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Project Summary

Chemical Analysis of Particle Size Fractions from Glass Melting Furnaces

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The capture efficiency of various control devices has been determined to be related to size distribution of the particulate in the emissions stream. Since some control systems have been shown to be less efficient for capturing fine particulates the determination of the probable metallic particulate specie that may escape capture is significant. The objective of this project report is to provide a quantitative analyses of the metallic species from glass furnaces in each size fraction. The quantitative information is determined as a function of particle size distribution of the emitted particulate matter. An estimate of the probability that a specific metallic species will pass through the collection device can be made.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In 1979 a research program was conducted which involved the characterization of emissions from glass melting furnaces. The title of that program and subsequent report is "Summary Report on Emissions from the Glass Manufacturing Industry," EPA Report No. 600/2-79-101, April 1979. Although particle size analyses were made on the emissions, chemical analyses of the size fractions were not conducted. The samples, however, were preserved for later analyses. This report is a summary of those analyses.

The emissions of fine particulate matter from glass melting furnaces may pose an environmental problem if they contain toxic substances. The problem may be even greater if the potentially toxic substances are in the respirable range (i.e., 3 μm). The emissions from typical glass furnaces have been shown to be generally in the respirable range; thus, it is important that the prevalent toxic elements in this respirable range be identified.

The program to collect the data for this report involved the testing of 13 different furnaces from which mass emissions and particle size fractions were determined. The most prevalent species of metal from furnaces melting glasses are Na, Ca, Se, Cr, and Pb. Other less prevalent species include As, Sb, and Sn.

Research Approach

The Andersen cascade impactor was used to collect the particle size fraction samples. OES was then used to determine the prevalent metallic species present in each size fraction. With these qualitative results a uniform series of AAS analyses were defined for each stage of the impactors with emphasis placed on the prevalent potentially toxic metal species. These analyses provided

Table 1. *Distribution of Ca from Soda-lime Furnaces*

Stage	Particle size μm	Weight percent A	D	E	H	I	J	L	M
0	7.5 -15.4	10.83	0.29	12.14	2.33	9.47	11.06	11.61	14.10
1	5.0 -12.0	10.67	24.02	13.09	23.04	10.42	10.32	9.16	9.35
2	3.5 - 8.0	9.87	0.31	12.20	2.92	9.85	12.09	11.61	9.64
3	2.2 - 5.5	10.35	37.86	12.62	18.28	9.28	11.50	9.29	11.80
4	1.13- 3.5	11.94	0.44	13.68	2.97	10.80	12.09	13.11	9.78
5	0.68- 1.7	11.78	32.12	12.18	25.47	14.20	11.80	13.25	14.82
6	0.55- 1.1	10.03	0.57	8.91	3.69	13.07	11.80	11.75	10.94
7	0.36- 0.75	11.94	4.07	12.18	19.01	12.31	10.91	9.97	10.94
8	<(0.36- 0.75)	12.58	0.31	2.99	2.28	10.61	8.41	10.25	8.63

Table 2. *Distribution of Na from Soda-lime Furnaces*

Stage	Particle size μm	Weight percent A	D	E	H	I	J	L	M
0	7.5 -15.4	8.96	8.80	6.57	7.89	11.50	11.91	9.37	10.49
1	5.0 -12.0	8.78	1.71	13.13	.97	10.08	10.97	8.29	9.50
2	3.5 - 8.0	8.26	9.21	6.31	8.85	9.38	11.60	10.12	9.17
3	2.2 - 5.5	8.70	2.18	6.57	1.25	8.60	10.66	9.04	9.99
4	1.13- 3.5	9.04	10.03	7.58	10.06	8.96	11.18	10.45	9.91
5	0.68- 1.7	10.61	7.44	9.60	10.46	8.39	13.27	10.61	14.78
6	0.55- 1.1	14.43	35.13	29.04	38.23	13.40	9.93	15.42	13.87
7	0.36- 0.75	17.57	13.98	12.88	11.99	13.61	11.39	13.85	11.48
8	<(0.36- 0.75)	13.65	11.53	8.33	10.30	16.08	9.09	12.85	10.82

Table 3. *Distribution of Se from Soda-lime Furnaces*

Stage	Particle size μm	Weight percent A	D	E	H	I	J	L	M
0	7.5 -15.4	9.60	5.29	12.45	12.90	5.35	7.74	16.36	18.65
1	5.0 -12.0	11.20	7.65	11.24	13.44	5.21	11.95	14.87	10.36
2	3.5 - 8.0	13.60	7.06	12.85	9.68	9.15	9.14	17.10	10.36
3	2.2 - 5.5	12.00	14.12	14.66	6.99	10.56	16.17	9.67	18.65
4	1.13- 3.5	6.40	9.41	13.86	10.75	21.83	16.88	14.13	14.50
5	0.68- 1.7	9.60	15.88	12.25	6.99	17.61	10.55	8.92	6.91
6	0.55- 1.1	7.20	1.76	8.84	6.99	16.20	13.36	5.58	6.08
7	0.36- 0.75	5.60	7.65	9.44	6.99	7.75	8.44	5.20	6.91
8	<(0.36- 0.75)	24.80	31.18	4.42	25.27	6.34	5.77	8.18	7.60

Table 4. *Distribution of Pb from Soda-lime Furnaces*

Stage	Particle size μm	Weight percent A	D	E	H	I	J	L	M
0	7.5 -15.4	—	—	—	—	—	—	—	—
1	5.0 -12.0	0.55	0.98	14.43	1.13	16.99	11.99	6.41	9.43
2	3.5 - 8.0	0.86	1.43	14.43	1.97	11.17	16.10	6.41	9.43
3	2.2 - 5.5	—	—	—	—	—	—	—	—
4	1.13- 3.5	3.07	3.67	14.43	6.19	11.17	20.55	6.41	9.43
5	0.68- 1.7	—	—	—	—	—	—	—	—
6	0.55- 1.1	15.66	58.14	23.71	88.61	33.98	32.53	51.28	35.85
7	0.36- 0.75	—	—	—	—	—	—	—	—
8	<(0.36- 0.75)	79.85	35.78	32.99	2.11	26.70	18.84	29.49	35.85

quantitative data relating the concentration of the metal species to the particle size fraction. The data was then compiled and reported in weight percent and graphed in cumulative weight percent.

The results of the particle size fraction analyses from soda-lime furnaces are given in Tables 1 to 5. The results indicate that the concentration of the identified heavy metals are generally equally distributed throughout the size fractions.

In lead glass furnace emissions, the results indicated that Na and Ca are uniformly distributed throughout the size fractions. The potentially toxic metals Pb, As, Sb and Cr, were found to be concentrated in the lower size fractions. Table 6 indicates that a significantly large percentage of their total emissions weight is in the submicron range.

Conclusion

The particle size distribution of the non toxic metallic species observed in glass furnace emissions parallel the particulate matter size distribution characteristic. However, in glass furnaces that contain larger amounts of Cr, As, Sb, and Pb, potentially toxic metals, they tend to concentrate in the smaller size fractions.

It cannot be concluded, however, that the identified metal that may escape maximum control represent an environmental problem. Analyses were not conducted to determine the chemical form of the metals. All of the metals identified can exist in chemical forms which will not present an environmental impact although they may be toxic in their pure metallic form.

Table 5. *Distribution of Cr from Soda-lime Furnaces*

Stage	Particle size μm	Weight percent							
		A	D	E	H	I	J	L	M
0	7.5 -15.4	—	—	—	—	—	—	—	—
1	5.0 -12.0	2.36	5.85	11.15	2.68	4.44	13.02	4.43	6.92
2	3.5 - 8.0	0.98	2.17	12.10	2.68	4.44	19.53	5.83	7.69
3	2.2 - 5.5	—	—	—	—	—	—	—	—
4	1.13- 3.5	2.36	2.51	13.06	12.75	4.44	22.14	6.99	13.85
5	0.68- 1.7	—	—	—	—	—	—	—	—
6	0.55- 1.1	13.78	48.49	35.03	73.83	55.56	33.85	51.28	36.92
7	0.36- 0.75	—	—	—	—	—	—	—	—
8	<(0.36- 0.75)	80.55	40.97	28.66	8.05	31.11	11.46	31.47	34.62

Table 6. *Distribution of Elements from an Electronic (Lead) Glass Furnace*

Stage	Particle size μm	Weight percent					
		Na	Ca	Sb	Pb	Cr	As
0	20.1	10.34	8.52	0.51	1.13	2.28	1.28
1	12.6	10.03	11.93	—	0.98	—	—
2	8.5	11.11	7.98	0.60	1.49	2.66	1.64
3	5.9	9.93	10.49	—	1.58	—	—
4	4.4	10.62	13.18	0.83	1.53	3.61	2.74
5	1.88	10.62	14.26	—	7.28	—	—
6	1.16	10.42	9.60	1.76	7.80	23.53	17.42
7	.79	10.42	10.49	—	11.98	—	—
8	.79	16.52	13.54	96.30	66.23	67.93	76.92

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The complete report, entitled "Chemical Analysis of Particle Size Fractions from Glass Melting Furnaces," (Order No. PB 81-160 889; Cost: $6.50, subject to change) will be available only from:
National Technical Information Service
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