Can Dust Control Reduce Feedyard Odor Intensity?

Chemical Characterization of Odorants Sorbed to Feedyard Dust. Implications for Odor Control

FINAL REPORT

Research project funded and submitted to the

Texas Cattle Feeders Association

November 14, 2003

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SUMMARY

Preseparator head for particulate sampling was modified for insertion and sampling of 4 different ranges of particulate matter and gases using solid phase microextraction (SPME). The modified preseparator was interfaced with an AirMetrics Mini-Vol sampling pump and deployed eight times at the Texas Agricultural Experiment Station Research Feedlot at Bushland, Texas and Feedyard C in northwest Texas. Sampling times ranged from 1.5 hrs to 24 hrs. Samples were analyzed using gas chromatography-mass spectrometry. A significant increase of the number of detected compounds was observed when sampling was moved from experimental feedyard and a commercial feedayrd. This was due to the improvement of the analytical method, the use of optimized sampling conditions.

More than 40 VOCs were detected when sampling was conducted at a commercial feedyard. The majority of compounds was detected in at least 3 out of 4 fractions sampled (TSP, PM-10, PM-2.5, and gas). Preliminary data analysis shows that there was no clear trend between a VOC and the dust/gas fraction at which a VOC was detected. The likely reason of this lack of apparent trend is due to the imperfections in the SPME fiber locations during the sampling. These imperfections could cause biased exposure of some SPME fibers due to different air velocities and therefore loading rates for dust/gases at each separating stage.

Based on the results on these experiments we cannot yet conclude if dust control would have any effect on odorous VOCs reduction. This is because more work needs to be done to perfect the sampling methodology. In particular, equal velocities in the dust/gas sampling train have to be achieved in order for unbiased SPME sampling. This can be accomplished using cyclones for size separation. Additional funding will be sought to continue experiments in this promising area. The analytical part of experiments worked very well.

METHODOLOGY

Preseparator head for particulate sampling was modified for insertion and sampling of 4 different ranges of particulate matter and gases using solid phase microextraction (SPME). **Figure 1** and **Figure 2** show the schematic and actual photo of the modified device.

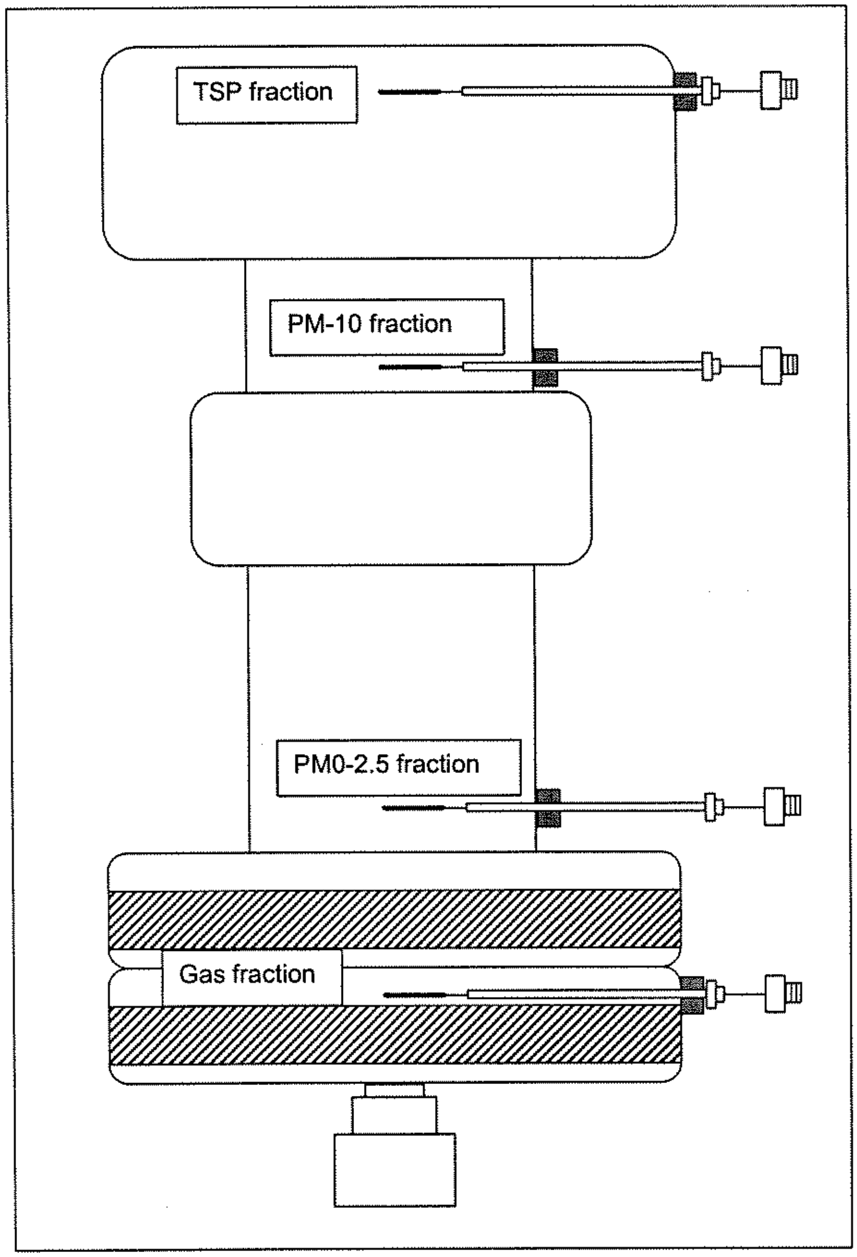

Figure 1. Modified particulate matter separator head for sampling of different size fractions with solid phase microextraction (SPME) fibers.

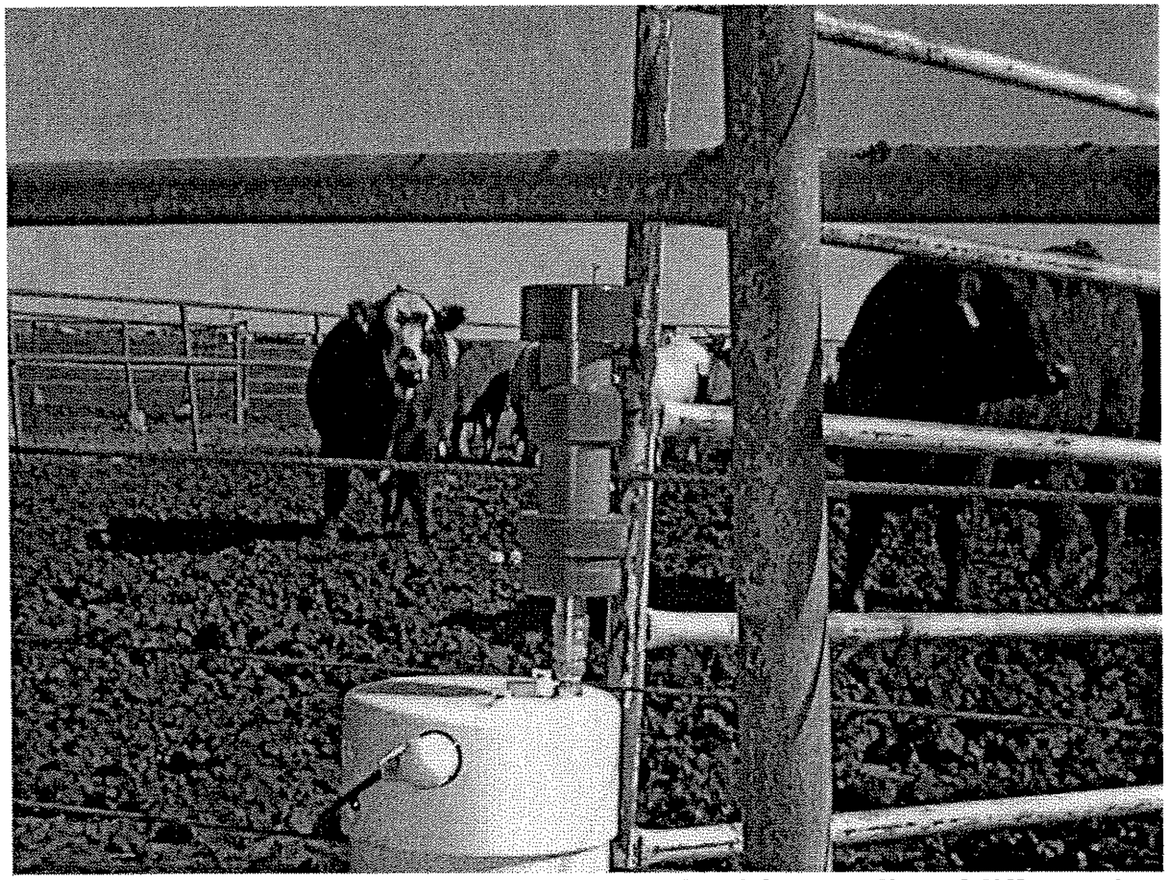

Figure 2. Modified particulate matter separator head for sampling of different size fractions with solid phase microextraction (SPME) fibers at Feedyard C.

Sample collection and sample analysis. Sampling took place on 8 different occasions at the Texas Agricultural Experiment Station Research Feedlot at Bushland, Texas and Feedyard C in northwest Texas. Samples were collected with SPME fibers. Sampling time varied from 1.5 hr to 24 hrs (**Table 1**). Each sample was capped with a PTFE plug, placed inside a glass culture vial, and placed on ice for transportation to the laboratory GC-MS to preserve the adsorbed breath components on the SPME coating.

Gas chromatography mass spectrometry methods. The model 3800 GC/MS (Varian Inc., Walnut Creek, CA) equipped with a 30 m by 0.25 mm by 0.25 μm film ZB-Wax capillary column (Phenomenex, Torrance, CA). A new Saturn user library was created with the new column to identify compounds in samples.

Data Analysis. Every breath sample was analyzed within 24 hrs from the time of collection. During that time samples were refrigerated at 4 °C. A user library was created for breath compounds with very short (0.5 s) extractions from the headspace of pure solvents. Peaks were considered "identified" when their mass spectral fit values were at the default value of 700 or above and their respective retention time matched the retention times (± 4 s) of the compounds in the user library. Peaks under the category of "unidentified" represent the best match to the NIST spectral data base library.

Table 1. Schedule of sampling events.

Date	Sampling location	Sampling time	Number of samples per each fraction
08/21/2001	Experimental Feedlot - Bushland	1:30 h	1
08/22/2001	Experimental Feedlot - Bushland	2:55 h	1
08/24/2001	Experimental Feedlot - Bushland	4:16 h	1
05/14/2002	Feedlot C	24 h	1
10/22/2002	Feedlot C	24 h	1
10/23/2002	Feedlot C	24 h	1
10/24/2002	Feedlot C	24 h	1
05/09/2003	Feedlot C	24 h	1

RESULTS

Tables 2 through 7 summarize area counts for each identified compound and given sample location. Area counts are related to concentrations of each compound.

Table 2. Area counts for VOCs in each dust/gas fraction collected with SPME (08/21/2002).

VOC	TSP	PM-10	PM-2.5	Gas
Isobutyraldehyde	128,666	nd	nd	nd
Acetone	213,814	24,415	21,106	18,204
2-Methyl-1-propanol	nd	14,792	nd	11,213
Pentadecane	nd	13,718	nd	nd
3-hydroxy-2-butanone	nd	nd	nd	18,283

No VOCs were detected in the samples collected on August 22 and August 24, 2001.

Table 3. Area counts for VOCs in each dust fraction collected with SPME (5/14/2002).

VOC	TSP	PM-10	PM-2.5	Gas
Isobutyraldehyde	128,666	nd	nd	nd
Acetone	213,814	24,415	21,106	18,204

Table 4. Area counts for VOCs in each dust fraction collected with SPME (10/22/2002).

VOC	TSP outside	TSP inside	PM10	PM2.5	gas
2,2-Butadione			114,726	362,990	370,500
2-Methyl-1-propanol	12,727	21,100	46,188	24,313	23,822
2-octanone	59,058	70,402			
4-ehtylphenol	73,448	46,848	11,972		
Acetaldehyde	66,680	28,619	21,701		21,556
Acetic acid	1,306,272	801,156	1,040,754	1,988,614	1,703,144
Acetone	49,952	40,271	39,719	64,705	80,793
Acetophenone	89,637	36,040	77,614	44,229	55,255
Butyl acetate			39,574	59,700	
Butyric acid	387,955	305,989	294,500	260,198	342,389
Decanal	54,311	129,748	329,703	711,576	788,775
Decane	19,380	17,186	34,114	32,518	29,895
Dodecane	21,865	29,632	74,984	53,036	
Ethylbenzene	12,679		21,150	37,387	26,043
Hexanal	29,081	21,100	46,188	36,823	35,764
Isobutyraldehyde				41,239	
Isobutyric acid	33,519	17,929			
Isopropyl alcohol	14,393				
Isovaleric acid	120,154	62,046	70,109	109,416	76,822
Methyl acetate	62,106		39,719		
Methyl ethyl ketone			114,726	362,990	370,500
Methylamine	2,077,089	802,162	583,590	556,084	572,237
Nonane				12,341	46,198
Nonanoic acid	127,718	101,750	137,605	82,566	121,309
Octanal	76,228	63,492	77,704	125,121	123,180
Octane			96,361		
Pentadecane	60,322	40,919	108,403	71,250	60,615
Phenol	400,410	273,073	361,249	131,568	364,208
Propionic acid	83,105	91,915		45,818	96,944
Styrene	12,317			15,911	18,034
Tetradecanal	25,713	28,200	15,117	13,715	17,905
Tetradecane	28,327	196,836	150,913	97,348	72,942
Toluene	20,721		15,163	80,602	59,414
Tridecane	21,460	20,997	73,880	57,006	43,335
Undecane	18,204	12,352	73,963	39,770	29,607
Undecanoic acid	25,713	28,200	15,117	13,715	17,905
Valeric acid	191,071	111,911	139,116	118,482	122,165

Table 5. Area counts for VOCs in each dust fraction collected with SPME (10/23/2002).

VOC	TSP outside	TSP inside	PM-10	PM-2.5	gas
2,3-Butadion			185,705	385,110	242,663
2-Methyl-1-propanol		23,435		27,036	17,016
2-octanone	47,453	33,157	85,406		
4-ehtylphenol	74,096	50,707		17,706	17,864
Acetaldehyde	57,930	56,220			54,403
Acetic acid	223,716	428,806	836,522	1,468,654	1,013,352
Acetone			57,053	97,021	58,740
Acetophenone	62,409	29,575	41,624	40,787	72,050
Benzene	18,792	22,030	13,624	11,099	
Butyl acetate		28,684		65,914	
Butyl alcohol			32,625		26,840
Butyric acid	161,556	247,656	87,672	186,327	161,626
Decanal	40,880	101,846	308,411	432,965	423,136
Decane	36,911	37,258	36,626	18,429	28,694
Dodecane	10,677	16,850			38,368
Ethylbenzene	72,375	64,571	33,825	39,595	26,484
Hexanal		30,947		70,710	17,016
Hexane				15,143	
Isobutyraldehyde		16,799			
Isobutyric acid			23,724	19,345	
Isopropyl alcohol		10,195			
Isovaleric acid	44,453	48,500	118,178	59,491	38,923
Methyl acetate			57,053		
Methyl ethyl ketone			185,705	385,110	302,608
Methylamine	1,470,785	1,154,417	430,073	283,496	182,985
Nonane	18,097	14,663	20,870	73,002	10,097
Nonanoic acid		60,428	216,724	59,052	52,367
Octanal	47,422	44,801	84,265	85,617	101,507
Octane			179,513	12,022	298,159
Pentadecane		25,588	174,899	50,383	17,308
Phenol	29,352	478,978	165,871	250,701	207,813
Propionic acid	47,922	70,004		59,886	29,652
Styrene	23,912				21,884
Tetradecanal	22,641	20,514			
Tetradecane	17,049		153,790	66,419	75,085
Toluene	183,453	196,064	103,530	214,311	106,601
Tridecane	37,455	23,032	69,512	76,362	
Undecane		30,245		49,691	18,519
Undecanoic acid	21,192	20,514			

Table 6. Area counts for VOCs in each dust fraction collected with SPME (10/24/2002).

VOC	TSP inside	PM-10	PM-2.5
2-Methyl-1-propanol	48,364	63,636	94,373
2-methylthiophene			13,753
Acetic acid	190,694	175,065	177,193
Acetone	58,612	12,582	40,954
Acetophenone	17,999	26,607	35,355
Benzene	20,605		12,575
Decanal	44,994	42,959	59,403
Decane	99,329	53,442	143,131
Dodecane	82,567	159,528	139,232
Ethylbenzene	112,780	148,167	153,390
Hexanal	54,840	71,413	94,373
Hexane	19,554		
Isobutyraldehyde	11,748		12,326
Isobutyric acid		13,586	
Isopropyl alcohol	28,640		23,836
Methyl acetate		12,582	
Methylamine	173,066	101,040	188,522
Nonane			15,168
Nonanoic acid	10,965		
Octanal	21,809	29,139	39,952
Octane	58,612		40,954
Pentadecane	56,981	88,624	94,404
Phenol	44,998	63,161	56,816
Propionic acid		12,526	
Styrene		22,106	37,179
Tetradecane	77,488	121,876	134,950
Toluene	115,822	99,921	146,909
Tridecane	38,033	68,349	72,033
Undecane	59,335	96,121	148,638

Table 7. Area counts for VOCs in each dust fraction collected with SPME (5/09/2002).

VOC	TSP inside	PM-10	PM-2.5
2-Methyl-1-propanol	48,364	63,636	94,373
2-methylthiophene			13,753
Acetic acid	190,694	175,065	177,193
Acetone	58,612	12,582	40,954
Acetophenone	17,999	26,607	35,355
Benzene	20,605		12,575
Decanal	44,994	42,959	59,403
Decane	99,329	53,442	143,131
Dodecane	82,567	159,528	139,232
Ethylbenzene	112,780	148,167	153,390

CONCLUSIONS

More than 40 VOCs were detected when sampling was conducted at a commercial feedyard. The majority of compounds was detected in at least 3 out of 4 fractions sampled (TSP, PM-10, PM-2.5, and gas). Preliminary data analysis shows that there was no clear trend between a VOC and the dust/gas fraction at which a VOC was detected. The likely reason of this lack of an apparent trend is due to the imperfections in the SPME fiber locations during the sampling. These imperfections could cause biased exposure of some SPME fibers due to different air velocities and therefore loading rates for dust/gases at each separating stage. We will be further exploring this bias with statistical analyses.

Based on the results on these experiments we cannot yet conclude if dust control would have any effect on odorous VOCs reduction. This is because more work needs to be done to perfect the sampling methodology. In particular, equal velocities in the dust/gas sampling train have to be achieved in order for unbiased SPME sampling. This can be accomplished using cyclones for size separation. Additional funding will be sought to continue experiments in this promising area. The analytical part of experiments worked very well.