

MILLILITERS OF SOLUTION:	1010
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	2.4
CHLORIDE CONCENTRATION (MG/DSCM):	1.57
TOTAL CHLORIDE AS HCl IN SAMPLE (PPM):	1.03
CHLORIDE EMISSION RATE (LBS/HR):	0.01

METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AM TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	BLM-OUT3	LAB #:	910027
CLIENT:	BIOWASTE MANAGEMENT	START TIME:	10:55 O'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	12:00 O'CLOCK
SAMPLE SITE:	SCRUBBER OUTLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 17, 1989		
RUN #:	3-METHOD 5/HCL		
OPERATORS:	QUENTMEIER/WIDMEYER		
CONTACT:	E. MUNDY		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G.	NET WT. OF H2O G.
836.6	574.9	261.7
805.7	601.2	204.5
1264.9	982.8	282.1
778.7	762.6	16.1
TOTAL H2O GAIN:		764.4
TOTAL VOLUME (SCF)		35.98
PERCENT MOISTURE:		47.33
Bws:		0.4733

PITOT Cp:	0.82
NOZZLE DIA INCHES:	0.433
NOZZLE AREA FT^2:	0.0010
STACK DIA. INCHES:	22.75
STACK AREA FT^2:	2.823
METER TEMP. DEG F:	77.9
BAROM. PRES. "HG:	26.06
STATIC PRES. "H2O:	0.01
STACK PRES. "HG:	26.06
ORIFICE PRES "H2O:	0.863
METER PRES. "HG:	26.12

INIT. METER VOLUME	273.815
FINAL METER VOLUME	320.860
VOLUME SAMPLED:	47.045
STD VOLUME (DSCF):	40.037
STD VOLUME (DSCM):	1.134
Y FACTOR:	0.993

AVERAGE % CO2:	10.0
AVERAGE % O2:	8.1
AVERAGE PPM CO:	58
STACK GAS MW. DRY:	29.92
STACK GAS MW. WET:	24.28

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
M 1	0.12	169	M 1	0.14	170
2	0.12	171	2	0.14	171
3	0.12	167	3	0.14	169
4	0.12	168	4	0.14	171
5	0.14	172	5	0.16	166
6	0.15	171	6	0.14	170
7	0.17	167	7	0.16	174
8	0.19	169	8	0.16	172
9	0.15	172	9	0.18	168
10	0.12	167	10	0.18	166
11	0.15	170	11	0.15	173
12	0.15	167	12	0.15	173

PERCENT ISOKINETICS:	106 %	
STACK TEMPERATURE:	169.7 DEG. F.	629.7 DEG. R.
AVERAGE VELOCITY HEAD:	0.147 " OF H2O	
STACK GAS VELOCITY:		26.80 FT/SEC.
STACK GAS AIR FLOW:	4539.5 ACF/MIN.	1746.1 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.030 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.001 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.031 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		71.5 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.038 GR/DSCF
POLLUTANT MASS EMISSION RATE:		0.47 LB/HR

Insolubles 11% of this or 0.0042 gr/dscf

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER:	#125-1068
TARE WEIGHT OF FILTER IN GRAMS:	0.7863
FINAL WEIGHT OF FILTER IN GRAMS:	0.8604
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0741
BEAKER NUMBER:	889-700
TARE WEIGHT OF BEAKER IN GRAMS:	64.5162
FINAL WEIGHT OF BEAKER IN GRAMS:	64.5209
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0047
VOLUME OF ACETONE IN MILLILITERS:	62.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0001
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.0787

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE	
TARE WEIGHT OF BEAKER IN GRAMS:	66.2112
FINAL WEIGHT OF BEAKER IN GRAMS:	66.2143
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0031
TOTAL VOLUME OF WATER IN MILLILITERS:	955.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	764.4
NET VOLUME OF WATER FOR BLANK IN MLS.:	190.6
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0004
"Cx" SECTION - HYDROCARBON EXTRACTION	
TARE WEIGHT OF BEAKER IN GRAMS:	65.8809
FINAL WEIGHT OF BEAKER IN GRAMS:	65.8809
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0000
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS:	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002
"D" SECTION - ACETONE RINSE OF CONDENSER	
TARE WEIGHT OF BEAKER IN GRAMS:	69.2739
FINAL WEIGHT OF BEAKER IN GRAMS:	69.2740
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0001
TOTAL VOLUME OF ACETONE IN MILLILITERS:	100.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0002
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.0025
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.0811

CHLORIDE AS HCl

MILLILITERS OF SOLUTION:	955
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	2.4
CHLORIDE CONCENTRATION (MG/DSCM):	2.02
TOTAL CHLORIDE AS HCl IN SAMPLE (PPM):	1.33
CHLORIDE EMISSION RATE (LBS/HR):	0.01

METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AH TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	RUN-OUT4	LAB #:	910028
CLIENT:	BIOWASTE MANAGEMENT	START TIME:	13:20 O'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	14:23 O'CLOCK
SAMPLE SITE:	SCRUBBER OUTLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 17, 1989		
RUN #:	4-METHOD 5,HCL		
OPERATORS:	BUENTMEIER/DIDMETER		
CONTACT:	B. MUNDY		

FINAL WT. OF H2O G.	INIT WT. OF H2O G	NET WT. OF H2O G.		
868.1	616.3	251.8	PITOT Cp:	0.82
853.9	591.8	262.1	NOZZLE DIA INCHES:	0.433
1222.5	1052.8	169.7	NOZZLE AREA FT^2:	0.0010
780.3	768.1	12.2	STACK DIA. INCHES:	22.75
TOTAL H2O GAIN:		695.8	STACK AREA FT^2:	2.823
TOTAL VOLUME (SCF)		32.75	METER TEMP. DEG F:	82.0
PERCENT MOISTURE:		47.43	BARON. PRES. "HG:	26.06
Bws:		0.4743	STATIC PRES. "H2O:	0.01
			STACK PRES. "HG:	26.06
			ORIFICE PRES "H2O:	0.675
			METER PRES. "HG:	26.11
INIT. METER VOLUME		321.624		
FINAL METER VOLUME		364.628	AVERAGE % CO2:	9.2
VOLUME SAMPLED:		43.004	AVERAGE % O2:	9.1
STD VOLUME (DSCF):		36.302	AVERAGE PPM CO:	789
STD VOLUME (DSCM):		1.028	STACK GAS MW. DRY:	29.84
Y FACTOR:		0.993	STACK GAS MW. WET:	24.22

SAMPLE POINT	VELOCITY " OF H20	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H20	TEMPERATURE DEGREES F.
M 1	0.100	169	N 1	0.120	170
2	0.100	170	2	0.120	172
3	0.110	172	3	0.110	166
4	0.110	166	4	0.110	170
5	0.130	171	5	0.130	171
6	0.130	166	6	0.130	169
7	0.110	172	7	0.120	172
8	0.110	167	8	0.140	172
9	0.120	166	9	0.140	169
10	0.120	172	10	0.140	171
11	0.110	173	11	0.130	171
12	0.110	171	12	0.130	170

PERCENT ISOKINETICS:	106 %	
STACK TEMPERATURE:	169.9 DEG. F.	629.9 DEG. R.
AVERAGE VELOCITY HEAD:	0.119 " OF H20	
STACK GAS VELOCITY:		24.14 FT/SEC.
STACK GAS AIR FLOW:	4089.4 ACF/MIN.	1569.5 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.025 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.001 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.026 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		59.1 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.034 GR/DSCF
POLLUTANT MASS EMISSION RATE:		0.35 LB/HR

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER: #125-1087	
TARE WEIGHT OF FILTER IN GRAMS:	0.7862
FINAL WEIGHT OF FILTER IN GRAMS:	0.8411
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0549
BEAKER NUMBER: 889-701	
TARE WEIGHT OF BEAKER IN GRAMS:	67.8061
FINAL WEIGHT OF BEAKER IN GRAMS:	67.8097
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0036
VOLUME OF ACETONE IN MILLILITERS:	65.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0001
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.0584

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE	
TARE WEIGHT OF BEAKER IN GRAMS:	66.7731
FINAL WEIGHT OF BEAKER IN GRAMS:	66.7760
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0029
TOTAL VOLUME OF WATER IN MILLILITERS:	892.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	695.8
NET VOLUME OF WATER FOR BLANK IN MLS.:	196.2
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0004
"Cx" SECTION - HYDROCARBON EXTRACTION	
TARE WEIGHT OF BEAKER IN GRAMS:	70.0061
FINAL WEIGHT OF BEAKER IN GRAMS:	70.0063
NET WEIGHT OF PARTIC. MATTER IN GRAMS	0.0002
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002
"D" SECTION - ACETONE RINSE OF CONDENSER	
TARE WEIGHT OF BEAKER IN GRAMS:	70.4880
FINAL WEIGHT OF BEAKER IN GRAMS:	70.4881
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0001
TOTAL VOLUME OF ACETONE IN MILLILITERS:	100.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0002
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.0025
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.0608

CHLORIDE AS HCL

MILLILITERS OF SOLUTION:	892
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	2.4
CHLORIDE CONCENTRATION (MG/DSCM):	2.08
TOTAL CHLORIDE AS HCL IN SAMPLE (PPM)	1.37
CHLORIDE EMISSION RATE (LBS/HR):	0.01

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METHOD 1-5 - PARTICULATE MATTER AND HCl EMISSION RESULTS
AM TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	BUR-OUT5	LAB #:	910029
CLIENT:	BIOWASTE MANAGEMENT	START TIME:	15:35 O'CLOCK
LOCATION:	KLAMATH FALLS, OR	STOP TIME:	16:37 O'CLOCK
SAMPLE SITE:	SCRUBBER OUTLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	JUNE 17, 1989		
RUN #:	5-METHOD 5/HCL		
OPERATORS:	GUENTHNER/WEDMEYER		
CONTACT:	E. MUNDY		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G	NET WT. OF H2O G.
838.9	602.0	236.9
795.0	572.0	223.0
1211.6	987.1	224.5
767.0	755.5	11.5
TOTAL H2O GAIN:		695.9
TOTAL VOLUME (SCF)		32.76
PERCENT MOISTURE:		47.75
Bws:		0.4775

PITOT Cp:	0.82
NOZZLE DIA INCHES:	0.433
NOZZLE AREA FT^2:	0.0010
STACK DIA. INCHES:	22.75
STACK AREA FT^2:	2.823
METER TEMP. DEG F:	83.1
BAROM. PRES. "HG:	26.06
STATIC PRES. "H2O:	0.01
STACK PRES. "HG:	26.06
ORIFICE PRES "H2O:	0.694
METER PRES. "HG:	26.11

INIT. METER VOLUME	365.552
FINAL METER VOLUME	408.100
VOLUME SAMPLED:	42.548
STD VOLUME (DSCF):	35.846
STD VOLUME (DSCM):	1.015
Y FACTOR:	0.993

AVERAGE % CO2:	9.7
AVERAGE % O2:	8.5
AVERAGE PPM CO:	19
STACK GAS MW. DRY:	29.89
STACK GAS MW. WET:	24.21

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
M 1	0.100	170	M 1	0.100	173
2	0.100	166	2	0.100	169
3	0.115	170	3	0.130	172
4	0.115	164	4	0.130	168
5	0.115	172	5	0.130	174
6	0.115	167	6	0.130	172
7	0.130	171	7	0.115	168
8	0.130	169	8	0.115	171
9	0.130	173	9	0.100	169
10	0.100	172	10	0.115	173
11	0.120	171	11	0.130	167
12	0.120	165	12	0.130	170

PERCENT ISOKINETICS:	107 %	
STACK TEMPERATURE:	169.8 DEG. F.	629.8 DEG. R.
AVERAGE VELOCITY HEAD:	0.117 " OF H2O	
STACK GAS VELOCITY:		23.98 FT/SEC.
STACK GAS AIR FLOW:	4060.9 ACF/MIN.	1549.4 DSCF/MIN.
PARTICULATE EMISSION CONCENTRATION (FRONT-HALF):		0.023 GR/DSCF
PARTICULATE EMISSION CONCENTRATION (BACK-HALF):		0.003 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		0.026 GR/DSCF
TOTAL PARTICULATE EMISSION CONC. (FRONT & BACK-HALF):		59.3 MG/DSCM
TOTAL PARTICULATE CONCENTRATION @ 12% CO2:		0.032 GR/DSCF
POLLUTANT MASS EMISSION RATE:		0.34 LB/HR

FRONT-HALF PARTICULATE MASS LOADING

FILTER NUMBER: #125-1089	
TARE WEIGHT OF FILTER IN GRAMS:	0.7858
FINAL WEIGHT OF FILTER IN GRAMS:	0.8362
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0504
BEAKER NUMBER: #89-702	
TARE WEIGHT OF BEAKER IN GRAMS:	64.5862
FINAL WEIGHT OF BEAKER IN GRAMS:	64.5888
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0026
VOLUME OF ACETONE IN MILLILITERS:	60.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0001
TOTAL FRONT-HALF PARTIC. MATTER IN GRAMS:	0.0529

BACK-HALF PARTICULATE MASS LOADING

"C" SECTION - CONDENSER PARTICULATE	
TARE WEIGHT OF BEAKER IN GRAMS:	99.9887
FINAL WEIGHT OF BEAKER IN GRAMS:	99.9965
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0078
TOTAL VOLUME OF WATER IN MILLILITERS:	895.0
VOLUME OF WATER CONDENSED IN MILLILITERS:	695.9
NET VOLUME OF WATER FOR BLANK IN MLS.:	199.1
WT./VOL. OF WATER BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO WATER IN GRAMS:	0.0004
"Cx" SECTION - HYDROCARBON EXTRACTION	
TARE WEIGHT OF BEAKER IN GRAMS:	69.9659
FINAL WEIGHT OF BEAKER IN GRAMS:	69.9660
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0001
TOTAL VOLUME OF CH2Cl2 IN MILLILITERS:	75.0
WT./VOL. OF CH2Cl2 BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 IN GRAMS:	0.0002
"D" SECTION - ACETONE RINSE OF CONDENSER	
TARE WEIGHT OF BEAKER IN GRAMS:	69.4916
FINAL WEIGHT OF BEAKER IN GRAMS:	69.4918
NET WEIGHT OF PARTIC. MATTER IN GRAMS:	0.0002
TOTAL VOLUME OF ACETONE IN MILLILITERS:	90.0
WT./VOL. OF ACETONE BLANK IN MG/ML:	0.002
NET WEIGHT OF PARTIC. DUE TO ACETONE IN GMS.:	0.0002
TOTAL BACK-HALF PARTIC. MATTER IN GRAMS:	0.0074
TOTAL WEIGHT OF PARTICULATE IN GRAMS:	0.0603

CHLORIDE AS HCl

MILLILITERS OF SOLUTION:	895
CHLORIDE CONCENTRATION (MILLIGRAMS/LITER):	2.4
CHLORIDE CONCENTRATION (MG/DSCM):	2.12
TOTAL CHLORIDE AS HCl IN SAMPLE (PPM):	1.40
CHLORIDE EMISSION RATE (LBS/HR):	0.01

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Oregon

AMTEST

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SOURCE EMISSION EVALUATION

JULY 19, 1989

Prepared For:

BIO-WASTE MANAGEMENT CORPORATION
CONSUMAT WASTE INCINERATOR
EMCOTEK CORPORATION
ROTARY ATOMIZING SCRUBBER
KLAMATH FALLS, OREGON
JUNE 16-17, 1989

Submitted by:

Kris A. Hansen

KRIS A. HANSEN
DIRECTOR, AIR QUALITY DIVISION

James A. Guenthoer

JAMES A. GUENTHOER
PROJECT ENGINEER

AM TEST, INC.
REDMOND, WASHINGTON

We certify that the information contained herein is accurate and complete to the best of our knowledge.

TABLE OF CONTENTS

INTRODUCTION

The purpose of this source emission evaluation conducted at Bio-Waste Management Corporation's facility in Klamath Falls, Oregon was to quantify the total particulate matter and hydrochloric acid emissions at the exhaust of an Emcotek Corporation Rotary Atomizing™ scrubber which controls the emissions from a newly installed Consumat biomedical waste incinerator and afterburner. The incinerator was burning an average of 964 pounds per hour (lb/hr) of biomedical waste on the test days. Three (3) particulate emission concentration tests were performed at the scrubber outlet by the Air Quality Division of Am Test, Inc. on June 16-17, 1989. State of Oregon Department of Environmental Quality (ODEQ) sampling methods were performed using procedures specified in the August 1981 Source Sampling Manual, Volume 1, Methods 1-5. Methods 1 and 2 were performed to determine the stack gas velocity and volumetric flow rate. Method 3 was performed to determine the molecular weight of the stack gas. Method 4 was performed to determine the moisture content of the stack gas. Method 5 was performed to determine the particulate matter emission concentration of the stack gas. The ODEQ requires that the condensable particulate matter present in the gas stream be quantified by performing an extraction of the backhalf portion of the Method 5 sample train. An aliquot of the condenser section from each Method 5 sample was also analyzed for chlorides to quantify the hydrochloric acid emissions.

Mr. James A. Guenthoer and Ms. Jan M. Widmeyer of Am Test, Inc.'s Air Quality Division based in Redmond, Washington performed the field sampling. Mr. Kris A. Hansen, Ms. Angela F. Blaisdell and Ms. Jan M. Widmeyer of Am Test, Inc. performed the laboratory analysis, data reduction, and report preparation. Am Test, Inc.'s Water Chemistry Division performed the chloride analyses. Mr. Edwin

S. Mundy III of Bio-Waste Management Corporation coordinated this project. Mr. Hank L. Marshall represented Emcotek Corporation on the test days. Mr. K. Steven Mackey of the ODEQ observed the field testing and process operations on June 16, 1989. Mr. Mackey provided Am Test, Inc.'s Water Chemistry Division with two (2) audit samples for chlorides.

SUMMARY OF RESULTS

The results of the three (3) Method 5 tests for determining total particulate matter emission concentration, collected at the scrubber outlet stack on June 16-17, 1989 are summarized on page 4 in a printout titled "Methods 1-5 - Summary of Results" and in Table 1 below:

Table 1. Summary of particulate matter emission concentration test results collected June 16-17, 1989 at Bio-Waste Management Corp. in Klamath Falls, Oregon.

Sample Run #	Am Test Lab #	Particulate Matter Emission Conc. gr/dscf	P.M. Emission Conc. @ 12% CO_2 gr/dscf	P.M. Mass Emission Rate lb/hr	Gaseous Chloride Emission Rate lb/hr
1	910025	0.046	0.056	0.46	0.01
2	910026	0.037	0.041	0.58	0.01
3	910027	0.031	0.038	0.47	0.01
Average		0.038	0.045	0.50	0.01

The total particulate matter emission concentration (includes front and backhalf) is presented in units of grains per dry standard cubic foot (gr/dscf). The particulate matter mass emission rate is presented in units of pounds per hour (lb/hr). The gaseous chloride mass emission rate is presented in units of lb/hr. An acceptable leak check of less than 0.02 cfm at the highest vacuum rate (or greater) used during the test preceded and followed each run. The percentage isokinetics were within the acceptable limits of 100 $\pm$ 10% for each run. Computer printouts which detail the complete results for each run are included in Appendix A of this report on pages 18-20.

METHODS 1-5 - SUMMARY OF RESULTS
AM TEST, INC. - AIR QUALITY DIVISION

FILE NAME:	BWMSUM
CLIENT:	BIOWASTE MANAGEMENT
LOCATION:	KLAMATH FALLS, OR
SAMPLE SITE:	SCRUBBER OUTLET
OPERATORS:	GUENTHOER/WIDMEYER
CONTACT:	E. MUNDY

	RUN #1	RUN #2	RUN #3	AVERAGE
LAB #:	910025	910026	910027	
DATE:	6/16/89	6/17/89	6/17/89	
START TIME:	13:05	08:37	10:55	
STOP TIME:	14:08	09:39	12:00	
SAMPLE TIME (Minutes):	60.0	60.0	60.0	
VOLUME SAMPLED (Cubic Feet):	44.868	66.336	47.045	52.750
VOLUME SAMPLED (Dry Std. Cubic Feet):	38.369	54.650	40.037	44.352
STACK GAS MOISTURE (Percent):	46.01	44.94	47.33	46.09
BAROMETRIC PRESURE (Inches of Hg):	26.06	26.06	26.06	26.06
STATIC PRESSURE (Inches of H2O):	0.01	0.01	0.01	0.01
STACK PRESSURE (Inches of Hg):	26.06	26.06	26.06	26.06
STACK TEMPERATURE (Degrees F.):	168.5	168.3	169.7	168.8
STACK TEMPERATURE (Degrees R.):	628.5	628.3	629.7	628.8
CARBON DIOXIDE (Percent):	9.8	10.9	10.0	10.2
OXYGEN (Percent):	8.3	6.9	8.1	7.8
CARBON MONOXIDE (ppm):	606	268	58	311
MOLECULAR WEIGHT (Dry, Lb/Lb-Mole):	29.90	30.02	29.92	29.95
MOLECULAR WEIGHT (Wet, Lb/Lb-Mole):	24.42	24.62	24.28	24.44
AVERAGE VELOCITY HEAD (Inches of H2O):	0.064	0.151	0.147	0.121
PITOT TUBE Cp:	0.82	0.82	0.82	
VELOCITY (Feet/Second):	17.60	26.92	26.80	23.77
STACK DIAMETER (Inches):	22.75	22.75	22.75	
STACK AREA (Square Feet):	2.823	2.823	2.823	
AIRFLOW (Dry Std. Cubic Feet per Min.):	1177.5	1837.7	1746.1	1587.1
AIRFLOW (Actual Cubic Feet per Min.):	2980.9	4559.7	4539.5	4026.7
NOZZLE DIAMETER (Inches):	0.506	0.506	0.433	
ISOKINETICS (Percent):	110	100	106	105
PARTIC. EMISS. CONC. (FRONTHALF-gr/dscf)	0.045	0.035	0.030	0.037
PARTIC. EMISS. CONC. (BACKHALF-gr/dscf):	0.001	0.002	0.001	0.001
PARTIC. EMISS. CONC. (TOTAL-gr/dscf):	0.046	0.037	0.031	0.038
PARTIC. EMISS. CONC. (TOTAL-mg/dscm):	104.7	84.4	71.5	86.9
PARTIC. EMISS. CONC. @ 12% CO2 (gr/dscf)	0.056	0.041	0.038	0.045
MASS EMISSION RATE (Lb/Hr):	0.46	0.58	0.47	0.50
CHLORIDE CONCENTRATION (mg/dscm):	2.83	1.57	2.02	2.14
TOTAL CHLORIDE AS HCL IN SAMPLE (ppm):	1.87	1.03	1.33	1.41
CHLORIDE EMISSION RATE (LBS/HR):	0.01	0.01	0.01	0.01

SOURCE OPERATION

The Consumat Systems, Inc. Model USR/DISC 2000A controlled-air incinerator (equivalent to Consumat C-550P/INF) installed at Bio-Waste Management Corporation's Klamath Falls, Oregon facility is used to reduce biomedical waste. The waste contains laboratory wastes, human materials, contaminated equipment, sharps containers, dialysis waste materials, and miscellaneous contaminated material. The waste is transported to the facility by truck and unloaded at the loading dock. The waste is contained in lined cardboard boxes which are unloaded to a storage area until they are manually fed to the incinerator loading hoppers which hydraulically move the waste into the lower burning chamber.

According to Biowaste and Emcotek personnel, the incinerator burned an average of 964 pounds per hour (lb/hr) of biomedical waste on June 16-17, 1989. During run 1 conducted on June 16, 1989 an average of 1000 lb/hr of waste was processed. During run 1 the primary outlet temperature averaged 1583° F, and the ~~primary~~ secondary inlet outlet temperature averaged 2011° F. During run 2 conducted on June 17, 1989 an average of 981 lb/hr of waste was processed. During run 2 the primary outlet temperature averaged 1378° F, and the ~~primary~~ secondary outlet ~~inlet~~ temperature averaged 1868° F. During run 3 conducted on June 17, 1989 an average of 910 lb/hr of waste was processed. During run 3 the primary outlet temperature averaged 1464° F, and the ~~primary~~ secondary outlet ~~inlet~~ temperature averaged 1852° F.

The exhaust gases from the incinerator and afterburner are ducted to an Emcotek Corporation Rotary Atomizing™ scrubber to clean the gases before they are vented to the atmosphere. The Method 1-5 and chloride samples were collected at the outlet of the scrubber. The quench tank circulation pump pressure averaged 27

psi during run 1, 28 psi during run 2, and 47 during run 3 (2 pumps). Copies of process information collected by Bio-Waste Management and Emcotek personnel are included in Appendix B of this report.

DISCUSSION

Methodology References

Sampling and analysis procedures specified in the State of Oregon Department of Environmental Quality (ODEQ) sampling methods were performed using procedures specified in the August 1981 Source Sampling Manual, Volume 1, Methods 1-5. These procedures are similar to sampling procedures specified in the July 1, 1988 Title 40 Code of Federal Regulations, Part 60 (40 CFR 60), Appendix A, Methods 1-5. Methodology suggested in the Environmental Protection Agency's (EPA's) Air Pollution Training Institute "Course 450 - Source Sampling for Particulate Pollutants" and quality assurance procedures outlined in the EPA's reference manual titled Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 3, EPA-600/4-77-027b, along with current updates, were used for supplemental information with respect to quality assurance and testing protocol. The laboratory analysis method used for gaseous chloride determination is EPA Method 9252 from SW-846.

SAMPLING PROCEDURES

The 22.75 inch circular stack has two (2) sampling ports located at 90 degrees. The sample ports were located 20 feet and 4 inches upstream and 26 inches downstream from the nearest flow disturbance. Two (2) traverses of twelve (12) points each were selected according to Method 1 criteria. Figure 1 located in Appendix C of this report is a schematic of the stack and the point locations selected. Each point was sampled for 2.5 minutes for a total sampling time of 60 minutes per run. The sample probe was marked with felt pen and heat resistant tape to indicate the proper point location.

Stack condition measurements were made prior to collecting a sample, including measurements of velocity, temperature and a check for cyclonic flow in the stack. A sample nozzle was chosen and isokinetic operating parameters were established utilizing a Hewlett-Packard 41CX programmable calculator. The sampling nozzle, probe and prefilter connective glassware were all cleaned and rinsed prior to use. The sample train was assembled and determined to be leak free following the procedures outlined in Method 5. Before each test, a final check was made to assure that the plant was operating at the desired production rate and the desired operating parameters. A final check was made of the sample box and probe heat temperatures. Crushed ice was added to the condenser section. The sample nozzle was positioned in the stack at the first sample point. The sample pump was then turned on and the gas sampling rate was adjusted for isokinetic sampling. Sampling proceeded at each of the 12 traverse points. The pump was then turned off and the sample train was moved to the second port. Care was taken to assure that the nozzle tip did not touch the port nipple. The nozzle was then positioned at the first point of the second traverse, the pump was again turned on and isokinetic sampling was performed at the 12 traverse points. Upon completion of

the test, the sample probe was removed from the stack and a post-test leak check was performed according to Method 5 procedures.

An Infrared Industries Model 2200 oxygen (O_2) analyzer was utilized to measure the percent oxygen at each sample point during the test. Integrated samples of the combustion gas were also collected in multilayer bags during each run for analysis in Am Test's laboratory. An Infrared Industries non-dispersive infrared (NDIR) analyzer (Model 702D) was utilized to measure the percent carbon dioxide (CO_2). An Infrared Industries Model 2200 oxygen (O_2) analyzer was utilized to measure the percent oxygen. An Automated Custom Systems (ACS) Model 3300 non-dispersive infrared analyzer was used to measure the parts per million (ppm) carbon monoxide (CO). These analyzers meet 40 CFR 60, Appendix B, Performance Specification 3 and 4 criteria. Appropriate calibration gases were utilized to check the calibration of the automatic analyzers. The measurements during each test period were used to calculate the molecular weight of the stack gas and to correct the emissions for dilution air at 12% carbon dioxide.

SAMPLE TRAIN

The sample train used was an EPA Method 5 design with modifications as shown in Figure 2, which is located in Appendix C of this report. The stainless steel button hook nozzles used for these tests were measured on-site with inside calipers. A stainless steel probe sheath with a heated quartz liner was used to draw the sample from the stack. The probe was equipped with "S" type pitot tubes and a thermocouple sensor. The thermocouple sensor was connected to a digital Fluke thermocouple indicator which was used to measure the stack gas temperature at each sample point. The Fluke thermocouple indicator has been recently re-certified by the manufacturer to be accurate within ±1 degree Fahrenheit. A field check with 32 degree icewater was performed. A glass filter assembly containing a 125 millimeter Whatman 934-AH glass fiber filter was enclosed in a temperature-controlled heated sample box. The average box temperature was maintained at 248° F ± 25° F. The nozzle, probe liner, prefilter connective glassware and filter is often referred to as the "fronthalf" of the sample train. Following the filter is a condenser section which, by convention, is referred to as the "backhalf". The condenser section consisted of a modified Greenburg-Smith bubbler containing 100 milliliters (ml) of deionized, distilled water, an impinger also containing 100 ml of deionized, distilled water, an empty bubbler, and a bubbler containing indicating silica gel desiccant. The backhalf was maintained at a temperature below 68° F by adding ice to the condenser section. The sample train was connected to a control box by means of an umbilical cord which contains a vacuum hose, pitot lines, thermocouple wires and a 4-wire electrical cord. The control box (meter box) was used to monitor stack conditions and to facilitate isokinetic sampling. The control box consists of a diaphragm pump which is used to pull the stack gas through the sample train, fine and coarse metering valves to control the sampling rate, a vacuum gauge which measures the pressure drop from the sampling nozzle to the

metering valves, and a dry gas meter. The dry gas meter was calibrated on February 23, 1989 using a spirometer at the Washington State Department of Ecology laboratory in Redmond, Washington and has a Y factor of 0.993. At the outlet of the dry gas meter is a calibrated orifice which is used to isokinetically control the flow of gas through the metering system. The pressure drop across the orifice was monitored with both low and high range magnehelic gauges. The pitot tubes utilized to measure stack gas velocity are connected to the control box via the umbilical cord. The control box contains low and high range magnehelic gauges which are used for the velocity measurement.

SAMPLE CLEAN-UP AND ANALYSIS

Following sample collection, the Method 5 sample box was transferred to a room free from air disturbances and airborne particulate matter. The filter was transferred to a glass petri dish labeled with the sample date, client name and run number. This filter portion of the particulate catch is referred to as the "A" section. Care was taken to assure that any loose particulate matter and filter mat were quantitatively transferred to the petri dish. The filters were transferred to a LABCONCO Auto-Dry constant humidity desiccator containing silicon dioxide (SiO_2) for at least 24 hours of desiccation prior to obtaining weights. The same weighing procedures were followed to obtain the tare weights for the filters. The tare and final weights were made using a Mettler AE163 electronic balance set to a time integrating mode with a readability of 0.1 milligrams. The filters containing particulate matter were weighed to a constant weight of $\pm$0.5 milligrams. The interval between weighings was at least 6 hours. These weights were recorded in a bound laboratory notebook.

The contents of the nozzle, probe liner and prefilter connective glassware were quantitatively transferred to the "B" section storage container labeled with sample date, client name, and run number following each run. Several rinses of acetone, with simultaneous loosening of particulate matter using a clean nylon brush, were used for the fronthalf clean-up. An iodine flask with a female ball joint end was attached to the male ball joint end of the probe to assure that no particulate matter was lost during the rinsing and brushing of the probe. The contents of the iodine flask were quantitatively transferred to the "B" section storage container. The contents of this "B" section acetone rinse were transferred to a tared, graduated 150 milliliter beaker. The volume of acetone was recorded and the beakers were placed in an evaporation chamber. A tared beaker with 100

milliliters of acetone was handled in an identical fashion to the "B" section samples as a control. The tare and final weights of the beakers were obtained following at least 24 hours of desiccation. The sa[illegible]es and acetone blanks were weighed to a [illegible]nt weight of ±0.5 milligrams [illegible] greater intervals.

[illegible]ubblers and i[illegible] condenser section, or "backhalf" of the [illegible]mple train were weighed with [illegible]ability of 0.1 grams before and after sampling on a Mettler PE3000 elec[illegible]nic top loading balance. The difference between the initial and final weights of the condenser section constitute the amount of moisture gain during the run. The contents of the bubblers and impingers were then transferred to a 1000 ml graduated cylinder. The bubblers and impingers were rinsed with deionized, distilled water into the graduated cylinder and the liquid level was recorded. A 50 ml aliquot of the solution was transferred to a labeled sample bottle for submittal to the Am Test laboratory for chloride analysis. This liquid was then transferred to a separatory funnel and the contents were extracted with three (3) 50 ml portions of dichloromethane (CH_2Cl_2). The organic layer was transferred to a tared 150 ml beaker labeled the "Cx" section and this beaker's contents were allowed to evaporate at laboratory temperature and pressure until dry. The water layer was transferred to a tared 150 ml beaker labeled the "C" section and this beaker's contents were heated to 103° C until dry. The bubblers and impingers were given a final rinse with acetone into another tared, graduated beaker ("D" section) and it's contents were allowed to evaporate at laboratory temperature and pressure until dry. Sample blanks containing deionized, distilled water, dichloromethane, and acetone were analyzed in an identical fashion as the representative "section". All beakers were desiccated for at least 24 hours and weighed to constant weights of ±0.5 milligrams after their contents had evaporated. The total particulate matter weight is the sum of the net

weights of the particulate matter found on the filter, plus the net weights found in the B, C, Cx and D section beakers, minus the acetone, water, and dichloromethane blank concentrations. The particulate weights are included on the "Method 1-5 - Particulate Emission Concentration Results" computer printouts which immediately follow the "Calculation of Results" section of this report.

QUALITY ASSURANCE

A strict quality assurance program was followed throughout preparation, sampling, analysis, and report preparation. This program includes recent equipment calibrations, proper maintenance of equipment, careful chain-of-custody procedures, the use of ACS quality or better reagents, analysis of control samples, and "by-hand" calculation checks of computerized results.

The sample nozzles used for these tests were calibrated on-site before sampling using inside calipers readable to 0.001 inches. The dry gas meter used for measuring sample volume was calibrated on February 23, 1989 using a spirometer at the Washington State Department of Ecology (DOE) laboratory in Redmond, Washington. The "S" type pitot tubes used for velocity measurement have been recently calibrated at the DOE laboratory utilizing a wind tunnel and a standard "P" type pitot tube and are inspected regularly for proper alignment. The Fluke thermocouple indicator used has been recently re-certified by the manufacturer to have an accuracy of ±1 degree Fahrenheit. Each thermocouple probe used to monitor temperature is checked each quarter at 3 different temperature settings.

In addition to quantitative clean-up and analysis procedures, acetone, distilled, deionized water, dichloromethane, and filter blanks were carried throughout the analysis procedures. All gravimetric samples were weighed to constant weights of ±0.5 milligrams following desiccation in a LABCONCO "Autodry Cabinet" desiccator. This desiccator is an electronic dehumidifier which automatically maintains the humidity inside the desiccator. An Airguide humidity indicator accurate to ±1% is used to check the humidity inside the desiccator when obtaining tare and final weights. The dehumidifier automatically recharges the internal

desiccant every 5.5 hours. The Mettler AE163 electronic balance used to obtain weights was set to a time integrating mode (100,000 readings per minute) with a readability of 0.1 milligrams. The balance was calibrated prior to every use. The calibration Am Test's Mettler balances is checked by the manufacturer on a yearly basis. The Oregon Department of Environmental Quality (ODEQ) provided two (2) laboratory quality assurance audit samples for chloride analysis. The results of Am Test's acceptable performance of this audit are presented in Appendix A along with the original laboratory data for chlorides. Additional information with respect to the Am Test, Inc. laboratory quality assurance and quality control protocol is included in Appendix C of this report.

CALCULATION OF RESULTS

The Method 1-5 test results were calculated in accordance with Oregon Department of Environmental Quality (ODEQ) Method 1-5 and EPA 40 CFR 60 Method 1-5 criteria. Copies of applicable EPA Method 1-5 equations are included in Appendix C of this report. Final results calculations were performed using spreadsheet programs run on a Hewlett-Packard Vectra computer system. A "by-hand" sample calculation was completed for run #2 using a Hewlett-Packard 11C calculator, and may be found in Appendix C of this report.

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SOURCE
EMISSION
EVALUATION

For Tables 4, 4A, and 6.
AWMA Paper - November 1989.

AUGUST 18, 1989

Prepared For:

EMCOTEK CORPORATION
ROTARY ATOMIZING SCRUBBER @
BIO-WASTE MANAGEMENT CORPORATION
CONSUMAT WASTE INCINERATOR
KLAMATH FALLS, OREGON
JUNE 16-17, 1989

Submitted by:

KRIS A. HANSEN
DIRECTOR, AIR QUALITY DIVISION

James A. Guenthoer

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AM TEST, INC.
REDMOND, WASHINGTON

We certify that the information contained herein is accurate and complete to the best of our knowledge.

TABLE OF CONTENTS

INTRODUCTION

The purpose of this source emission evaluation conducted at Bio-Waste Management Corporation's facility in Klamath Falls, Oregon was to quantify the total particulate matter and hydrochloric acid emissions simultaneously at the inlet and outlet of an Emcotek Corporation Rotary Atomizing™ scrubber which controls the emissions from a Consumat biomedical waste incinerator and afterburner. On June 16-17, 1989 Bio-Waste Management was conducting three (3) outlet tests for determining compliance with the State of Oregon Department Environmental Quality (ODEQ) standards. Emcotek Corporation contracted Am Test, Inc.'s Air Quality Division to conduct five (5) inlet samples and an additional two (2) outlet samples in conjunction with the tests being contracted by Bio-Waste Management.

State of Oregon Department of Environmental Quality (ODEQ) sampling methods were performed using procedures specified in the August 1981 Source Sampling Manual, Volume 1, Methods 1-5. Methods 1 and 2 were performed to determine the stack gas velocity and volumetric flow rate. Method 3 was performed to determine the molecular weight of the stack gas. Method 4 was performed to determine the moisture content of the stack gas. Method 5 was performed to determine the particulate matter emission concentration of the stack gas. The ODEQ requires that the condensable particulate matter present in the gas stream be quantified by performing an extraction of the backhalf portion of the Method 5 sample train. An aliquot of the condenser section from each Method 5 sample was also analyzed for chlorides to quantify the hydrochloric acid emissions. The fronthalf filters from the five (5) outlet samples were analyzed to determine the amount of insoluble matter on the filters.

Mr. James A. Guenthoer and Ms. Jan M. Widmeyer of Am Test, Inc.'s Air Quality Division based in Redmond, Washington performed the field sampling. Mr. Kris A. Hansen, Ms. Angela F. Blaisdell and Ms. Jan M. Widmeyer of Am Test, Inc. performed the laboratory analysis, data reduction, and report preparation. Am Test, Inc.'s Water Chemistry Division performed the chloride and soluble/insoluble analyses. Mr. Hank L. Marshall coordinated this project for Emcotek Corporation. Mr. Edwin S. Mundy III represented Bio-Waste Management Corporation. Mr. K. Steven Mackey of the ODEQ observed the field testing and process operations on June 16, 1989. Mr. Mackey provided Am Test, Inc.'s Water Chemistry Division with two (2) audit samples for chlorides.

SOURCE OPERATION

The Consumat Systems, Inc. Model USR/DISC 2000A controlled-air incinerator (equivalent to Consumat C-550P/INF) installed at Bio-Waste Management Corporation's Klamath Falls, Oregon facility is used to reduce biomedical waste. The waste contains laboratory wastes, human materials, contaminated equipment, sharps containers, dialysis waste materials, and miscellaneous contaminated material. The waste is transported to the facility by truck and unloaded at the loading dock. The waste is contained in lined cardboard boxes which are unloaded to a storage area until they are manually fed to the incinerator loading hoppers which hydraulically move the waste into the lower burning chamber.

According to Biowaste and Emcotek personnel, the incinerator burned an average of 964 pounds per hour (lb/hr) of biomedical waste on June 16-17, 1989. During run 1 conducted on June 16, 1989 an average of 1000 lb/hr of waste was processed. During run 1 the primary outlet temperature averaged 1583° F, and the secondary outlet temperature averaged 2011° F. During run 2 conducted on June 17, 1989 an average of 981 lb/hr of waste was processed. During run 2 the primary outlet temperature averaged 1378° F, and the secondary outlet temperature averaged 1868° F. During run 3 conducted on June 17, 1989 an average of 910 lb/hr of waste was processed. During run 3 the primary outlet temperature averaged 1464° F, and the secondary outlet temperature averaged 1852° F. During run 4 conducted on June 17, 1989 an average of 852 lb/hr of waste was processed. During run 4 the primary outlet temperature averaged 1379° F, and the secondary outlet temperature averaged 1845° F. During run 5 conducted on June 17, 1989 an average of 841.2 lb/hr of waste was processed. During run 5 the primary outlet temperature averaged 1074° F, and the secondary outlet temperature averaged 1898° F.

The exhaust gases from the incinerator and afterburner are ducted to an Emcotek Corporation Rotary Atomizing™ scrubber to clean the gases before they are vented to the atmosphere. The Method 1-5 and chloride samples were collected at the inlet and outlet of the scrubber. The quench tank circulation pump pressure averaged 27 psi during run 1, 28 psi during run 2, 47 during run 3 (2 pumps), 47 during run 4 (2 pumps) and 47 during run 5 (2 pumps). Copies of process information collected by Bio-Waste Management and Emcotek personnel are included in Appendix B of this report.

SUMMARY OF RESULTS

SCRUBBER INLET SAMPLES

The results of the five (5) Method 5 tests for determining total particulate matter emission concentration, collected at the scrubber inlet on June 16-17, 1989 are summarized in Table 1 below:

Table 1. Summary of particulate matter emission concentration test results collected June 16-17, 1989 at the Emcotek scrubber inlet at Bio-Waste Management's incinerator in Klamath Falls, Oregon.

SAMPLE RUN #	AM TEST LAB #	PARTICULATE MATTER EMISSION CONC. gr/dscf	P.M. EMISSION CONC. @ 12% CO_2 gr/dscf	P.M. MASS EMISSION RATE lb/hr	GASEOUS CHLORIDE EMISSION RATE lb/hr
1	910020	0.569	0.697	5.42	8.6
2	910021	0.196	0.216	2.22	11.3
3	910022	0.186	0.224	2.00	10.3
4	910023	0.125	0.162	1.67	14.3
5	910024	0.243	0.301	2.61	13.3
AVERAGE		0.258	0.320	2.78	11.6

The total particulate matter emission concentration (includes front and backhalf) is presented in units of grains per dry standard cubic foot (gr/dscf). The particulate matter mass emission rate is presented in units of pounds per hour (lb/hr). The gaseous chloride mass emission rate is presented in units of lb/hr. An acceptable leak check of less than 0.02 cfm at the highest vacuum rate (or greater) used during the test preceded and followed each run. The percentage isokinetics were within the acceptable limits of 100 $\pm$ 10% for each run. Computer printouts which detail the complete results for each run are included in Appendix A of this report on pages 21-25.

SCRUBBER OUTLET SAMPLES

The results of the five (5) Method 5 tests for determining total particulate matter emission concentration, collected at the scrubber outlet on June 16-17, 1989 are summarized in Table 2 below:

Table 2. Summary of particulate matter emission concentration test results collected June 16-17, 1989 at the Emcotek scrubber outlet at Bio-Waste Management's incinerator in Klamath Falls, Oregon.

SAMPLE RUN #	AM TEST LAB #	PARTICULATE MATTER EMISSION CONC. gr/dscf	P.M. EMISSION CONC. @ 12% CO_2 gr/dscf	P.M. MASS EMISSION RATE lb/hr	GASEOUS CHLORIDE EMISSION RATE lb/hr
1	910025	0.046	0.056	0.46	0.01
2	910026	0.037	0.041	0.58	0.01
3	910027	0.031	0.038	0.47	0.01
4	910028	0.026	0.034	0.35	0.01
5	910029	0.026	0.032	0.34	0.01
AVERAGE		0.033	0.040	0.44	0.01

The total particulate matter emission concentration (includes front and backhalf) is presented in units of grains per dry standard cubic foot (gr/dscf). The particulate matter mass emission rate is presented in units of pounds per hour (lb/hr). The gaseous chloride mass emission rate is presented in units of lb/hr. An acceptable leak check of less than 0.02 cfm at the highest vacuum rate (or greater) used during the test preceded and followed each run. The percentage isokinetics were within the acceptable limits of 100 $\pm$ 10% for each run. Computer printouts which detail the complete results for each run are included in Appendix A of this report on pages 26-30.

Particulate Matter Removal Efficiency

The overall total particulate matter removal efficiency based on simultaneous Method 5 testing at the inlet and outlet was 82%. The removal efficiency from each individual run is presented in Table 3 below:

Table 3. Particulate matter removal efficiency of Emcotek Corporation Rotary Atomizing Scrubber installed at Bio-Waste Management in Klamath Falls, Oregon.

Run #	Inlet Mass Emission Rate lb/hr	Outlet Mass Emission Rate lb/hr	Particulate Matter Removal Effic. %
1	5.42	0.46	92
2	2.22	0.58	74
3	2.00	0.47	77
4	1.67	0.35	79
5	2.61	0.34	87
Average	2.78	0.44	82

The particulate matter removal efficiency was calculated based on the mass emission rate of particulate matter in units of pounds per hour (lb/hr).

Gaseous Chloride Removal Efficiency

The overall gaseous chloride (as hydrochloric acid) removal efficiency based on simultaneous Method 5 testing at the inlet and outlet was 99.9%. The removal efficiency from each individual run is presented in Table 4 below:

Table 4. Gaseous chloride removal efficiency of Emcotek Corporation Rotary Atomizing Scrubber installed at Bio-Waste Management in Klamath Falls, Oregon.

Run #	Inlet Chloride Emission Rate lb/hr	Outlet Chloride Emission Rate lb/hr	Chloride Removal Effic. %
1	8.6	0.01	99.9
2	11.3	0.01	99.9
3	10.3	0.01	99.9
4	14.3	0.01	99.9
5	13.3	0.01	99.9
Average	11.6	0.01	99.9

The chloride removal efficiency was calculated based on the mass emission rate of chloride in units of pounds per hour (lb/hr).

Soluble/Insoluble Analysis Results

The fronthalf filters from the five (5) scrubber outlet samples were analyzed to determine the amount of insoluble matter on the filters. This analysis was performed to determine what percentage of the particulate matter exiting the incinerator is not soluble in water, and therefore, would not be removed by the scrubber. The results from the analysis are presented in Table 5 below:

Table 5. Summary of soluble/insoluble analysis results from fronthalf filters used at the Emcotek Rotary Atomizing scrubber outlet at Bio-Waste Management.

Run #	Percent Insoluble
1	30
2	4
3	11
4	6
5	0
Average	10

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AWMA SPECIALTY CONFERENCE-THERMAL TREATMENT OF MUNICIPAL, INDUSTRIAL AND HOSPITAL WASTE II
PITTSBURGH, PA.
&
PACIFIC NORTHWEST INTERNATIONAL SECTION ANNUAL MEETING - SPOKANE, WA.

NOVEMBER 1989

ABSTRACT

Design of a new, privately-owned 1000 lb/hr. off-site medical waste incinerator began early in 1988. Contracts for air and water pollution controls were let to **EMCOTEK** Corp. in December 1988, and the plant was installed in spring 1989. The plant is located in a rural area, subject to Oregon's zero wastewater discharge rule, as well as compliance with the Oregon DEQ Air Permit requirements. All results of compliance tests were approved, and the unit began commercial operation in July 1989.

EMCOTEK utilized its experience with another medical waste incinerator, to include its latest innovations in the **ROTARY ATOMIZING™** Scrubber used for air pollution control. This scrubber can attain 99.9% reduction of HCl emissions from the incinerator, and can attain particulate emissions below 0.015 grain/dscf at 7% 02, at a pressure drop of less than 4 inches of water. In Oregon, wastewater is internally concentrated and treated, to separate it into a non-hazardous salt brine and a non-leachable, cohesive filter cake. The wastewater treatment process can be used with neutralized liquid wastes from most air scrubbers .

INTRODUCTION

The concept of a new, off-site bio-medical waste incineration plant inspired a group of investors to begin planning in 1987, for a venture that would be profitable as well as demonstrate good environmental practices. The plant would accept bio-medical wastes, under contract, from sources in the Pacific Northwest. It would be located in southern Oregon, in an accessible but non-urban area.

An option was obtained on a plot of land with industrial zoning, located in an otherwise rural area south of Klamath Falls, Oregon. The site is located a short distance from a major highway. Application was made to the Oregon Department of Environmental Quality (DEQ) for both a Solid Waste Disposal Permit and an Air Discharge Permit. An understanding was reached between the owners and the DEQ that all regulations would be met, and where possible, operating standards would go beyond mere compliance. Oregon's philosophy of zero-discharge of wastewater from new facilities, to lakes and streams, led to a decision not to apply for a Water Discharge Permit.

PERMITTING AND STANDARDS

As expected, the proposal for the plant drew both local opposition -- because of the unusual nature of the industry in this area; and support -- because it would provide badly-needed diversity of employment, in a region of high unemployment. A hearing was called by DEQ in August, 1988, for the expression of residents' views. Meanwhile, the permit applications were revised to include changes requested by both the owners, and by DEQ officials.

As finally issued (November 1988) the major features of the Waste Permit were: Only bio-medical wastes may be accepted, but not if radioactive, or classified as hazardous at the point of origin. All wastes shall be transported and stored in sealed containers, and held no longer than 96 hours unless refrigerated. Contaminated washdown water and process waste water shall not be discharged to public waters of the State of Oregon. All ash solids shall be routinely tested for EP Toxicity (US EPA SW-846) and landfilled as hazardous or in a monofill, unless toxics are one order of magnitude below EP Tox limits. Then, such solids may be landfilled with municipal solid wastes. The permit contains, in all, 64 requirements to assure the plant will be properly managed, monitored, and eventually closed, in an acceptable manner.

Major features of the Air Permit, issued at the same time, were: During operation, the incinerator secondary chamber shall always be kept at 1800°F, minimum, with a minimum residence time of 1.0 second. Particulate emissions shall not exceed 0.07 gr/dscf of exhaust, corrected to 12% CO2, or 1.6 lb/hr. Hydrogen chloride emissions shall be reduced by 95% by the pollution control equipment, and not exceed 1.0 lb/hr. Opacity shall not exceed 20% (excluding water vapor), a qualified operator must always be present, and ash removal may occur only during daylight hours. Finally, a trial burn must take place on non-pathogenic waste before startup on medical waste. Testing for particulate and HCl must take place on the first day that bio-medical waste is burned. As with the Waste Permit, monitoring and reporting requirements for on-going operation are included.

Once the permits were granted, purchase of the land was completed, and contracts were let for buildings on the site. A single large steel building was put up for storage of boxed waste awaiting incineration, the incinerator, and its air and water pollution controls. Separate buildings were erected as the business office, and as a machine shop/lunch room.

MAJOR EQUIPMENT SELECTION

A standard controlled-air, two-chamber modular incinerator built by DISC International, of North Little Rock, Arkansas, was selected by the owners for this project. The unit is DISC Model A-2000 equipped with ram feed, electronic and hydraulic controls, and manual ash discharge. Design capacity is 1000 lb/hr bio-medical waste of 10,000 Btu/lb heating value, although this unit is capable of burning as high as 2000 lb/hr, of wastes of lower heating value.

Wet scrubbers were the first choice for air pollution control, because their low

operating temperature condenses dioxins, furans, and other condensible toxics (Figures 1 and 2), and because of their ability to more rapidly respond to changing HCl emissions than can dry scrubbers. The EMCOTEK ROTARY ATOMIZING™ scrubber was selected over other wet scrubbers based on its low pressure drop (under 4 inches W.C.), competitive price, ongoing experience in another medical-waste application, low-blowdown, and water treatment package. The EMCOTEK Model 230 chosen is shown in Figure 3. The Rotary Atomizer, which is the heart of this machine, is shown in Figure 4. A minimum of 7 hp/1000 acfm, is applied as scrubbing power, to a maximum of 8500 acfm exiting the scrubber at 170°F. The power is applied in a controlled manner to the liquid being atomized, rather than to raise gas pressure drop as in a venturi scrubber. The advantage of this more-efficient design is illustrated by Table 1.

To meet the Permit requirement that no wastewater be discharged to public waters, the scrubber flowsheet was configured to maximize water recycle, and to blow down a very concentrated salt brine. During combustion, HCl is released from plastics in the medical waste, in concentrations exceeding 1000 ppm in the raw incinerator exhaust. The scrubbing water is maintained at a pH of at least 7.5 by controlled addition of NaOH. The NaCl is the reaction product, formed in the scrubber in proportion to chlorine-bearing plastics burned. Other salts (KCl, $PbCl_4$, Na_2SO_3) are also present, as are uncombusted solid residues (soot) and fine particulate generated during combustion (fly ash). However, the mass rate of NaCl generation greatly exceeds that of all other substances dissolved or suspended in the scrubbing water.

A proprietary (patent pending) water treatment system was devised by EMCOTEK, to treat this blowdown stream in a manner that would convert it to a non-toxic filtrate and a non-hazardous, non-leachable cake, each of which could be disposed independently of the other and separately from the bottom ash, if desired.

ADVANCED DESIGN FEATURES

The concept of the water treatment system is shown in Figure 5. As the scrubber is operating, a conductivity controller constantly monitors the salt concentration at the point where it is highest. It automatically opens a valve to bleed off enough solution to keep the concentration at a pre-determined level. This bleed, or blow-down, is directed into a tank where it is held until a reasonably large batch has accumulated. The wastewater treatment is carried out batchwise, as operating manpower is available.

Meanwhile, fresh water is fed to the scrubber, and levels are maintained in the scrubber tanks by automatic control. Water and exhaust gas flows are counter-current, so that the cleanest gases, moving toward the fan, are scrubbed by the fresh water entering the system. This "tight-loop" water control is optimum when wastewater discharge volume must be kept to a minimum. When other criteria govern, a different pattern of water flow can be established. In every case, however, the fresh water fed to the system must equal water evaporated plus water expelled as liquid waste, or blowdown.

The scrubber fan must overcome the resistance of the scrubber, and always maintain the incinerator firebox at a slight but carefully maintained vacuum. This draft is critical to proper incinerator operation, so the incinerator draft gage is probably the most-used instrument on the control panels. At various stages of incinerator operation, one or more of five forced-air blowers may be in operation on the incinerator. To provide operator-friendly control of the draft, therefore, it was decided that the scrubber fan would have a variable-speed drive, adjustable by the operator from his control panel. This is both more convenient and more energy-efficient than a constant speed fan with a mechanical damper. (Provision can be made to tie in fan speed with draft, so no operator control is needed to hold constant draft. However, operator preference has been for remote manual speed control.)

All major elements of the EMCOTEK scrubber are removable for maintenance, including the Rotary Atomizers. These are designed, in fact, so that in a system with two or more atomizers, one may be

blanked-off or removed from service while the rest of the system continues to operate. Within an hour, a spare Atomizer can be substituted, and the system restored to its original feedrate and emissions control. This is possible because each Atomizer and its drive are mounted on a sliding frame. Quick-release compression seals couple the Atomizer to the scrubber ductwork at each end of the Atomizer module.

Quick-acting safety devices are essential to protect any pollution control device handling the 1800°F. or higher exhaust gases from an incinerator. The EMCOTEK scrubber is interlocked so that its fan must be pulling a draft, and its quench sprays must be operational, before the incinerator dump stack can be closed. All these steps are normally taken before lighting the incinerator. However, if an essential part of the scrubber should ever fail during steady operation, the incinerator dump (or emergency) stack will re-open, and will not close until the scrubber is restored to a safe condition. Also, a water deluge system will come on, if the scrubber quench reaches a temperature high enough to potentially damage down-stream components. Finally, the Rotary Atomizer will coast to a stop, if its pressurized oil lubrication system should lose pressure for any reason. This prevents damage due to loss of lubrication.

Corrosion is a potentially serious problem, when handling highly saline solution at temperatures normally 170°F and occasionally up to 180°F. All scrubber vessels are constructed of alloy AL6XN, a "super-stainless" containing 6% molybdenum, and much more chromium and nickel than 300-series alloys. Teflon, Titanium, or Hastelloy C-22 are used in critical locations. In addition, each scrubber circulation vessel is equipped with an independent pH-control system, to maintain the entire system at pH 7.5 or higher. Separate alarms are provided, should pH fall substantially below the control point, for example, due to failure of caustic soda supply.

A computer system monitors the status of the scrubber. It collects information through 16 digital and 13 analog inputs, compares it with programmed standards, and sounds a centralized alarm if operator action is required. It also prints a daily report, consisting of one line for each hour of normal operation, listing important pressure, temperature, draft, and pH data.

This serves as an official record of scrubber operation to satisfy Permit requirements. The major safety devices and controls, though linked to the computer, can and do operate independently of it. This allows the scrubber to continue to run safety, in the event of temporary computer problems. Automatic start-up and shut-down of the scrubber, through the computer, is also possible.

INSTALLATION

A new plant is an opportunity to optimize equipment layout. In this instance, the goals were cleanliness, accessibility, and efficiency. Layout and design were done in winter 1989. An insulated steel building 50 ft. wide, 125 ft. long, and 24 ft. high (at the eaves) had been selected by the owners. An area 50 ft. by 50 ft. at one end was chosen to house the incinerator, scrubber, and water treatment. The remaining space was for unloading and storing boxed bio-medical waste, and to blend and weigh it before feeding the incinerator.

EMCOTEK made the recommendation that the wet system of the scrubber be installed in a concrete-lined pit 5 ft. below the main operating floor. This included the circulating tanks and piping, and all pumps, integrated on a single skid. The main gas-handling elements of the scrubber were mounted on another, longer skid, parallel to and above the wet system, at the same level as the incinerator and control panels. This skid included the quench vessel, Rotary Atomizers, demisters, and fan. To catch drainage and equipment washdowns, two 500-gallon sumps were built, by making two covered sections of the pit 7 ft. rather than 5 ft. deep. From these, water could be pumped to re-use, or to brine processing. The pit also can facilitate the collection and handling of solid wastes (bottom ash and filter cake).

Equipment installation took place in the spring 1989. The EMCOTEK scrubber was installed by a four-man crew in two weeks, except for the computer and some instrumentation interfaces. The re-fractory-lined breeching, forming the

bridge between incinerator and scrubber, was installed last, along with the dump stack. These were handled by the incinerator contractor.

COMMISSIONING (Permit to Operate)

One requirement of the Air Discharge Permit issued by Oregon DEQ was a trial burn, for adjustment of the new incinerator. For this purpose only non-medical waste could be burned, so a mixture of corrugated board and plastic was chosen. This was required for a minimum of eight hours per day, for two days operation. During the second day, certain temperature conditions had to be met, resulting in a major effort by the incinerator contractors to get air flows and fuel mixtures into proper adjustment. The scrubber ran during both trial-burn days.

Immediately following this trial burn, medical waste could be fed for purposes of emissions testing for particulate and HCl. Since a DEQ witness and stack test crew had been scheduled, this testing was started at once. The following day, four additional emissions tests were performed, for a total of five, in all, on June 16-17, 1989.

This emissions testing was done by AmTest, Inc. of Redmond, WA. All air emissions tests passed all requirements of the Air Permit and Oregon DEQ, and are discussed in a later section of this paper.

The water treatment system was started up shortly thereafter, to process the waste brine generated by these tests. It was found to work as designed, to produce a non-hazardous salt brine and a non-leachable, cohesive filter cake. Analyses of the filtrate are shown in Table 2, and of the cake, in Table 3. The filtrate is hauled off weekly by a local ponding contractor, who blends it to neutralize an acidic wood-products waste. The blend is then used as a soil amendment, after partial drying.

OPERATION

Approval to operate the incinerator on bio-medical waste was secured by the owners in early July, 1989, and routine operations commenced. Feed rates have been 800 to 1000 lb/hr, 24 hr/day for several consecutive days, followed by a weekly shut-down for cleaning and maintenance. Operating routines and procedures have been established. Minor corrections and improvements to the equipment have been made, but no major changes have been needed. Recent yard and road improvements have been made, to insure access to the facility during the coming winter.

PERFORMANCE TEST RESULTS

Particulate Emissions

The design outlet particulate emission for the Klamath Falls incinerator and scrubber system was .07 gr/dscf @ 12% CO2, and as stated previously, demonstration of this emissions level had to be shown the first day of operation with medical waste. This level was easily met with the ROTARY ATOMIZING™ Scrubber at all times, even though during the first test the unscrubbed incinerator emissions were .70 gr/dscf @ 12% CO2. The results of the initial series of particulate tests, using an Oregon Method 5 sampling train, are shown in Table: 4. Particulate emissions were as low as .023 gr/dscf and condensible emissions were as low as .001 gr/dscf, the last tests having the lowest emissions.

EMCOTEK has pursued further studies of scrubber emissions, in anticipation of future installations in states requiring lower emissions than those in Oregon. The results of the additional performance tests are summarized in Table 5. The first series of tests was a repeat of the initial testing, to establish a set of baseline data. This data was taken approximately four months after start up. Results were similar to those obtained during the initial test period.

Two other series of tests were run, to evaluate two of several options for reducing emissions with the ROTARY ATOMIZING™ Scrubber. In the second series of tests the scrubber blowdown was increased from 1/2 gpm to 10 gpm, and in the third group the outlet temperature was 130°F. instead of 170°F., to simulate outlet temperatures for systems with heat recovery boilers. In the latter case, outlet emissions less than .015

gr/dscf @ 7% 02 were obtained. The options of increasing atomizer horsepower, or the use of additional atomizers, were not evaluated during these tests.

Gaseous Chloride Emission Control

The ROTARY ATOMIZING™ Scrubber collected gaseous chloride (as hydrochloric acid) at removal efficiencies of 99.9%, as shown in Table 6. Inlet HCl ranged from 1300 to 1900 ppm. Stack outlet HCl was 1 ppm in all tests, or an emission of 0.01 lb/hr. Approximately 11 lb/hr of inlet HCl was coverted to 19 lb/hr of NaCl. This salt throughput is significantly higher than the inlet particulate loading to the scrubber of 2 to 3 lb/hr. An analysis of the particulate filter catches from the Method 5 sampling trains has found that 90% of the catch is soluble, with a 47% percent chloride content.

Waste Water System

In addition to limiting air emissions, EMCOTEK equipment had to also control the composition and quantity of the waste water stream. Tables 2 and 3 report the concentration of toxic metals in the filtrate from the waste water treatment system, and from the leachate of the filter cake from the waste water treatment system. The filtrate extract contaminants were analyzed according to Title 22, Article II, California Administrative Code for hazardous waste determination, and the filter cake was analyzed in accordance with EPA's 24-hour extraction EP Toxicity Test, method SW-846.

In most localities, filtrate from this process would be clean enough to meet sewer requirements, as long as the NaCl concentration is not restricted. Recent laboratory work shows that by use of a different form of additive, mercury can be reduced to 0.01 mg/l and cadmium to 0.03 mg/l.

CONCLUSIONS

The Klamath Falls, Oregon installation has been successfully started up and operated. The system is meeting all design requirements. Further testing of variations in operating mode have demonstrated that the stringent emission requirements of other states can be met with proper design and operation of the ROTARY ATOMIZING™ Scrubber system. The priorietary (Patents Pending) waste water treatment system for the scrubber has been shown to produce non-toxic liquids and solids for disposal.

TABLE 1

COMPARISON OF WET SCRUBBER SYSTEM PRESSURE DROPS AND PARTICULATE COLLECTION POWER REQUIREMENTS

Particle Size, D50, microns	3.0	1.5	3.0	1.5
	System Pressure Drop, in WC		Particulate Collection Power Required hp/1000 ACFM	
Venturi Scrubber	21	68	5	20
Collision Scrubber™	17	38	4	12
ROTARY ATOMIZING™ Scrubber	4	4	3.5	8

The above requirements are for 92.5% removal of particulate matter, of median size (D50) shown.

TABLE 2

WASTEWATER FILTRATE

HAZARDOUS WASTE DETERMINATION

DISSOLVED CONSTITUENTS	SAMPLE mg/l	CRITERIA mg/l
ARSENIC	0.01	5.0
BARIUM	0.22	100.0
CADMIUM	<0.05	1.0
CHROMIUM	<0.05	560.0
COPPER	<0.05	25.0
LEAD	<0.25	5.0
MERCURY	0.10	0.2
NICKEL	<0.25	20.0
SELENIUM	0.06	1.0
SILVER	<0.05	5.0
THALLIUM	<0.5	7.0
ZINC	0.11	250.0
HEX CHROMIUM	<1.0	5.0

TABLE 3

WASTEWATER CAKE

EP TOXICITY TEST
24-HOUR EXTRACTION

CONSTITUENTS	SAMPLE mg/l	CRITERIA mg/l
ARSENIC	0.08	5.0
BARIUM	0.29	100.0
CADMIUM	0.08	1.0
CHROMIUM	<0.01	5.0
LEAD	1.33	5.0
MERCURY	<0.002	0.2
SELENIUM	0.02	1.0
SILVER	<0.01	5.0

TABLE 4

COMPLIANCE TESTING,
MEDICAL WASTE INCINERATOR WITH
ROTARY ATOMIZING™ SCRUBBER

KLAMATH FALLS, OR

BURN RATES, 840-1000 LB/hr

Scrubber Outlet Particulate Emission
Oregon Method 5; grains/dscf

Test No.	Front Half	Back Half	Total	Total, Adj. to 12% CO_2	Total lb/hr
1	0.045	0.001	0.046	0.056	0.46
2	0.035	0.002	0.037	0.041	0.58
3	0.030	0.001	0.031	0.038	0.47
4	0.025	0.001	0.026	0.034	0.35
5	0.023	0.003	0.026	0.032	0.34
Average				0.040	

EMISSION CONTROL TECHNOLOGY

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Addendum to Technical Paper, November, 1989:

TABLE 4 - A

COMPLIANCE TESTING, MEDICAL WASTE INCINERATOR WITH ROTARY ATOMIZING™ SCRUBBER

KLAMATH FALLS, OR BURN RATES 840-1000 Lb/Hr

Scrubber Inlet Particulate
Oregon Method 5; grains/dscf

Test No.	Front Half	Back Half	Total	Total, Adj. to 12% CO_2	Total lb/hr
1	0.497	0.072	0.569	0.697	5.42
2	0.182	0.014	0.196	0.216	2.22
3	0.178	0.008	0.186	0.224	2.00
4	0.119	0.005	0.125	0.162	1.67
5	0.238	0.006	0.243	0.301	2.61

TABLE 5

PERFORMANCE TESTING,

MEDICAL WASTE INCINERATOR

WITH

ROTARY ATOMIZING™ SCRUBBER

KLAMATH FALLS, OR — BURN RATE, 860 LB/hr

Scrubber Outlet Particulate Emission
Oregon Method 5: grains/dscf

Test Series	Front Half	Back Half	Total	Total, Adj. to 7% 02
0.5 gpm Blowdown	0.027	0.004	0.031	0.036 @ 170°F.
10 gpm Blowdown	0.017	0.001	0.018	0.023 @ 170°F.
8 gpm Blowdown	0.009	0.000	0.009	0.013 @ 130°F.

TABLE 6

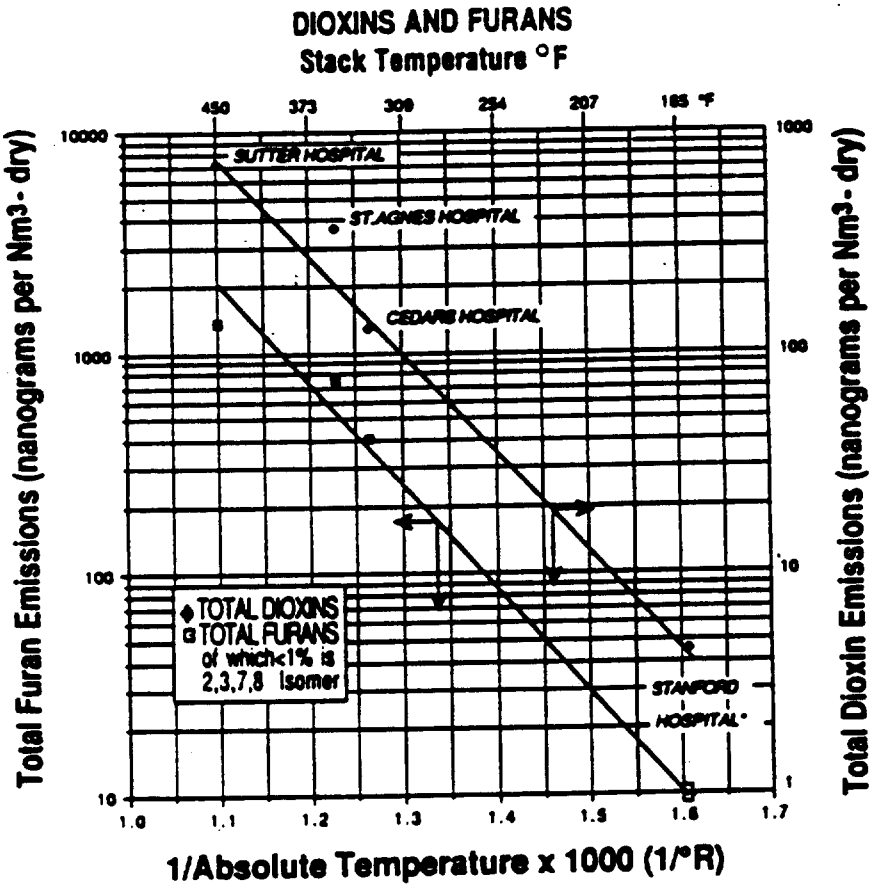
GASEOUS HCl CONTROL
MEDICAL WASTE INCINERATOR WITH
ROTARY ATOMIZING™ SCRUBBER

KLAMATH FALLS, OR — BURN RATES, 840-1000 LB/hr

OTest No.	Scrubber Inlet PPM	Scrubber Inlet LB/HR	Scrubber Outlet PPM	Scrubber Outlet LB/HR	Percent Removal
1	1369	8.6	1.9	0.01	99.9
2	1509	11.3	1.0	0.01	99.9
3	1449	10.3	1.3	0.01	99.9
4	1608	14.3	1.4	0.01	99.9
5	1873	13.3	1.4	0.01	99.9

FIGURE 1

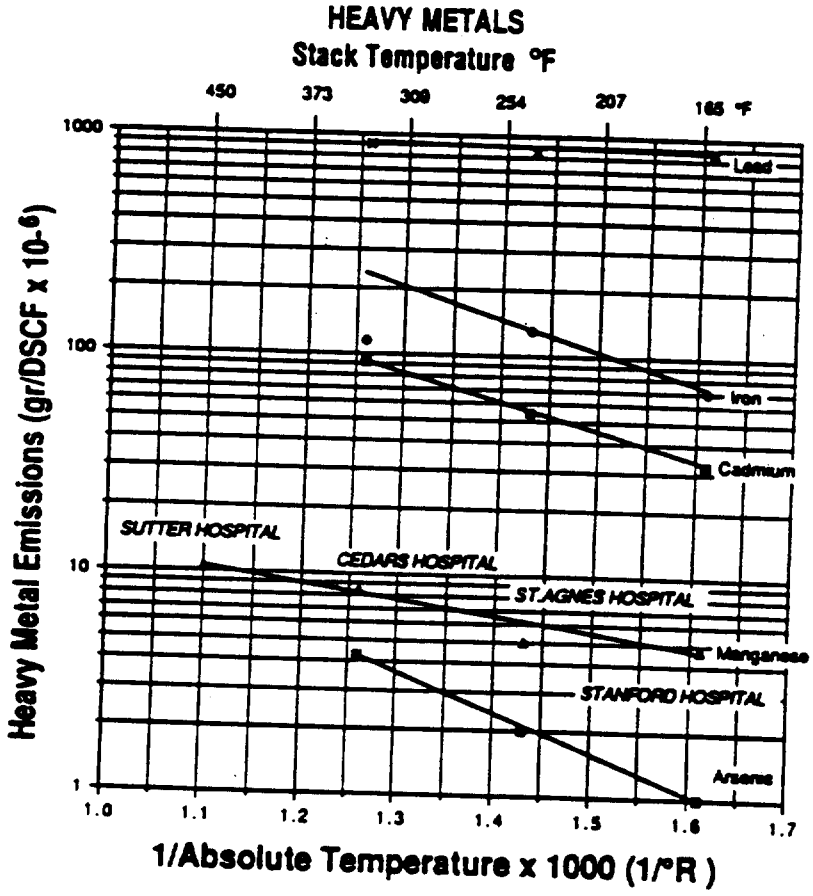
Effect of Pollution Control Device Temperature on Hospital Incinerator Emissions



Data Source - correlated from California Air Board reports, 1987 and 1988

FIGURE 2

Effect of Pollution Control Device Temperature on Hospital Incinerator Emissions



Data Source - correlated from California Air Board reports, 1987 and 1988

FIGURE 3

ROTARY ATOMIZING™ SCRUBBER

FOR INCINERATOR APPLICATION

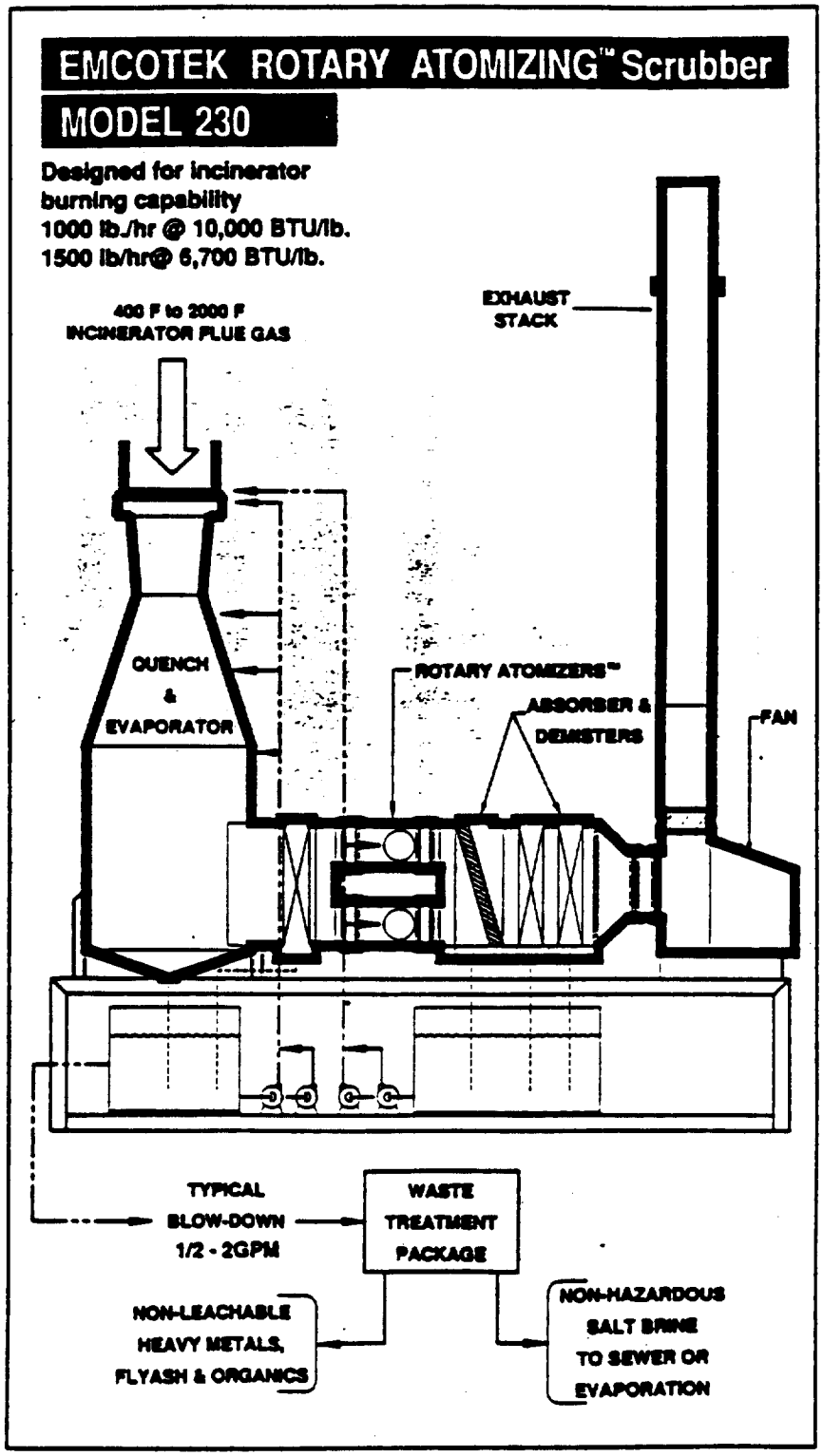


FIGURE 4

ROTARY ATOMIZING™ MODULE

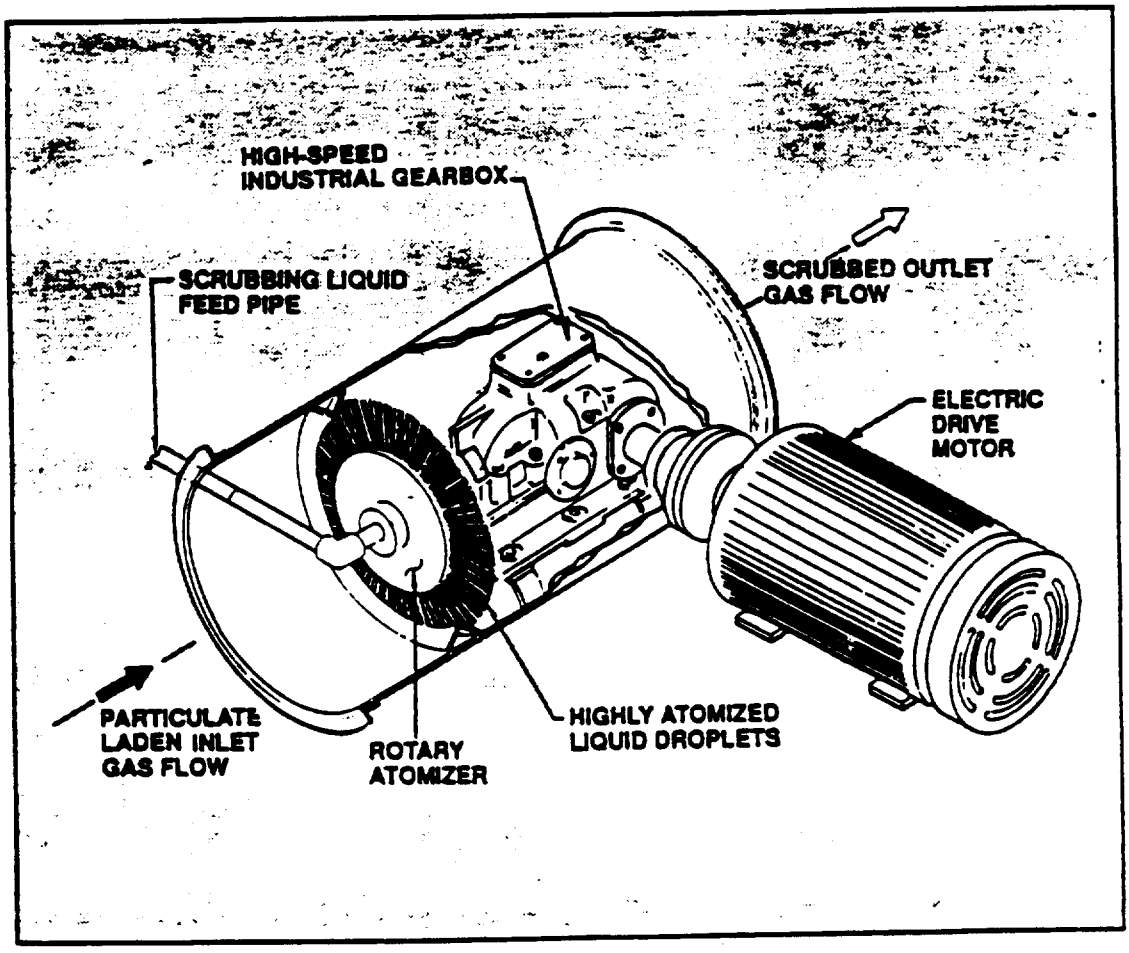


FIGURE 5

Scrubber Wastewater Treatment Flowsheet