Particle Size Distribution of Cattle Feedlot Dust Emission

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Abstract. *The cattle feedlot industry is under increased scrutiny and regulatory involvement at state and national levels with regard to particulate matter (PM) emissions from fugitive sources. Concentrations of total suspended particulate matter (TSP) and PM less than 10 micrometers (PM_{10}) aerodynamic equivalent diameter (AED) were measured, using high volume samplers and Sierra Andersen samplers, respectively. Particle size distributions of dust captured on sampler filters were measured with a Coulter Counter model TAII. Mass median diameters for high volume and PM_{10} samplers averaged 9.5 ± 1.5 and 6.9 ± 0.8 µm (AED), respectively. Three cattle feedlots (17,000 to 40,000 head capacity) in the Southern Great Plains were used in the study.*

Keywords. *Feedlots, Emission, Beef, Cattle, Manure, Air quality, Particulates, Particles, Dust, Agriculture.*

The United States has 102 million cattle and calves (average for 1995-1997), and in 1996, a monthly average of 9.2 ± 1.1 million head were in beef cattle feedlots being finished for slaughter (TCFA, 1997). These cattle generally range in live weight from 272 to 544 kg per head with an average of approximately 408 kg. Each animal fed in a normal 150 day fattening period leaves behind approximately 900 kg of dry manure solids, or about 1800 dry kg per head of feed lot capacity each year (Sweeten, 1996). The animal spacing per head varies regionally, according to rainfall and winter temperatures. Average animal spacings are typically 7 to 12 square meters (m^2) per head in the desert southwest (less than 250 mm annual precipitation), 14 to 18 m^2 per head in the southern central Great Plains (380 to 500 mm/yr precipitation), and 20 to 37 m^2 per head in the eastern and northern Great Plains (500 to 900 mm/yr precipitation).

Most of the manure deposited on the feedlot surface is compacted in a relatively moist state of 35 to 50% moisture content wet basis. The surface manure becomes pulverized by cattle hooves and is subject to drying in dry weather to moisture contents of only 10 to 25% through mixing and evaporation.

Measurements of total suspended particulate matter (TSP) with standard high volume samplers both upwind and downwind of 25 California feedlots during the summer resulted in an average net TSP concentration of 654 µg/m^3 with a range of 54 to 1268 µg/m^3 (Algeo et al., 1972). The net TSP was the difference between the downwind and upwind concentrations and reflected the dust contribution from the feedlots. The peak daily total suspended particulate concentrations were usually observed at or just after sundown for 2 h (1900-2200 h local time), and ranged from 1946 to 35 536 µg/m^3, averaging 14 200 ± 11 815 µg/m^3 for 10 feedlots (Elam et al., 1971). The high peak dust concentrations in early evening result from increased cattle activity as ambient temperatures drop following daytime heating. Dust control practices in place for two of the 10 feedlots reduced concentrations to 1446 and 3153 µg/m^3 at the peak hours. Minimum dust concentrations observed in early morning (0600 h) were one or two orders of magnitude below the maximum and mean TSP concentrations.

At three Texas feedlots, Sweeten et al. (1988) measured net particulate (TSP) concentrations for 24-h sampling periods. Net particulate concentrations are the downwind concentration adjusted for upwind concentration to reflect the contribution of the feedlot only. Net concentrations averaged 410 µg/m^3 and ranged from 68 to 882 µg/m^3. For 4- and 5-h time intervals within the 24-h sampling periods, the extreme range of TSP dust concentrations was 16 to 17 000 µg/m^3.

By comparison, U.S. Environmental Protection Agency (USEPA, 1982) National Ambient Air Quality Standards (NAAQS) for 24-h average sampling periods from 1971 to 1987, in place at the time of the California study, were as follows: (a) primary standard, 260 µg/m^3; (b) secondary standard, 150 µg/m^3. The purpose of primary standards, according to the 1970 Federal Clean Air Act was immediate protection of the public health. As such, primary standards were to be achieved regardless of cost within a specified time limit. Secondary standards were to protect the public from known or anticipated adverse effects. The time schedule for their achievement was to be determined by state and local governments (Wark and Warner, 1981). Care must be taken when comparing the NAAQS to net

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concentrations downwind from feedyards. An ambient standard is used to estimate the average 24-h exposure of the public in an area such as a city or town. Net concentrations downwind from feedyards which are usually located in a rural area will disperse downwind and will not correspond to the 24-h concentrations measured to determine compliance with the NAAQS in the city or town that may be located thousands of meters downwind.

The USEPA (1987) replaced the TSP standards for all sources in the U.S. with a PM_{10} standard based on particulate matter (PM) having mass median diameter of 10 microns (μm) (AED). In essence, the revision was based on the premise that fine, rather than coarse dust, needed to receive greater focus in protecting human health. The PM_{10} primary and secondary 24-h standards were changed to 150 $\mu g/m^3$ for a 24-h average with no more than one exceedance per year (USEPA, 1987). Two instruments (manufactured by Wedding and Associates and by Sierra Andersen) were accepted for PM_{10} measurement by the USEPA, and other instruments or methods have been developed as well (Herber and Parnell, 1988).

A procedure developed by Raina and Parnell (1994) involved use of a Coulter Counter to determine particle size distribution of particulate collected with a high volume sampler and, based on these measurements, mathematically deriving the PM_{10} concentration. Their data with agricultural processing dusts suggested that the Coulter Counter method may give a more accurate indication of median aerodynamic particle diameter and cumulative PM_{10} concentration.

With increasing concerns for human health effects believed caused by fine particulate matter (respirable dust), the NAAQS was again revised in July 1997 by USEPA, adding new primary and secondary standards for $PM_{2.5}$ (AED) (Anderson, 1997). The new 24-h primary and secondary $PM_{2.5}$ standard is 65 $\mu g/m^3$ calculated as the three-year average of the 98th percentile reading at each monitor. The annual standard is 15 $\mu g/m^3$ as the three-year average of annual arithmetic means. In addition to the new $PM_{2.5}$ standard, the 1987 NAAQS for PM_{10} was left in place, except that the PM_{10} exceedance criterion for 24-h samples was changed to 99th percentile (i.e., fourth highest concentration) rather than one exceedance per year.

Purpose and Objectives

The purpose of this article was to compare field data from both TSP and PM_{10} samplers at cattle feedyards. Historically, there is a much larger database in the literature for TSP samplers than for PM_{10} samplers. The TSP data from California was used as the basis for USEPA emission factors for the cattle feeding industry. The first PM_{10} data from feedyards was Sweeten et al. (1988), and no data on $PM_{2.5}$ from feedlots has appeared in the literature.

The objectives of this research were as follows: (1) to determine and compare particle size distributions of PM collected from cattle feedlots using high volume (TSP) and PM_{10} samplers; and (2) to compare the mass fraction less than 10 micrometers of PM captured with paired PM_{10} and standard high volume samplers. The goal of this research was to illustrate how historical TSP data from feedyards can be placed in perspective of more recently adopted EPA sampling methods.

Procedure and Scope

The research project was conducted by agricultural engineers at Texas A&M University System in three, open, unpaved cattle feedlots in the Texas High Plains and West Central Texas. These three feedlots had capacities of: 45,000 head (Moore County), 42,000 head (Deaf Smith County), and 17,000 head (Tom Green County) for Feedlots A, B, and C, respectively. The sampling program was conducted for 12 months: January to December 1987. The experimental design was provided in Sweeten et al. (1988). Each feedlot was sampled on three occasions, during which the intent was to sample at each feedyard for two successive 24-h periods. However, operational difficulties or weather events prevented a second sampling on three occasions. Hence, of the 16 experiments started, 15 were completed, in that Experiment 6 was terminated due to heavy rainfall soon after startup. The numbers of experiments completed at feedlots A, B, and C were 5, 4, and 6, respectively. Detailed procedures together with resulting upwind and downwind dust concentrations and feedlot manure moisture contents, were reported earlier (Sweeten et al., 1988).

The feedlot particulate emissions were monitored using standard high-volume samplers shop-built at Texas A&M University's Department of Agricultural Engineering in accordance with the TSP reference method (USEPA, 1982). Samplers were positioned upwind and downwind of the feedlots. For each sampler, particulates were collected on a cellulose filter (20.3 cm × 25.4 cm) that was held in a standard filter holder cartridge (General Metal Works, Inc.). Airflow was controlled using a Dayton 0.45-kw vacuum motor with speed manually controlled by rheostat. Pressure drop across the orifice meter was measured with a magnahelic gauge (Dwyer). Pressure differentials were 5.1 to 7.6 cm of water.

For some of these experiments, a selective 10-micron (μm) inlet designed as a PM_{10} sampler (Sierra-Andersen Model 321-A) was mounted on top of a standard high volume sampler (General Metal Works). The PM_{10} sampler operated like the TSP sampler except the inlet baffle design atop the filter was more complex and removed coarse particles. The PM_{10} sampler was placed alongside of (within 2.4 m) one of the standard high volume samplers at a downwind position during the 24-h sampling.

Dust particles collected on filters were extracted from a subsample of each exposed filter. Particle size distribution (PSD) was determined for this dust using a Coulter Counter Model TAII (Coulter Electronics, Inc., 1980). The resulting PSD data from the Coulter Counter TAII were in a form of percent volume versus equivalent spherical diameter (ESD). The percent volume is equivalent to percent mass if one assumes that the particle density is constant for the different particle size ranges. The ESD can be converted to aerodynamic equivalent diameter (AED) by multiplying by the square root of particle density (McFarland et al., 1978). The result is a PSD in the form of percent mass versus AED. The particle density of cattle feedlot dust was determined to be 1.71 ± 0.05 g/cm^3.

With respect to budget and technical staff time available, Experiments 11, 14, and 16 at Feedlots A, C, and B, respectively, were selected for obtaining the particle size distribution data from both TSP and PM_{10} samplers. These experiments were considered typical in that: (a) they contained the range of net downwind dust concentrations for 4- and 5-h sampling intervals (i.e., 16 to 17 000 $\mu g/m^3$); and (b) the 24-h net TSP concentrations ranged from 313 to 862 $\mu g/m^3$. The average dust concentration for Experiments 11, 14, and 16 used for the particle size distribution analysis was 29% higher than the average for all 15 experiments (Sweeten et al., 1988). The three selected experiments used a total of 15 pairs of cellulose filters (i.e., 30 filters) exposed to TSP and PM_{10} dust. However, two of the filters in Experiment 14 (Feedlot C) were not used because of a 180° wind shift during the sampling interval. Data on particle size distribution of TSP feedlot dust emissions collected with high volume samplers only at all three feedlots in Experiments 1-5 and 7-8 are also discussed herein for comparison in validating the more extensive results of Experiments 11, 14, and 16.

Results and Discussion

Dust Concentrations

A comparison of particulate measured TSP and PM_{10} concentrations at the same downwind location for Experiments 11, 14, and 16 are shown in table 1. TSP concentrations for 5-h time intervals ranged from 97 to 1685 $\mu g/m^3$ and averaged 700 ± 484 $\mu g/m^3$. Correspondingly, the PM_{10} particulate concentrations ranged from 11 to 866 $\mu g/m^3$ and averaged 285 ± 214 $\mu g/m^3$. In all cases, these results represented the approximate center of the downwind plume at the location of the samplers (i.e., 15 m to 61 m beyond the feedpens).

Particle Size Distribution

The resulting cumulative PSD (16 particle size ranges) for the PM captured by the high volume samplers is presented in table 2 and by the PM_{10} samplers in table 3. Each value in tables 2 and 3 represents a total of 13 filters with three sub-samples per filter or 39 observations each. The MMD for the high volume sampler was 9.54 ± 1.45 µm (AED) (table 2) and for the PM_{10} sampler was 6.91 ± 0.78 µm (AED) (table 3). Standard deviations for each size range were largest near the median diameter.

The cumulative percentages (mean ± standard deviation) for the high volume and the PM_{10} samplers are shown in figure 1. This data shows that 34% of the particles trapped

Table 1. Comparison of downwind dust concentrations measured with standard high volume sampler vs adjacent PM_{10} sampler inlet

Feedlot and Experiment Number	Nominal Time Interval	Measured Particulate Concentration ($\mu g/m^3$): TSP, High Vol Sampler	Measured Particulate Concentration ($\mu g/m^3$): Andersen Sampler PM_{10} Inlet	Ratio of PM_{10} to TSP
A-11 (6-7 Oct 1987)	1p-6p	1,685	531	0.31
	6p-11p	1,017	379	0.37
	11p-4a	466	236	0.51
	4a-9a	659	222	0.34
	9a-1p	1,604	866	0.54
C-14 (15-16 Oct 1987)	3p-8p	777	274	0.35
	8p-1a	366	107	0.29
	1a-6a	97	11	0.11
B-16 (8-9 Dec 1987)	5p-10p	228	191	0.84
	10p-3a	412	216	0.52
	3a-8a	426	171	0.40
	8a-1p	730	250	0.34
	1p-6p	632	250	0.40
Mean		700	285	0.41
Standard Deviation		484	214	0.17

Table 2. Cumulative percent of downwind cattle feedlot dust larger than or equal to specified aerodynamic equivalent diameter (µm) — High volume samplers; N = 39 (13 filters @ 3 subsamples/filter)

Coulter Counter: Channel Number	Coulter Counter: Size Range (µm)	Aerodynamic Equivalent Diameter* (µm)	Cumulative Percent by Particle Mass Exceeding Aerodynamic Equivalent Diameter: Mean	Standard Deviation	Minimum Value	Maximum Value
1	1.26-1.59	1.65-2.08	100.00	0.00	100.00	100.00
2	1.59-2.00	2.08-2.62	99.26	0.05	99.17	99.33
3	2.00-2.52	2.62-3.29	96.82	0.58	95.56	97.73
4	2.52-3.17	3.29-4.14	93.75	1.35	91.25	95.88
5	3.17-4.00	4.14-5.23	89.75	2.36	85.54	93.51
6	4.00-5.04	5.23-6.59	84.41	3.64	77.77	90.20
7	5.04-6.35	6.59-8.30	77.18	5.15	67.75	85.37
8	6.35-8.00	8.30-10.46	68.53	6.60	56.37	78.90
9	8.00-10.08	10.46-13.18	58.18	7.75	44.16	70.57
10	10.08-12.7	13.18-16.61	46.54	8.34	31.99	59.77
11	12.7-16.0	16.61-20.92	34.38	7.93	20.68	46.89
12	16.0-20.1	20.92-26.41	23.44	6.44	12.99	33.49
13	20.2-25.4	26.41-33.21	14.79	4.40	7.52	22.50
14	25.4-32.0	33.21-41.84	8.21	2.60	4.33	13.87
15	32.0-40.3	41.84-52.70	3.84	1.50	1.57	8.74
16	40.3-50.8	52.70-66.43	1.56	1.00	0.76	5.30
Mass Median Diameter (MMD)			9.54	1.45	—	—
Geometric Standard Deviation (GSD)			2.11	0.06	—	—

* Aerodynamic equivalent diameter equals Coulter Counter Mass Median Diameter times the square root of the particle density (g/cm^3), i.e., Aerodynamic equivalent diameter, µm = Coulter Size, µm × $\sqrt{1.71}$.

Table 3. Cumulative percent of downwind cattle feedlot dust larger than or equal to specified aerodynamic equivalent diameter (µm) — Andersen PM_{10} sampler inlet, N = 38 (13 filters @ 3 subsamples/filter)

Coulter Counter: Channel Number	Coulter Counter: Size Range (µm)	Aerodynamic Equivalent Diameter* (µm)	Cumulative Percent by Particle Mass Exceeding Aerodynamic Equivalent Diameter: Mean	Standard Deviation	Minimum Value	Maximum Value
1	1.26-1.59	1.65-2.08	100.00	0.00	100.00	100.00
2	1.59-2.00	2.08-2.62	99.27	0.05	99.17	99.33
3	2.00-2.52	2.62-3.29	96.05	0.59	94.67	97.27
4	2.52-3.17	3.29-4.14	91.74	1.49	88.19	94.67
5	3.17-4.00	4.14-5.23	85.77	2.68	79.10	91.07
6	4.00-5.04	5.23-6.59	77.51	4.10	67.16	85.63
7	5.04-6.35	6.59-8.30	66.44	5.52	52.53	77.23
8	6.35-8.00	8.30-10.46	54.11	6.32	38.73	66.29
9	8.00-10.08	10.46-13.18	41.64	6.38	27.13	53.57
10	10.08-12.7	13.18-16.61	30.83	5.79	19.06	40.84
11	12.7-16.0	16.61-20.92	22.46	4.72	14.02	30.92
12	16.0-20.1	20.92-26.41	16.21	3.65	10.18	23.06
13	20.2-25.4	26.41-33.21	11.17	2.68	6.82	16.62
14	25.4-32.0	33.21-41.84	7.03	1.86	4.27	11.54
15	32.0-40.3	41.84-52.70	3.86	1.44	1.74	7.19
16	40.3-50.8	52.70-66.43	1.79	0.88	0.74	4.06
Mass Median Diameter (MMD)			6.91	0.78	—	—
Geometric Standard Deviation (GSD)			2.14	0.07	—	—

* Aerodynamic equivalent diameter equals Coulter Counter Mass Median Diameter times the square root of the particle density (g/cm^3), i.e., Aerodynamic equivalent diameter, µm = Coulter Size, µm × $\sqrt{1.71}$.

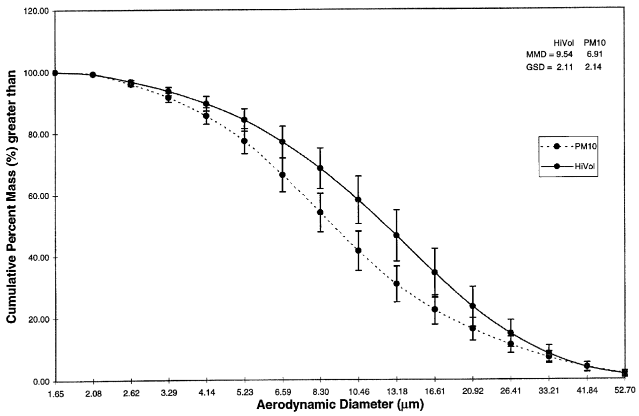

Figure 1–Mass fraction of feedlot dust of given size captured with high volume and PM_{10} samplers.

on the PM_{10} sampler filters were actually larger than 10 µm and 66% were smaller than 10 µm. Theoretically, a PM_{10} sampler should be able to provide a sample with 100% of particles smaller than 10 µm. Hence, the Andersen PM_{10} sampler used in this experiment over-sampled large particles, which is consistent with the previous finding (Sweeten et al., 1988) that the Andersen PM_{10} sampler yielded a much higher PM_{10}/TSP ratio (0.40) than for two Wedding PM_{10} monitors (0.19) used simultaneously in several experiments (data not shown).

Comparison of Downwind Dust Particle Size for Two Types of Samplers

Values of MMD and geometric standard deviation (GSD) were determined for each of the three subsamples per filter, and mean MMD and GSD values were determined for each filter. Mean values of MMD and GSD for each filter and for all feedlots were tabulated as shown in table 4. Experiment 11 at Feedlot A resulted in a grand mean MMD value of 8.57 ± 0.74 µm (AED) from the TSP sampler and 6.22 ± 0.44 µm (AED) with the Andersen PM_{10} sampler. For Experiment 14 at Feedlot C, the grand mean value of MMD was 11.38 ± 0.55 µm (AED) for the high volume sampler versus 7.85 ± 0.49 µm (AED) for the PM_{10} sampler. Mean values of MMD at Feedlot B (Experiment 16) averaged 9.41 ± 1.44 µm (AED) with a high volume sampler and 7.00 ± 0.52 µm (AED) for the PM_{10} sampler, which were intermediate to those particle sizes determined for Feedlots A and C.

Table 4. Mass Median Diameters (MMD) and Geometric Standard Deviations (GSD), means* and standard deviations, for paired tests using high volume (TSP) and PM_{10} samplers at 3 feedlots

Feedlot & Exp. Number	Standard High Volume Sampler			Andersen PM_{10} Sampler Inlet		
	Filter No.	MMD ± Std. Dev.	GSD ± Std. Dev.	Filter No.	MMD ± Std. Dev.	GSD ± Std. Dev.
A-11	108	7.39 ± 0.01	2.07 ± 0.04	109	5.49 ± 0.27	2.13 ± 0.08
	115	9.08 ± 0.29	2.20 ± 0.10	116	6.35 ± 0.12	2.10 ± 0.05
	122	9.26 ± 0.26	2.10 ± 0.06	123	6.65 ± 0.21	2.10 ± 0.11
	129	8.78 ± 0.21	2.06 ± 0.01	130	6.23 ± 0.06	2.13 ± 0.02
	136	8.36 ± 0.20	2.13 ± 0.01	137	6.37 ± 0.07	2.09 ± 0.02
		8.57 ± 0.74	2.11 ± 0.06		6.22 ± 0.44	2.11 ± 0.02
C-14	216	10.75 ± 0.20	2.06 ± 0.03	217	8.19 ± 0.30	2.10 ± 0.05
	221	11.78 ± 0.20	2.05 ± 0.02	222	8.08 ± 0.24	2.13 ± 0.03
	228	11.62 ± 0.18	2.09 ± 0.02	229	7.29 ± 0.09	2.19 ± 0.02
		11.38 ± 0.55	2.07 ± 0.02		7.85 ± 0.49	2.14 ± 0.05
B-16	291	7.19 ± 0.03	2.08 ± 0.03	292	7.45 ± 0.20	2.24 ± 0.06
	302	8.73 ± 0.10	2.06 ± 0.02	303	6.31 ± 0.05	2.02 ± 0.01
	312	10.12 ± 0.32	2.17 ± 0.02	313	6.61 ± 0.06	2.14 ± 0.04
	322	10.38 ± 0.45	2.22 ± 0.06	323	7.10 ± 0.14	2.21 ± 0.02
	332	10.62 ± 0.05	2.16 ± 0.02	333	7.51 ± 0.06	2.19 ± 0.05
		9.41 ± 1.44	2.14 ± 0.07		7.00 ± 0.52	2.16 ± 0.09
Grand mean, all filters	9.54†			6.89†		
Standard dev. of filter means	1.47			0.79		

* Data are means of 3 subsamples per filter, except for filter no. 130 (n = 2).
† Statistically significant difference at $p < 0.001$.

Within each feedlot, a statistical comparison was made between the grand mean value of MMD for high volume versus PM_{10} samplers. The comparison involved data for all filter subsamples. These data were analyzed as a group experiment assuming both equal variances and unequal variances within feedlots using a Students t-test statistic (Steel and Torrie, 1960). In both cases, there was no statistically significant difference between the grand mean values of MMD for high volume versus PM_{10} samplers.

The grand mean MMD and standard deviations were 9.54 ± 1.47 µm (AED) for the TSP sampler and 6.89 ± 0.79 µm (AED) for the PM_{10} sampler (table 4). Statistical analysis was conducted to determine if there was a significant difference between the grand mean value of MMD of dust captured by the standard high volume sampler versus the Andersen PM_{10} sampler. Analyzing these data as a group experiment with the assumption of equal variances yielded no significant differences at the 5% probability level of Type I error ($p < 0.05$). However, when these data were analyzed as a paired experiment (Steel and Torrie, 1960), significant differences were found at $p < 0.001$ probability level. Hence, the null hypothesis of equal means of MMD (AED) resulting from the two type of samplers was rejected.

The values plotted in figure 1 indicate that less than 50% of the TSP collected on downwind samplers was smaller than 10 µm (AED). Figure 1 also shows that 5% or less of downwind TSP was smaller than 2.5 µm (AED).

Experiments 1 to 8 — PSD Analysis on High Volume Sampler Filters

Particle size distribution data was also obtained for Experiments 1-5 and 7 to 8 (Experiment 6 was aborted due to rainfall) for comparison in validating results of Experiments 11, 14, and 16. These experiments involved continuous 24-h TSP sampling with high volume samplers and therefore produced only one filter per sampler for each experiment. The TSP concentrations for these experiments ranged from 68 to 882 µg/m^3 net increase (downwind minus upwind) across the feedyards. PM_{10} data were not collected because PM_{10} samplers had not yet become available to the research team.

The Coulter Counter particle size distribution analyses for all seven experiments representing all three feedlots are shown in table 5. These data compare downwind and upwind results in terms of MMD of particulate emissions together with GSD. Across all three feedlots, the MMD of TSP captured in downwind high volume samplers was 14.2 µm (AED) as compared to 12.3 µm (AED) captured in upwind samplers.

Also shown in table 5 is the mass fraction (percent) of feedlot dust particles below 10 µm (AED). Results indicated that 33.2% of the downwind TSP was smaller

Table 5. Mass Median Diameters (MMD) and Geometric Standard Deviations (GSD) of ambient dust captured on upwind and downwind TSP filters at three feedlots in 24-h continuous sampling (experiments 1-5 and 7-8)

Feedlot & Experi-ment	Mass Median Diameter (µm)		Geometric Standard Deviation (µm)		Percent of Particles Below 10 µm	
Numbers	Upwind	Downwind	Upwind	Downwind	Upwind	Downwind
A-1, 7, 8	13.6	14.6	2.8	3.5	34.9	31.6
B-2, 5	11.5	15.2	2.8	2.8	41.8	31.4
C-3, 4	11.2	12.5	2.7	2.7	44.6	38.5
Mean, 3 feedlots	12.3	14.2	2.8	3.1	39.6	33.2

than 10 µm (AED), while 39.6% of the upwind TSP was smaller than 10 µm (AED). The remaining 66.8% and 60.4% of TSP was larger than 10 µm (AED). Less than 5% of the TSP downwind samples was smaller than 2.5 µm (AED).

Summary and Conclusions

Total suspended particulate (TSP) concentrations emitted from three West Texas and High Plains cattle feedlots were measured with standard high volume samplers. Particulate with aerodynamic particle size of 10 µm (AED) or less (PM_{10}) was also measured simultaneously for three of the experiments. Comparative percentages of particulate that exceeded 16 discrete aerodynamic particle sizes ranging from 1.65 to 66.4 µm (AED) were determined on subsamples of filters exposed at downwind locations using both types of samplers and results were compared. The principal findings and conclusions were as follows:

1. Most of the TSP sampled downwind of three feedlots was found to be relatively coarse material as compared to current USEPA standards pertaining to PM_{10} and $PM_{2.5}$.
2. The mass median diameters were 9.5 ± 1.5 µm (AED) and 6.9 ± 0.8 µm (AED) for particulate matter sampled with TSP and PM_{10} samplers at downwind locations, respectively.
3. The geometric standard deviations (GSD) were 2.11 ± 0.06 µm (AED) for TSP and 2.14 ± 0.07 µm (AED) for PM_{10}.
4. The concentrations of PM_{10} determined by multiplying the mass fraction less than 10 µm (from the Coulter Counter PSD) times the TSP concentration measured by the high volume sampler was always less than direct measurement of PM_{10}. There is a possibility that the PM_{10} sampler "over-sampled" PM_{10}.
5. Differences between MMD values for the two types of samplers were not statistically significant within feedlots, nor were significant difference found between MMD values for the two samplers across all three feedlots when analyzed as a group experiment. However, differences between MMD values for TSP and PM_{10} samples were statistically significant at $p < 0.001$ across all three feedlots when data were analyzed as a paired experiment.
6. The MMD values for TSP found in these experiments were smaller than obtained with 24-h sampling intervals in seven previous experiments at the same three feedlots in which downwind MMD values averaged 14.2 µm (AED) and upwind MMD values were 12.3 µm (AED).
7. Particles smaller than 2.5 µm (AED) represented approximately 5% of TSP.
8. The Coulter Counter method can be used to determine PSD for feedlot dust and to supplement direct data collection using PM_{10} samplers.

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