

The Impact of Particulate Emissions Control On the Control of Other MWC Air Emissions

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On December 20, 1989, the Environmental Protection Agency (EPA) proposed revised new source performance standards for new municipal waste combustion (MWC) units and guidelines for existing sources. The proposed national regulations require tighter particulate matter control and address pre-combustion, combustion, and post-combustion controls, the latter two depending on capacity and age of the facility.

The air pollutants of concern when municipal solid waste (MSW) is burned will be discussed. Generally, particulate control is an inherent part of the systems used to limit the emissions of these air pollutants. The relationships between MWC air emissions (acid gases, trace organics, and trace heavy metals) control and particulate control will be discussed. Test results to quantify air pollutant emissions from MWC units and their control will be presented and compared with the proposed regulations.

The combustion of municipal solid waste (MSW) has nearly doubled over the past three years in the United States, with waste-to-energy conversion complementing the volume reduction of waste to be landfilled. Now about 15 percent of the 145 million tonnes (160 million tons) of MSW generated annually is being burned, with about 63,000 tonnes/day (70,000 tons/day)¹ being combusted in energy recovery facilities. While municipal waste combustion (MWC) ranks after waste reduction and material recovery (recycling) in EPA's agenda for solving the MSW crisis, it precedes land disposal—a disposal option now facing higher costs, rapidly shrinking existing capacity, tighter siting constraints, and declining availability of land. However, along with the benefits of MWC, there are environmental concerns regarding air pollutant emissions and the safe disposal of ash or residues.

On December 20, 1989, EPA proposed more stringent new rules to control pollutant emission from MWC facilities.²

New Source Performance Standards (NSPS) were proposed under Section 111 (b) while guidelines for existing sources were proposed under Section 111 (d) of the Clean Air Act. The proposed rules require all facilities to use three complementary methods to control air polluting emissions: material separation (pre-combustion fuel cleaning), combustion control [good combustion practice (GCP)], and post-combustion flue gas cleaning (FGC).

Whereas the current federal rule for municipal waste incinerators applies only to particulate matter (PM), the proposed rules address "MWC emissions," nitrogen oxides (NO_x), and carbon monoxide (CO). "MWC emissions" are defined to include: "MWC metals" as measured by total PM, "MWC organics" as measured by total polychlorinated dibenzo-p-dioxins (CDD) and dibenzofurans (CDF) (tetra through octa isomers), and "MWC acid gas" as measured by hydrogen chloride (HCl) and sulfur dioxide (SO₂). As shown in Table I, the proposed rules incorporate emission limits which depend on the facility's size (capacity) and age (existing or new). All facilities must comply with PM, CDD/CDF, and CO emission limits. All facilities, except small existing sources [≤ 225 tonnes/day (≤ 250 tons/day)], must also comply with acid gas emission limits. Only large new sources [> 225 tonnes/day (> 250 tons/day)] must comply with NO_x emissions limits. The new rules also include facility operating and monitoring requirements to ensure compliance with the proposed emission limits.

Most advanced air pollution control techniques (dry scrubbers) used at MWC facilities are designed to convert metals, organics, and acid gases to a solid form which can be collected as PM. Thus, strategies for controlling organic emissions, metals emissions, and acid gas emissions are directly or indirectly related to the techniques for controlling PM emissions. The focus of this paper will be a discussion of the relationship between combustion and FGC process conditions which affect collection of organics, metals, and acid gas reaction products as PM. The potential effects of material separation and NO_x emission control technologies on PM emissions are outside the main focus of this paper and will not be discussed. Similarly, the treatment or disposal of ash or solid residue will not be discussed as this waste is subject to solid waste rules.

Good Combustion Practice (GCP)

GCP is to be employed on all combustors to limit the formation and emission of organic emissions. Total CDD/

Table I. Proposed municipal waste combustion emission standards.^{a,2}

	New source performance standards (NSPS) ^b		Emission guidelines ^b		
	≤225 (≤250)	>225 (>250)	≤225 (≤250)	>225, ≤2000 (>250, ≤2200)	>2000 (>2200)
Capacity, tonnes/day (tons/day)					
Metal emissions					
Particulate Matter, mg/dscm (gr/dscf)	34 (0.015)	34 (0.015)	69 (0.030)	69 (0.030)	34 (0.015)
Opacity, %	10	10	10	10	10
Organic emissions					
Chlorinated Dibenzo-p-dioxins & Dibenzofurans (CDD/CDF), ng/dscm	75 250 ^d	5-30 ^c	500 1000 ^d	125 250 ^d	5-30 ^c 250 ^d
Acid gas control, %, OR Emissions (ppmv)					
HCl	80 (25)	95 (25)	None	50 (25)	95 (25)
SO ₂	50 (30)	85 (30)	None	50 (30)	85 (30)
NO _x	None	(120-200) ^c	None	None	None

^a All emission limits are referenced to dry gas with 7% O₂ concentration.

^b New source performance standards apply to units for which construction begins on or after the date on which the standards are proposed. Emissions guidelines apply to units which are under construction or operational on the date the guidelines are proposed.

^c Single value, probably in this range, will be supplied at the promulgation of rules.

^d Value applies only to refuse-derived fuel (RDF) combustors in the capacity (size) category shown.

CDF was selected as a surrogate for "MWC organics" because of concern regarding their potential health effects. Also, more is known about the emission and control of these compounds than other organics. The GCP provisions of the proposed MWC rules include requirements related to combustor operating conditions and flue gas CO concentrations. Operator certification and MWC personnel training are also required.

Organic emissions may originate from compounds contained in the waste which are not destroyed during combustion, waste thermal decomposition products which are not completely destroyed, and chemical reactions which occur at relatively low temperatures downstream of the combustor. Three goals of GCP are to: (1) maximize in-furnace destruction of organics, (2) minimize entrainment and carry-over of the PM from the furnace, and (3) minimize the occurrence of low temperature reactions which form CDD/CDF.

The concentration of CO in MWC flue gases is a good indicator of combustion conditions associated with the destruction of organics: appropriate waste feed conditions; adequate combustion temperatures; and the proper amount, distribution, and mixing of combustion air. To ensure continuous furnace destruction of organics, the proposed MWC rules specify CO emission limits ranging from 50 to 150 ppm depending on the type of combustor (Table II).

Low temperature reactions downstream of the combustor lead to the de novo synthesis of CDD/CDF on the surface of flyash.^{3,4} Design and operation of the combustor at conditions which minimize downstream PM surface area are deemed to be key factors in limiting post-furnace formation of CDD/CDF. Figure 1 shows that CDD concentrations at the electrostatic precipitator (ESP) are highly correlated (correlation coefficient, $r^2 = 0.899$) with the total PM carried from two types of combustors.⁵ High levels of PM carryover are generally related to flue gas volumetric flow rates above design conditions and improper overfire-to-underfire air ratios. The proposed MWC rules prohibit operation in excess of 100 percent rated load as measured by steam load to avoid excessive PM carryover.

There is substantial evidence that de novo synthesis of CDD/CDF occurs on the surface of flyash at temperatures ranging from less than 250°C (480°F) to more than 400°C (750°F). Maximum net rates of formation occur at approximately 300°C (570°F). MWC facilities equipped with only

an ESP for PM control exhibit higher CDD/CDF concentrations at the outlet than at the inlet for ESP operating temperatures higher than approximately 230°C (450°F), an indicator that PM control devices can operate as reactors which generate CDD/CDF. Thus, the proposed MWC rules specify a maximum temperature of 230°C (450°F) at the inlet to the PM control device to limit CDD/CDF formation.

Acid Gas Control

While in-furnace sorbent injection is being used in several MWCs to control HCl and SO₂, the degree of control is estimated because uncontrolled emissions are not measured directly when this control option is used. Tests on an Alexandria, VA, mass burn waterwall unit equipped with an ESP gave average estimated HCl and SO₂ removals of 67 and 82 percent, respectively, for average outlet HCl and SO₂ concentrations of 166 and 37 ppmv, both referenced to dry gas with 7 percent O₂.⁶ Hydrated lime, supplied at 68 kg/hr (150 lb/hr) and corresponding to a stoichiometric ratio of 0.9, was

Table II. Proposed CO limits according to combustor type for good combustion practice.²

Combustor type	Maximum CO, ppmv ^a
Mass burn	
Modular	50
Waterwall	100
Refractory	100
Rotary, Waterwall	150
Refuse-derived fuel (RDF)	
Spreader stoker	150
Fluidized bed	100
Coal/RDF CO-fired ^b	150

^a Value is referenced to dry gas with 7% O₂ concentration and CO measurement by a continuous emission monitor.

^b Fuel is more than 50% municipal solid waste (mixture of paper, wood, yard wastes, plastics, rubber, and other combustible materials, plus noncombustible materials such as glass, metal, rock, and soil). Municipal solid waste includes household wastes, municipal-type wastes from commercial, industrial (but not process wastes), and institutional (but not medical waste) sources, and processed solid waste such as refuse-derived fuel (RDF).

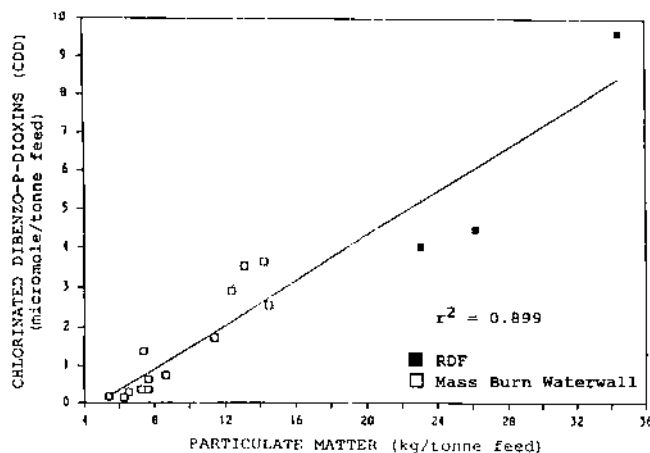


Figure 1. Dependency of chlorinated dibenzo-p-dioxin emissions on particulate matter.⁵

injected into the combustor with the overfire air for each of the three test runs. Other ESP outlet (controlled) emissions during the 1987 tests were 55 ng/dscm* (correlated to 7 percent O₂) for CDD/CDF and 54 mg/dscm (0.024 gr/dscf) for PM versus a permit limit of 69 mg/dscm (0.03 gr/dscf), with the PM data being referenced to 12 percent CO₂ in dry gas.[†] Since the PM emissions for the two other Alexandria units without sorbent injection averaged 61 mg/dscm (0.027 gr/dscf), the injection of hydrated lime into the furnace did not degrade the ESP's performance during the tests. However, CDD/CDF data for these two units were not reported.

The 295 tonne/day (325 ton/day) mass burn unit tested at Alexandria would meet the proposed air emission guidelines for organic and PM emissions, assuming the unit performed as tested in December 1987. It would also meet the least stringent acid gas guidelines because over 50 percent removal of both the inlet HCl and SO₂ was attained, although the outlet concentration of both HCl and SO₂ exceeded the alternative guideline concentrations. No data were available on the control of metal emissions.

Particulate Matter Control

For both the proposed NSPS and the emission guidelines, PM control is used as a surrogate for controlling heavy metals [e.g., arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg)] emissions. Since a PM emission limit of 34 ng/dscm (0.015 gr/dscf) corresponds to 99 percent removal of all heavy metals of concern (except Hg) and a PM limit of 69 ng/dscm (0.03 gr/dscf) corresponds to 97 percent removal of heavy metals (except Hg), PM collection downstream of the combustor will be needed to meet the proposed rules. The discussion on the proposed rules notes that Hg removals of 70 percent with a lime spray dryer absorber (SDA)/fabric filter (FF) system and 30 percent with duct injection of lime/ESP system can be achieved by the proposed PM rules.² However, these correlations are being studied by EPA because other results show inconsistent Hg control at several plants.

* Standard conditions are: 20°C (68°F) and 101.3 kPa (14.7 psia).

† Unless otherwise noted, all concentration data are referenced to dry gas at 7% O₂, except PM which is referenced to dry gas at 12% CO₂. The PM values referenced to 12% CO₂ are about 6% lower than if referenced to 7% O₂.²

Dry scrubbing systems continue to be preferred for controlling air pollutant emissions from MWC units in the U.S. While several plants, generally with combustors rated at 180 tonnes/day (200 tons/day) or less, use in-duct (or duct) injection of powdered hydrated lime followed by a FF or baghouse, most recent plants and those being planned use lime SDAs followed by FFs or ESPs. Figures 2 and 3 are schematic diagrams of these systems. The duct sorbent injection (DSI) system is an all-dry system, while an alkali slurry is injected into the SDA. Dry solids and unsaturated clean flue gas are discharged from the SDA/PM collection system. Thus, the latter system is often called a semi-dry, rather than a dry plants scrubber.

While acid gas scrubbers in MWC plants are intended primarily for controlling HCl and SO₂, they also remove organic and heavy metal pollutants. Several factors appear to be responsible for removal of the organics and metals. First, the flue gas entering the dry scrubber has been cooled, by heat recovery components or humidification following the furnace/boiler system, to about 150°C (300°F) for DSI and to about 200°C (400°F) at the SDA inlet. Thus, most heavy metals which were volatilized from the MSW feed during combustion are condensed onto ash or adsorbed onto the surface of other flyash. These particles are then removed with PM partly in the SDA, if present, but mostly in the following FF or ESP. While chemical reactions leading to solid-phase products of calcium (Ca), chlorine (Cl), and sulfur (S) are responsible for removing HCl and SO₂, chemical reactions converting metals to solid-phase compounds in the scrubber are not believed to be significant in controlling heavy metals emissions.

Flue gas cleaning techniques now used in the U.S. can achieve the proposed PM emission limits and adequately control the metal emissions of concern, except possibly Hg.² Hg in MWC flue gas has been reported to be predominantly mercuric chloride and elemental Hg,^{7,8} with the former representing about 70 percent of the total Hg. At flue gas temperatures near 150–200°C (300–400°F), a reduction of oxidized Hg to elemental Hg has been observed.⁹ One theory proposed for the reduction is that steel corrosion [on flue gas duct walls or other iron (Fe) surfaces] induced by HCl at these temperatures results in an activated Fe surface on which the Hg (II) compounds (i.e., mercuric chloride and mercuric oxide) may be reduced.⁹ This theory may be important in explaining the different ratios of elemental Hg to total Hg present in ESPs and FFs, with the latter often showing lower ratios and greater Hg removal.

Another factor that may impact Hg control is the carbon (C) content of flyash. RDF combustors, which typically have higher C content in flyash than some very combustion-efficient (as determined by CO content of flue gas) mass burn combustors, followed by SDA/FF systems have shown high Hg removal. Very combustion-efficient mass burn units with similar flue gas cleaning systems have shown little or no Hg control.¹⁰ In one case, the addition of activated C to the flue gas entering a lime SDA/ESP system improved Hg removal to about 90 percent, with an emission of 30 µg/m³ (referenced to dry gas with 11 percent O₂)¹¹ or 42 µg/m³ at 7 percent O₂.

Another additive used to enhance Hg removal from flue gas is sodium sulfide. A spokesman for Flakt, Inc., reported to an EPA/industry meeting on Hg control issues on February 7, 1990, that the addition of this additive to flue gas entering a fluid bed reactor preceded by humidification (see Figure 2) limited the Hg emission to 100 µg/Nm³, an objective that was not attained with the original design. The design of this system in Vancouver, Canada, was based on pilot-scale data from the Quebec City tests. Hg removals over 90 percent were reported for the Quebec City pilot unit when it operated with a FF inlet gas temperature of 140°C (285°F) or less.¹²

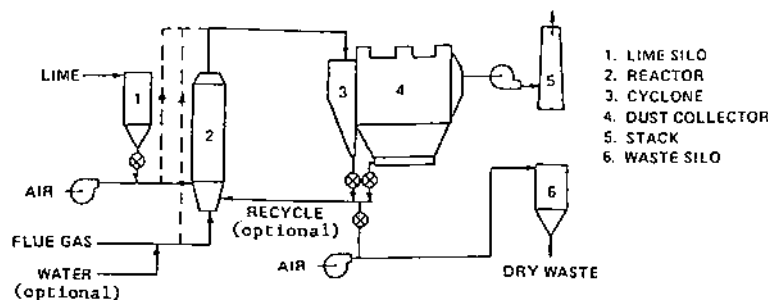


Figure 2. Dry sorbent injection into fluid bed reactor or flue gas duct (dashed line).

Since the vapor pressure curves for elemental Hg and mercuric chloride indicate vapor pressures significantly higher than partial pressures for these substances in MWC flue gas at temperatures corresponding to dry FGC system operation, condensation does not explain their removal. Mercuric chloride is normally a solid at these temperatures and, if present, would be expected to be removed in the PM collector. Cooling the flue gas in the acid gas removal process would also be expected to enhance the adsorption of Hg onto ash, reaction products, and lime particles. It has also been observed that a noticeable oxidation of elemental Hg occurs even in the absence of HCl when activated C is added to the flue gas.⁹ Reference 9 further noted that activated C acts as a catalyst for the formation of mercuric oxide and may do so even at elevated temperatures, while the oxidation of elemental Hg to mercuric oxide normally occurs in the flue gas temperature range of 300–500°C (570–930°F). Thus, conversion of elemental Hg, which passes through an ESP or FF as a fine particulate, to solid-phase compounds would enhance Hg removal in either an ESP or FF.

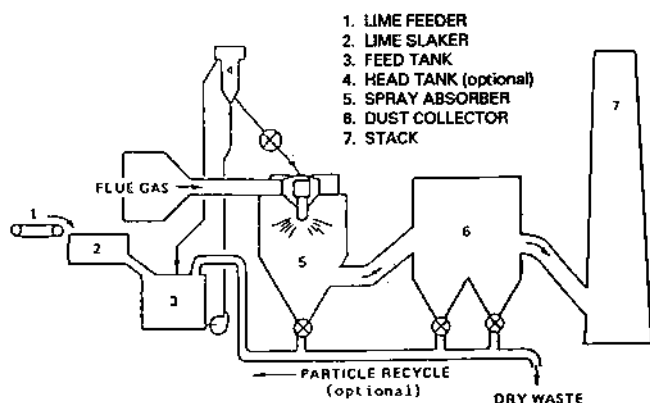


Figure 3. Spray dryer absorption (semi-dry) process.

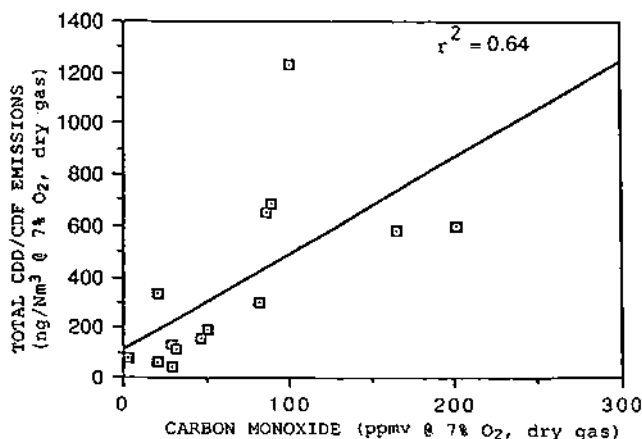


Figure 4. Total CDD/CDF emissions as a function of carbon monoxide concentration, both measured at the outlet of the ESP of the Quebec City, MWC unit.¹⁵

CDD/CDF removal in an acid gas scrubber parallels that of heavy metals, but appears to be aided by the presence of lime-based sorbents. The scant vapor pressure data on chlorinated dioxins suggest that condensation of these compounds is not the sole removal mechanism. Reduced flue gas temperatures, however, are believed to promote adsorption of CDDs, CDFs, and other organics onto fine particles having relatively large surface areas. The C content of the particles seems to affect the capture of these compounds. The addition of activated C to flue gas has been reported to enhance CDD/CDF and Hg capture in a lime DSI/FF system.¹³ With the injection of C additive, powdered hydrated lime, and filter-aid material, CDD/CDF capture exceeded 93 percent and Hg capture was over 96 percent, both significantly greater than without C addition. However, the individual effects of C and lime could not be determined from the reported test conditions.¹³

Table III. Acid gas control with duct lime injection/fabric filter system.⁶

Location and test date	Average concentration, ppmv @ 7% O ₂ , dry				Removal, %	
	HCl		SO ₂			
	inlet	outlet	inlet	outlet	HCl	SO ₂
Claremont, NH						
Unit 1, 5/87	788	104	NA ^a	231	86.8	NA
Unit 2, 5/87	642	36.6	NA	60.1	94.3	NA
Springfield, MA ^b						
7/88	503	31	129	22	94	83
St. Croix, WI						
10/88	743	ND ^c	99	28	100	71.7
Dutchess County, NY						
Unit 1, 2/89	NA	30	121	105	NA	16.4
Unit 2, 2/89	NA	183	138	123	NA	10.2

^a Not available or not measured.

^b All concentrations are referenced to dry gas with 12% CO₂.

^c Not detected.

Table IV. Acid gas control with lime spray dryer absorber/particulate collector (PC).^{6,10,14}

Location and test date	PC	Average concentration, ppmv @ 7% O ₂ , dry				Removal, %	
		HCl		SO ₂		HCl	SO ₂
		inlet	outlet	inlet	outlet		
Marion County, OR							
Unit 1, 6/87	FF	646	48.0	333	161	92.5	54.7
Biddeford, ME							
Unit A, 12/87	FF	582	5.84	101	22.6	99.0	77.6
Mid-Connecticut ^a							
Unit 11 7/88	FF	451	4.2	NA ^b	NA	99.1	NA
1/89 ^c		367	15	165	11	95.9	93.3
Millbury, MA							
Unit 1, 2/88	ESP	770	23.3	205	53.9	97.0	73.7
Unit 2, 2/88	ESP	697	6.08	296	61.5	99.1	79.2
SEMASS							
Unit 1, 3/89	ESP	NA	NA	154	67	NA	56.6
Unit 2, 4/89	ESP	NA	NA	162	55	NA	65.0

^a All values for this location are referenced to dry gas with 12% CO₂.

^b Not available or not measured.

^c These are averages of characterization test runs 12 and 12a which were for normal unit operation.

Acid gas control test results from nine different facilities with dry scrubbers are shown in Tables III and IV. These results indicate that the currently used technologies can control HCl and SO₂ to levels needed to meet the proposed NSPS and emission guidelines. However, the Dutchess County [225 tonnes/day (250 tons/day)] units in Table III and Marion County [249 tonnes/day (275 tons/day)] and the Millbury [680 tonnes/day (750 tons/day)] units in Table IV would require upgrading to meet the proposed emission guidelines, if implemented and the units performed as shown. HCl removal data would also be needed for the Dutchess County and SEMASS units.

Particulate Matter

As discussed above, the collection of PM matter appears to be a major factor in the control of CDD/CDF (semi-volatile organics) and heavy metals. Test results for CDD/CDF and heavy metals are given in Tables V and VI. Inlet concentrations were not normally measured for the DSI/FF systems (Table V). Higher CDD/CDF control (>95 percent) with the lime SDA/FF system than with the lime SDA/ESP combination (64 percent) is indicated by the limited data. The Hg outlet emissions of the Millbury SDA/ESP systems approximate the inlet values of the SDA/FF systems shown

Table V. Control of particulate matter (PM), chlorinated dibenzo-p-dioxins (CDD) and dibenzofurans (CDF), and selected heavy metals with dry lime injection/fabric filter systems.^{6,16}

Location and test date	Average PM concentration ^a gr/dscf @ 12% CO ₂		Average Total CDD/CDF concentration ng/dscm @ 7% O ₂ outlet	Average concentration, µg/dscm @ 7% O ₂		
	inlet	outlet		chromium outlet	lead outlet	mercury outlet
Claremont, NH						
Unit 1, 5/87	NA ^b	0.011	NA	NA	NA	NA
7/87	NA	NA	37.6	NA	NA	NA
Unit 2, 5/87	NA	0.0043	NA	NA	NA	NA
7/87	NA	NA	32.3	NA	NA	NA
St. Croix, WI						
5/88	NA	0.015	NA	NA	NA	NA
6/88	NA	0.015 ^c	NA	NA	18	35
10/88	NA	0.012	NA	NA	NA	NA
Springfield, MA ^d						
7/88	0.090	0.0016	0.15 ^e	10	21	300
Dutchess County, NY						
Unit 1, 2/89	NA	0.0097	4.83	8.27	38.9	1080
Unit 2, 2/89	NA	0.035	17.9	6.48	49.1	84.7
3/89	NA	0.011	NA	NA	NA	NA
5/89	NA	0.0079	NA	NA	NA	NA

^a Multiply gr/dscf by 2288 to obtain mg/dscm.

^b Not available or not measured.

^c Not measured simultaneously with metals, but is value from 5/88 tests.

^d All concentrations are referenced to dry gas with 12% CO₂.

^e Reported as 2,3,7,8 tetrachlorinated dibenzodioxin equivalent (EPA method).

Table VI. Control of particulate matter (PM), chlorinated dibenzo-p-dioxins (CDD) and dibenzofurans (CDF), and selected heavy metals with lime spray dryer absorber (SDA)/fabric filter (FF) or electrostatic precipitator (ESP) systems.^{6,10,17}

Location, control system and test date	Average PM concentration ^a gr/dscf @ 12% CO ₂		Average total CDD/CDF concentration ng/dscm @ 7% O ₂		Average concentration µg/dscm @ 7% O ₂						Removal, %				
					chromium (Cr)		lead (Pb)		mercury (Hg)						
	inlet	outlet	inlet	outlet	inlet	outlet	inlet	outlet	inlet	outlet	PM	CDD/CDF	Cr	Pb	Hg
Marion County, OR Unit 1, SDA/FF 9/86	0.881	0.0023	43.0	1.26	4.22	0.17	20,500	19	NA ^b	239	99.7	95.7	99.9	99.9	NA
Biddeford, ME Unit A, SDA/FF 12/87	3.20	0.014	903	4.38	2,745	ND ^c	27,352	159	389	ND	99.5	99.4	NA	NA	100
Mid-Conn. ^d Unit 11, SDA/FF 7/88	2.41	0.0040	996	0.646	NA	NA	NA	NA	845	48.6	99.8	99.9	NA	NA	94.2
	1.78	0.0018	747	0.368	NA	NA	NA	NA	657	8.8	99.9	99.9	NA	NA	98.7
Millbury, MA Unit 1, SDA/ESP 2/88	NA	0.0018	NA	NA	NA	98.7	NA	278	NA	565 ^f	NA	NA	NA	NA	NA
Unit 2, SDA/ESP 2/88	NA	0.0083	170	59.2	NA	47.7	NA	330	NA	954	NA	64.3	NA	NA	NA
SEMASS Unit 1, SDA/ESP 3/89	4.280	0.008	NA	9.3	NA	386 ^g	NA	300	NA	59.3	99.8	NA	NA	NA	NA
Unit 2, SDA/ESP 4/89	3.860	0.012	NA	311 ^b	NA	15.6	NA	235	NA	105	99.6	NA	NA	NA	NA

^a Multiply gr/dscf by 2288 to obtain mg/dscm.

^b Not available or not measured.

^c Not detected.

^d All concentrations are for dry gas referenced to 12% CO₂.

^e Values shown are averages for normal SDA/FF temperature operation (performance tests 6, 8, 12, 13, and 14).

^f From May 1988 test.

^g Average value of 4.0, 1148, and 7.3.

^h Average value of 18.0, 6.6, and 907.

in Table VI; thus, little, if any, Hg control is apparent for this SDA/ESP system. The SEMASS units, however, have outlet Hg emissions values suggesting some control, but probably less than the Mid-Connecticut values. Without inlet Hg concentrations for the SEMASS and Marion County units, quantitative comparisons are not possible. The control of Cr and Pb by the SDA/FF systems is similar to PM control (>99 percent). While the PM emissions with the three-field ESPs at Millbury were similar to those with the SDA/FF systems shown in Table VI, the metal concentrations across the ESPs were higher than those for units with FFs. Noting that the ESP inlet temperature at Millbury was about 125°C (255°F) compared with about 140°C (285°F) at the FF inlet and the suspected affinity of both organics and metals for fine particles, it is suspected that the FFs showed higher control of CDD/CDF and metals because of their higher capture of fine particles relative to the ESP.

An ESP is the only air pollution control device on many existing MWC units. Under the proposed emission guidelines, facilities with capacities greater than 225 tonnes/day (250 tons/day) would be required to add acid gas controls and might be required to upgrade or replace PM collectors as well as reduce CDD/CDF emissions. One approach to reducing CDD/CDF emissions is to improve combustion. Combustion modifications at Quebec City led to reduced PM emissions and improved CDD/CDF and CO control.¹⁵ Figure 4 shows the effect of improved combustion (as shown by reduced CO emission) on reducing CDD/CDF emissions. The addition of effective acid gas control and improved PM removal would also be expected to reduce both CDD/CDF and heavy metal emissions.

Summary

The proposed NSPS for MWC facilities concern material separation, good combustion practice, MWC emissions (acid

gases, chlorinated dioxins and furans, heavy metals, and particulate matter), and NO_x control. For existing sources, emission guidelines have been proposed which include material separation, good combustion practice, and the control of MWC emissions. Effective particulate control is essential to minimizing air pollutant emissions such as CDD/CDF and heavy metals. Well-designed and properly operated combustors augmented by multipollutant control systems, such as the lime SDA/FF system, can meet the proposed NSPS for HCl, SO₂, CDD/CDF, and PM. Although some existing facilities now comply with most proposed guidelines, many will require equipment modifications or additions to comply with the proposed GCP and GFC requirements.

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