IMPACT OF WATER CHEMISTRY ON TEST RESULTS

by

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This paper presents data obtained from tests performed on two municipal incinerators of about 181 metric tons (200 U.S. tons) per day capacity; each equipped with water-scrubbing APC devices. The emissions averaged .76 and .37 g/m^3 (.33 and .16 gr/SCF) adjusted to 12% CO_2.

In both instances, scrubber water was recycled and corrected for PH. Fresh make-up water was provided by water from a well.

Emission tests were performed in accordance with procedures extablished by the 23 December 71 issue of the Federal Register, specifically Method 5. Water analyses were made by Standard Methods.

An investigation was conducted to chemically characterize the particulate and dissolvable solids generated from refuse incinerators. The study was centered on the solids content of filters and the dissolved solids in the scrubber waste.

Plant I

Recycled scrubber water was sampled periodically during a 24-hour period. The results, as expected, indicated increasing concentration of solids upon repeated exposure to scrubber gas. These solids were then analyzed. The results of these analyses are presented in Table I.

Two emission tests were performed, one using 96-hour recycled water and the second using fresh well water, in an attempt to determine whether any salts captured in the recycled water were returned to the gas stream on subsequent passes. To test with fresh well water, the water was rerouted so that well water made only one pass through the system and was then discharged. The results are presented for comparison in Table II below. Neither the gross catch nor the chemical composition of the catch seemed to be appreciably affected by the use of fresh instead of recycled water.

TABLE I

Hour	Pass	0	1	4	8	12	16	24	96
PH	2.5	6.4	6.51	2.84	2.21	2.41	2.11	2.21	5.7
Chloride	132.2	4.4	2.71	240	563	524	637	779	397
Hardness	120	8.0	50	500	500	600	600	700	585
Phosphorous Total	5.9	ND	2.4	4.6	2.5	2.9	3.1	3.5	ND
Solids, Dissolved	482.0	24.5	85	735	1665	1440	1705	2520	1364
Solids, Settable (ml/l)	0.6	0	0.3	0.35	0.3	0.35	0.35	1.3	10
Solids, Suspended	80	1.5	100	200	165	310	265	430	108
Solids, Volatile	234.0		65	502	1015	860	1010	1560	
Sulfate	18.3	ND	11.7	54	83	92	108	104	140
Calcium	16.9	.44	2.31	14.5	33.5	25.0	26.5	38.0	199
Iron	3.2	.46	1.8	5.75	15.2	16.0	21.0	26.5	11.7
Magnesium	3.6	.3	1.61	5.3	14.0	13.6	15.2	21.0	17.0
Potassium	10.0	.3	4.61	21.2	35.9	36.0	39.0	49.0	37.0
Sodium	13.3	3.2	6.9	21.3	37.8	36.0	37.1	51.8	43.5
Aluminum	8.1		2.8	17.8	36.0	44.0	48.5	65.2	
Chromium	0.14		1.4	2.81	3.25	3.75	4.3	5.15	
Copper	0.16		0.005	0.058	0.092	0.092	1.02	1.45	
Nickel	0.05		ND	ND	0.13	0.25	0.37	0.60	
Zinc	7.7		3.9	23.0	49.0	47.0	42.0	50.0	

All results reported in mg/l
ND - Not Detectable
The first pass and 96-hour samples are presented above although not taken in sequence. First pass represents water taken from the well and fed to the scrubber and then discharged. 96-hour water is water that has been recycled for that period of time.

TABLE II

	TEST USING RECIRCULATED WATER (1)*				TEST USING FRESH WATER			
	FILTER CATCH		WATER		FILTER CATCH		WATER	
	mg	%	ml/1	%	mg	%	ml/1	%
Ca	6.39	0.96	38.8	2.58	4.12	0.53	0.44	1.65
Na	54.07	8.07	51.8	3.57	60.71	7.84	3.20	12.30
K	62.58	9.38	49.0	3.32			0.30	1.15
Cl	209.0	31.52	779.0	52.92	173.04	22.34	4.4	16.92
Fe	3.28	0.49	26.5	1.80	2.89	.37	0.46	1.79
SO_4	84.64	12.79	104.0	7.06	51.38	6.63	ND	ND
PO_4	8.61	1.30	3.5	0.23	12.73	1.64		
Total C	2.29	0.34			2.56	.33		
Organic C	2.46	0.34			3.26	.42		
Zn			50.0	3.39	120.1	15.51		
Al			65.2	4.42	ND			
Mg	228.31	34.50	21.0	1.42	.78	0.1	.30	1.15
Other			284.0	19.29	342.73	44.26	16.90	65.0
Total	661.63		1472.0	100.0	774.3		26.0	100.0
PH			2.2				6.4	
Hardness			700				8.0	
Dis. Sol.			1364				24.5	
Set. Sol.			10					
Sus. Sol.			108				1.5	

*(1) Recycled water after 96 hours with 5.05 lit/sec (80 gpm) evaporation rate.

Plant II

Two series of tests were performed on this installation. The only variable during the test series was an increase in the scrubber flow water which produced a low stack temperature for a high water flow.

Two of twelve filters obtained during this series of tests were selected for chemical analysis and compared with corresponding scrubber water and stack condensate. Stack condensate is water obtained from the bottom of the stack. Flue gas for Series I had a 8.41% moisture and Series IV had 28.28% moisture. The two filters were analyzed for Na, K, Cl, SO_4 and Zn. The results are presented in Table III for comparison.

A significant relationship was found in the two series between the % moisture in the stack gas and the dissolved solids in the stack condensate. You will note that the % moisture is 8.41% for Series I and 28.28% for Series IV. The ratio of percent moisture, Series I to Series IV

(8.41/28.28) is approximately the same as the ratio of dissolved solids in PPM as reported in the stack condensate, Series IV to Series I (2193/6723).

From these relationships we would make the following observations:

A. The same total amount of dissolved solids passed through the scrubber in both series.
B. The media of conveyance is the moisture in the gas stream.
C. By reducing the % moisture, we do not eliminate the solids but only make them more concentrated in the remaining moisture in the gas stream.

An attempt was also made to develop elemental emission potentials from the above analysis. Table IV shows the amount of each element emitted and captured in pounds per ton of municipal refuse burned. The major filtered particulate discharges from the furnace is Cl (see "Potential from Furnace"). However, a relatively high percentage of this material is removed in the scrubber. Though K and Na form a much lower percentage of the furnace emissions, the scrubber is much less efficient in removing these chemicals and so they form a substantially larger percentage of the stack emissions.

Filter analysis was carried further by electron microscopic techniques. Two additional filters from Plant II Series I and IV were examined. A typical unused glass filter of the type called for in the EPA test train and one from the stack test series are shown in Figures 1 through 4.

The unused filter at 3000 x shows a glass fiber mat. X-Ray energy dispersive analysis showed predominately silicon, a lesser amount of calcium and traces of sodium, aluminum and potassium. The used filter magnified 5000 x showed major amounts of potassium, chlorine and sulfur; lesser amounts of sodium and zinc, and traces of iron, aluminum and silicon.

Recent scrubber failures have raised questions as to their ability to meet the EPA and State emission requirements. Increasing the pressure drop does not necessarily increase the collection efficiency. There is a definite need in the industry to know what parameters or combination of parameters will not only make the scrubber a good gas remover but also a good particulate remover.

The preliminary data presented above and some of the statements made may stimulate some interest to research the particulate mechanism in scrubbers i.e.

Does the EPA test train generate particulate?

How can scrubbers designed for small cut-diameters pass well-defined sharp edge crystals of much larger size?

Approximately 50% of the particulate catch of the EPA filter is water soluble. How then did it pass through the scrubber?

TABLE III

PLANT NO. 2 FILTER, STACK CONDENSATE, AND SCRUBBER WATER ANALYSIS

	FILTER		STACK COND.		SCRUBBER WATER IN		SCRUBBER WATER OUT	
	mg	%(1)	PPM	%(1)	PPM	%(1)	PPM	%(1)
Na	26.73	12.33	920	16.03	10	11.90	40	14.66
K	84.39	38.95	1200	20.90	10	11.90	20	7.33
Cl	73.31	33.88	2500	43.58	52	61.88	132	48.48
SO_4	20.75	9.58	800	13.93	12	14.27	80	29.34
Zn	11.45	5.28	320	5.57	0.05	0.05	0.70	0.25
Sub-Total	216.63	100.00	5740	100.00	84.05	100.00	272.7	100.00
Other	0.47		983		342.95		585.3	
TOTAL	217.10		6723		427		758	

STACK
% MOISTURE 8.41
VOLUME 30,939 SCFM
TEMP. 109.2°F
CONDENSATE 1 GPM

SCRUBBER WATER
1906 GPM

	FILTER		STACK COND.		SCRUBBER WATER IN		SCRUBBER WATER OUT	
	mg	%(1)	PPM	%(1)	PPM	%(1)	PPM	%(1)
Na	63.60	16.32	290	15.00	30	26.31	40	12.00
K	79.89	20.49	360	18.70	10	8.77	20	6.00
Cl	187.50	48.09	800	41.55	60	52.61	172	51.61
SO_4	27.21	6.97	350	18.18	14	12.27	100	30.00
Zn	31.70	8.13	125	6.49	0.05	0.04	1.3	0.39
Sub-total	389.90	100.00	1925	100.00	114.05	100.00	333.3	100.00
Other	57.20		268		327.95		557.7	
TOTAL	447.10		2193		442		891	

STACK
% MOISTURE 28.26
VOLUME 30,033 SCFM
TEMP. 155.8°F
CONDENSATE 3 GPM

SCRUBBER WATER
1653 GPM

(1) PERCENT OF TOTAL REPORTED

Conversion Factors: (SCFM) = 0.02832 (CM/M)

$(^{o}K) = \frac{5}{9}(F - 32) + 273.2$

(GPM) = 0.0631 (lit/sec)

TABLE IV

SUMMARY

SERIES IV LOW FLOW

LBS PER U.S. TON OF REFUSE

COMPONENT	STACK EMISSION	STACK CONDENSATE	CAPTURE IN SCRUBBER	POTENTIAL FROM FURNACE	EFFICIENCY OF COLLECTION
	Lbs/Ton	Lbs/Ton	Lbs/Ton	Lbs/Ton	%
Na	0.631	0.050	0.947	1.628	58.2
K	0.793	0.062	0.947	1.802	52.6
Cl	1.862	0.138	10.608	12.608	84.1
SO_4	0.270	0.060	8.145	8.475	96.1
Zn	0.315	0.021	0.118	0.454	26.0
TOTALS	3.871	0.331	20.765	24.967	83.2
OVERALL EFFICIENCY - TOTAL SOLIDS					
TOTAL SOLIDS	4.439	0.301	42.527	47.267	90.0

SERIES I HIGH FLOW

LBS PER U.S. TON OF

COMPONENT	STACK EMISSION	STACK CONDENSATE	CAPTURE IN SCRUBBER	POTENTIAL FROM FURNACE	EFFICIENCY OF COLLECTION
	Lbs/Ton	Lbs/Ton	Lbs/Ton	Lbs/Ton	%
Na	0.370	0.051	3.161	3.582	88.2
K	1.167	0.066	1.054	2.287	45.1
Cl	1.014	0.138	8.430	9.582	88.0
SO_4	0.287	0.044	7.165	7.496	95.6
Zn	0.158	0.018	0.068	0.244	27.9
TOTALS	2.996	0.317	19.878	23.191	85.7
OVERALL EFFICIENCY- TOTAL SOLIDS					
TOTAL SOLIDS	3.002	0.348	34.879	38.229	91.2

Conversion Factor: (lbs/U.S. Ton) = 0.5 (Kg/metric ton)

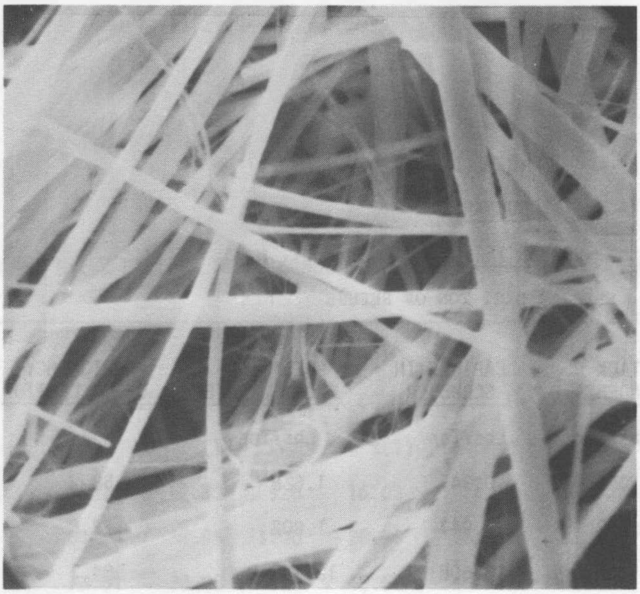

FIGURE 1
UNUSED FILTER
3000X

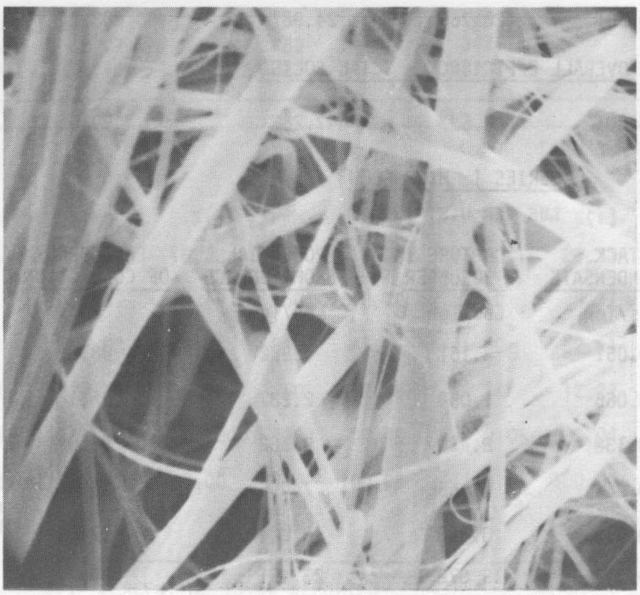

FIGURE 2
UNUSED FILTER
3000X

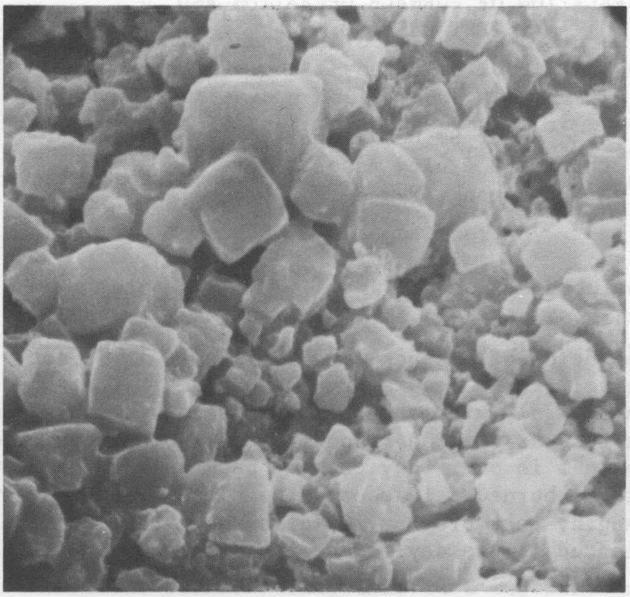

FIGURE 3
5000X
1 Micron

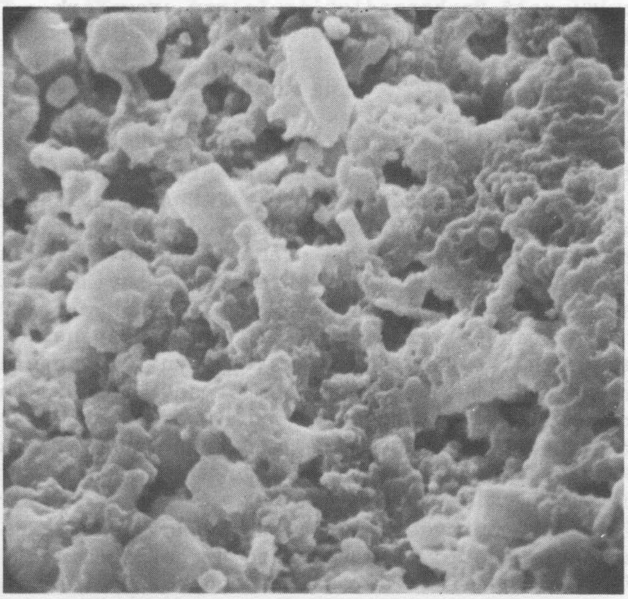

FIGURE 4
5000X
1 Micron