AP42 Section:	9.12.1
Title:	Emission Factor Documentation for AP-42 Section 9.12.1 Malt Beverages Final Report October 1996 APPENDICES ONLY

Emission Factor Documentation for AP-42 Section 9.12.1

Malt Beverages

Final Report

For Emission Inventory Branch
Office of Air Quality Planning and Standards
U. S. Environmental Protection Agency

Appendices only

EPA Contract No. 68-D2-0159
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APPENDIX A

REPORT EXCERPTS FROM REFERENCE 8

(Characterization of Fermentation Emissions, 1983)

SAI-83/1209

CHARACTERIZATION OF FERMENTATION EMISSIONS FROM CALIFORNIA BREWERIES

FINAL REPORT

26 OCTOBER 1983

Richard D. Rapoport
Principal Investigator

Authors

Richard D. Rapoport
Michael A. Guttman
Michael B. Rogozen

Science Applications, Inc.
1900 Avenue of the Stars
Suite 900
Los Angeles, California 90067

Prepared for
State of California
Air Resources Board
Sacramento, California 95812

Contract No. A2-073-32

Joseph Pantalone, Project Officer

Table 5.3-4

SPECIES PRUFILE - FERMENTATION ROOM EXHAUST VENT, RUN #1, ANCHOR BREWING[a]

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[b] g/hr	(oz/hr)	kg/yr	(lbs/yr)
ethanol	210.00	99.30	278.71	(9.83)	2,441.50	(5,382.58)
ethyl acetate	1.40	0.64	1.86	(0.07)	16.29	(35.91)
unidentified	0.13	0.06	0.17	(0.01)	1.49	(3.28)
Total	211.53	100.00	280.74	(9.91)	2,459.28	(5,421.77)

[a] represents emissions from one 3-day-old brew and two 2-day-old brews.

[b] exhaust flow rate (95-percent confidence interval; d.f. = 17) = 22.12 $\pm$ 2.45 actual m^3/min; cycle time = 1,440 min/day, 365 days/year.

Table 5.3-5

SPECIES PROFILE - FERMENTATION ROOM EXHAUST VENT, RUN #2, ANCHOR BREWING[a]

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[b] g/hr	(oz/hr)	kg/yr	(lbs/yr)
ethanol	62.00	99.70	82.29	(2.90)	720.86	(1,589.22)
unidentified	0.20	0.30	0.26	(0.01)	2.28	(5.03)
Total	62.20	100.00	82.55	(2.91)	723.14	(1,594.25)

[a] represents emissions from two 2-day-old brews and one new brew.

[b] exhaust flow rate (95-percent confidence interval; d.f. = 17) = 22.12 $\pm$ 2.45 actual m^3/min; cycle time = 1,440 min/day, 365 days/year.

Table 5.3-6

SPECIES PROFILE - BREW KETTLE STACK, ANCHOR BREWING[a]

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[b] g/day	(oz/day)	kg/yr	(lbs/yr)
dimethyl sulfide	56.00	32.22	105.84	(3.73)	22.01	(48.52)
C_5-aldehyde	46.00	26.47	86.94	(3.07)	18.08	(39.86)
acetaldehyde	26.00	14.96	49.14	(1.73)	10.22	(22.53)
C_5-aldehyde	19.00	10.93	35.91	(1.27)	7.47	(16.47)
myrcene	9.00	5.18	17.01	(0.60)	3.54	(7.80)
ethanol	4.00	2.30	7.56	(0.27)	1.57	(3.46)
others	9.78	5.63	18.48	(0.65)	3.84	(8.47)
unidentified	4.00	2.30	7.56	(0.27)	1.57	(3.46)
Total	173.78	99.99	328.44	(11.59)	68.30	(150.57)

[a] Uncontrolled mode

[b] Exhaust flow rate (95-percent confidence interval; d.f. = 21) = 10.50 $\pm$ 2.04 actual m^3/min; average two cycles (90 minutes each) per day; brewing 4 days/week, 52 weeks/year.

Table 5.3-7

SPECIES PROFILE - HOT WORT TANK VENT, ANCHOR BREWING[a]

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[b]			
			g/day	(oz/day)	kg/yr	(lbs/yr)
myrcene	103.00	34.44	23.90	(6.84)	4.97	(10.96)
C_5-aldehyde	41.00	13.71	9.51	(0.33)	1.98	(4.36)
ethanol	35.00	11.70	8.12	(0.29)	1.69	(3.73)
dimethyl sulfide	31.00	10.37	7.19	(0.25)	1.50	(3.31)
acetaldehyde	16.00	5.35	3.71	(0.13)	0.77	(1.70)
B-caryophyllene	11.00	3.68	2.55	(0.09)	0.53	(1.17)
C_5-aldehyde	9.30	3.11	2.16	(0.08)	0.45	(0.99)
furfural	7.20	2.41	1.67	(0.06)	0.35	(0.77)
phenyl acetaldehyde	5.40	1.81	1.25	(0.04)	0.26	(0.57)
cyclic hydrocarbons	4.50	1.50	1.04	(0.04)	0.22	(0.48)
others	24.35	8.14	5.65	(0.20)	1.17	(2.58)
unidentified	11.30	3.78	2.62	(0.09)	0.54	(1.19)
Total	299.05	100.00	69.37	(2.44)	14.43	(31.81)

[a] Working emissions

[b] Exhaust flow rate (95-percent confidence interval; d.f. = 20) = 2.90 $\pm$ 1.00 actual m^3/min; average two cycles (40 minutes each) per day, 4 days/week, 52 weeks/year.

Table 5.3-8

SPECIES PROFILE - MASH TUN STACK, ANCHOR BREWING

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[b]			
			g/day	(oz/day)	kg/yr	(lbs/yr)
dimethyl sulfide	56.00	53.48	18.75	(0.66)	3.90	(8.60)
C_5-aldehyde	23.00	21.97	7.70	(0.27)	1.60	(3.53)
C_5-aldehyde	15.00	14.33	5.02	(0.18)	1.04	(2,29)
ethanol	4.60	4.39	1.54	(0.05)	0.32	(0.70)
C_5-alcohol	2.70	2.58	0.90	(0.03)	0.19	(0.42)
others	2.82	2.69	0.95	(0.03)	0.20	(0.44)
unidentified	0.59	0.56	0.20	(0.01)	0.04	(0.09)
Total	104.71	100.00	35.06	(1.23)	7.29	(16.07)

[a] Exhaust flow rate (95-percent confidence interval; d.f. = 20) = 1.08 $\pm$ 0.35 actual m^3/min; average two cycles (155 minutes each) per day; brewing 4 days/week, 52 weeks/year.

Table 5.3-9

SPECIES PROFILE - LAUTER TUN STACK, ANCHOR BREWING

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[a]			
			g/day	(oz/day)	kg/yr	(lbs/yr)
ethanol	16.00	54.24	9.19	(0.32)	1.91	(4.21)
dimethyl sulfide	5.90	20.00	3.39	(0.12)	0.71	(1.57)
C_5-aldehyde	3.70	12.54	2.12	(0.07)	0.44	(0.97)
C_5-aldehyde	2.30	7.80	1.32	(0.05)	0.27	(0.59)
acetaldehyde	1.60	5.42	0.92	(0.03)	0.19	(0.42)
Total	29.50	100.00	16.94	(0.59)	3.52	(7.76)

[a] Exhaust flow rate (95-percent confidence interval; d.f. = 10) = 1.98 $\pm$ 0.57 actual m^3/min; average two cycles (145 minutes each) per day, 4 days/week, 52 weeks/year.

Table 5.3-10

SPECIES PROFILE - SPENT GRAIN HOLDING TANK, ANCHOR BREWING

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[a] g/day	(oz/day)	kg/yr	(lbs/yr)
ethanol	5.10	100.00	5.21	(0.18)	1.08	(2.39)

[a] Exhaust flow rate > 25.53 actual m^3/min (beyond range of hot-wire anemometer); average two cycles (20 minutes each) per day, 4 days/week, 52 weeks/year.

Table 5.3-11

VOC CONCENTRATION AND EMISSION RATES AS A FUNCTION OF PROCESS SITE, FACILITY A

Site	Concentration (mg/m^3)	Exhaust Flow Rate (actual m^3/min)	Process Cycle Time (min)[b]	Emission Rate kg/day	(lbs/day)	mt/yr	(tons/yr)
Mash tun stack	6.19[a]	134.20	120[f]	1.50	(3.30)	0.55	(0.60)
Rice cooker stack	0.28	141.39	45	0.03	(0.06)	0.01	(0.01)
Brew kettle stack	49.26	133.78	90	8.89	(19.62)	3.25	(3.58)
Strainmaster stack	96.59	94.82	25	3.44	(7.58)	1.25	(1.38)
Activated carbon regeneration vent	467.72 52.86	10.76	1440[e]	1.68[d]	(3.70)	0.61	(0.67)
Beechwood chip washer vent	25.37	98.45	60[c]	2.10	(4.63)	0.77	(0.84)
Waste beer sump	120.00	9.9	1440[e]	1.71	(3.77)	0.62	(0.69)
Total				19.35	(42.66)	7.06	(7.77)

[a] Average of two cycles; standard error = $\pm$ 0.76

[b] 15 brews/day, 365 days/yr

[c] 14 cycles/day

[d] Estimate based on first sample; see Section 5.3.5.2 for calculations

[e] One cycle

[f] Facility operates two mash tuns; one brew's mashing cycle overlaps another in time.

Table 5.3-12

SPECIES PROFILE - BREW KETTLE STACK, FACILITY A

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[a]			
			kg/day	(lbs/day)	kg/yr	(lbs/yr)
myrcene	23.00	46.69	4.15	(9.16)	1,516.16	(3,342.57)
dimethyl sulfide	14.00	28.42	2.53	(5.57)	922.88	(2,034.61)
ethanol	1.90	3.86	0.34	(0.76)	125.25	(276.12)
C_5-aldehyde	1.70	3.45	0.31	(0.68)	112.06	(247.06)
B-caryophyllene	1.10	2.23	0.20	(0.44)	72.51	(159.86)
acetaldehyde	1.10	2.23	0.20	(0.44)	72.51	(159.86)
aliphatic hydrocarbons	0.69	1.40	0.12	(0.27)	45.48	(100.28)
others	3.82	7.75	0.69	(1.52)	251.81	(555.16)
unidentified	1.95	3.96	0.35	(0.78)	128.54	(283.39)
Total	49.26	99.99	8.89	(19.62)	3,247.20	(7,158.19)

[a] Exhaust flow rate = 133.78 actual m^3/min; 15 cycles (90 minutes each) per day.

Table 5.3-13

SPECIES PROFILE - STRAINMASTER EXHAUST STACK, FACILITY A

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[b]			
			kg/day	(lbs/day)	kg/yr	(lbs/yr)
dimethyl sulfide	77.00	79.72	2.74	(6.04)	999.34	(2,203.18)
C_5-aldehyde	9.80	10.14	0.35	(0.77)	127.19	(280.40)
acetaldehyde	4.80	4.97	0.17	(0.38)	62.30	(137.34)
others	4.68	4.85	0.17	(0.37)	60.74	(133.91)
unidentified	0.31	0.32	0.01	(0.02)	4.02	(8.87)
Totals	96.59	100.00	3.44	(7.58)	1,253.59	(2,763.70)

[a] Stack flow rate = 94.82 actual m^3/min; 15 cycles (25 minutes, each) per day.

Table 5.3-14

SPECIES PROFILE - BEECHWOOD CHIP WASHER VENT, FACILITY A

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[a]			
			kg/day	(lbs/day)	kg/yr	(lbs/yr)
ethanol	25.00	98.54	2.07	(4.56)	754.62	(1,663.65)
unidentified	0.37	1.46	0.03	(0.07)	11.17	(24.62)
Total	25.37	100.00	2.10	(4.63)	765.79	(1,688.27)

[a] Exhaust flow rate = 98.45 actual m^3/min; 14 cycles (60 minutes each) per day, 365 days/year.

Table 5.3-15

SPECIES PROFILE - CO_2 PURIFICATION SYSTEM, ACTIVATED CARBON REGENERATION VENT, RUN #1 FACILITY A[a]

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[b]			
			g/day	(oz/day)	kg/yr	(lbs/yr)
ethanol	360.00	76.97	1,291.20	(45.55)	471.29	(1,039.01)
ethyl acetate	59.00	12.62	211.61	(7.46)	77.24	(170.28)
C_7-ester	13.00	2.78	46.63	(1.64)	17.02	(37.52)
C_5-alcohol	11.00	2.35	39.45	(1.39)	14.40	(31.75)
dimethyl sulfide	8.00	1.71	28.69	(1.01)	10.47	(23.09)
others	14.52	3.10	52.08	(1.84)	19.01	(41.91)
unidentified	2.20	0.47	7.89	(0.28)	2.88	(6.35)
Total	467.72	100.00	1,677.55	(59.17)	612.31	(1,349.91)

[a] Run #1 taken during the first two hours of the cycle.

[b] Exhaust flow rate = 10.76 actual m^3/min (9.10 standard m^3/min at 68^oC), 365 cycles/year; see Section 5.3.5.2 for calculations.

Table 5.3-16

SPECIES PROFILE - CO_2 PURIFICATION SYSTEM, ACTIVATED CARBON REGENERATION VENT, RUN #2, FACILITY A[a]

Compound	Concentration (mg/m^3)	Percent of Total Concentration
ethyl acetate	24.00	45.40
ethanol	11.00	20.81
C_5-alcohol	8.70	16.46
C_7-ester	3.44	6.51
dimethyl sulfide	2.70	5.11
unidentified	1.96	3.71
others	1.06	2.00
Total	52.86	100.00

[a] Run #2 taken during last 1.5 hours of the cycle.

Table 5.3-17

SPECIES PROFILE - WASTE BEER SUMP, FACILITY A

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[a]			
			kg/day	(lbs/day)	kg/yr	(lbs/yr)
ethanol	120.00	100.00	1.71	(3.77)	624.41	(1,376.59)

[a] Exhaust flow rate = 9.9 actual m^3/min; one cycle (1,440 minutes) per day.

Table 5.3-18

SPECIES PROFILE - MASH COOKER STACK, FACILITY A

Compound	Concentration[a] (mg/m^3)	Percent of Total Concentration	Emission Rate[b] kg/day	(lbs/day)	kg/yr	(lbs/yr)
ethanol	3.30 ± 0.10	53.31	0.80	(1.76)	290.95	(641.43)
dimethyl sulfide	2.75 ± 0.65	44.43	0.66	(1.46)	242.46	(534.53)
hexanal	0.03 ± 0.00	0.48	0.01	(0.02)	2.64	(5.83)
unidentified	0.11 ± 0.01	1.78	0.03	(0.06)	9.70	(21.38)
Total	6.19 ± 0.76	100.00	1.50 ± 0.10	(3.30 ± 0.22)	545.75 ± 67.01	(1,203.17 ± 147.73)

[a] Mean ± standard error (n = 2)

[b] Exhaust flow rate = 134.20 actual m^3/min; 15 cycles (120 minutes each) per day; totals represent mean ± std. error.

Table 5.3-19

SPECIES PROFILE - RICE COOKER STACK, FACILITY A

Compound	Concentration (mg/m^3)	Percent of Total Concentration	Emission Rate[a]			
			g/day	(oz/day)	kg/yr	(lbs/yr)
hexanal	0.18	64.29	17.18	(0.61)	6.27	(13.82)
unidentified	0.10	35.71	9.54	(0.34)	3.48	(7.68)
Total	0.28	100.00	26.72	(0.95)	9.75	(21.50)

[a] Exhaust flow rate = 141.39 actual m^3/min; 15 cycles (45 minutes each) per day, 365 days/yr.

Table 5.4-1

EMISSION FACTOR CALCULATIONS FOR ANCHOR BREWING[a]

Parameter	Process Site					
	Mash Tun Stack	Lauter Tun Stack	Brew Kettle Stack	Hot Wort Tank Vent	Fermentation Room Exhaust Vent[b]	Spent Grain Holding Tank
VOC Concentration in the Sample, mg/m^3	104.71	29.50	173.78	299.05	211.53	5.10
Exhaust Flow Rate, m^3/min	1.08 $\pm$ .35	1.98 $\pm$ .57	10.50 $\pm$ 2.04	2.90 $\pm$ 1.00	22.12 $\pm$ 2.45	>25.53
Process Cycle Time, min	155	145	90	40	1440	20
Amount of Beer Per Cycle, bbls	96	96	96	96	288	96
Emission Factor, kg VOC/10^3 bbl	.183 $\pm$ .059	.088 $\pm$ .025	1.711 $\pm$ .332	.361 $\pm$ .125	23.395 $\pm$ 2.591	>.027
(lb VOC/10^3 bbls)	(.403 $\pm$ .130)	(.194 $\pm$ .056)	(3.771 $\pm$ .733)	(.797 $\pm$ .275)	(51.578 $\pm$ 5.713)	(>.060)

bbls = barrels of beer (31 gallons/barrel)

[a] Uncertainty ranges based on 95-percent confidence interval for exhaust flow rate measurements.

[b] Based on Run #1

Table 5.4-2

EMISSION FACTOR CALCULATIONS FOR FACILITY A

	Process Site					
Parameter	Mash Cooker Stack	Rice Cooker Stack	Strainmaster Stack	Brew Kettle Stack	Activated Carbon Regeneration Vent	Beechwood Chip Washer Vent
VOC Concentration in the Sample, mg/m^3	6.19 ± 0.76	0.28	96.59	49.26	467.72	25.37
Exhaust Flow Rate, m^3/min	134.20	141.39	94.82	133.78	10.76	98.45
Process Cycle Time, min	120	45	25	90	NA	60
Amount of Beer Per Cycle, bbls	800	800	800	800	5600	343
Emission Factor kg VOC/10^3 bbl	0.125 ± 0.015	0.002	0.286	0.741	0.300	0.437
(lbs VOC/10^3 bbls)	(0.275 ± 0.034)	(0.005)	(0.631)	(1.634)	(0.660)	(0.963)

NA - not applicable

APPENDIX B

REPORT EXCERPTS FROM REFERENCE 10

(Coors, March 1993)

Brewing

Operation	Emission Factor
Brewhouse - VOC	0.94 lb/1000 barrels (7)
Brewhouse - PM	0.52 lb/1000 barrels
Extract-Grain Separation (CARB report)	*0.63 lb/1000 barrels*
Wort Processing - Trub Settling Tank	0.075 lb/1000 barrels
Wort Processing - Open Wort Cooling/Aeration (1)	0.022 lb/1000 barrels
Fermenting - venting of CO2 (2)	2.0 lb/1000 barrels
Aging - fill on vent	0.09 lb/1000 barrels
Aging - venting of CO2 pressure (3)	0.43 lb/1000 barrels
Aging - tank purging of CO2 (4)	3.1 lb/1000 barrels
Blending/Finishing - fill on vent (5)	0.29 lb/1000 barrels
Blending/Finishing - tank evacuation (6)	1.0 lb/1000 barrels

(1) Based on emission data from open wort cooler.
(2) Based on venting of CO2 for the first 24 hours of fermentation cycle.
(3) Factor applies to facility which opens aging vessel to atmosphere for any reason after each batch.
(4) Factor applies to facilty which purges CO2 from aging vessels after each batch.

(6) Factor will vary slightly depending on atmospheric conditions to which tank is evacuated.
(7) In all cases "1000 barrels" refers to finished product volume i.e. total volume of beer produced at the facility.

BREWHOUSE

General Process Description

In the brewhouse, the milled raw materials are mixed together with water and cooked in large kettles. The kettles have names such as mash tuns, cereal cookers, mash-in kettles, and brew kettles. In the course of cooking these materials, VOC and PM are emitted. The VOC consists of a complex mixture of at least 60 different compounds. No ethanol is present in the liquid at this point in the process.

Information Relating to Source Test

In November 1990 Western Environmental Services and Testing Inc performed a source test on the north brew kettle stack and the north combined cooker stack The results are reported in Stack Test Report No. 7. The north brew kettle stack vents the brew kettles from four brew lines. The north combined cooker stack vents all other vessels from the same four brew lines. During the source test, three of the four brew lines were operating.

The north brew kettle stack is equipped with a system to recover some of the energy lost when the water is converted to steam. The closed loop system is known as stack heat reclaim. The water in the closed loop system is sprayed into the kettle exhaust stack through a series of nozzles. This system also acts as a stack scrubber, as can be seen from the stack test data taken with stack heat reclaim on. In developing our emission factor we used data with the stack heat reclaim off, for maximum applicability to other facilities. Our emission factor for VOC from brewhouse operations is 0.94 lbs/1000 barrels beer produced (finished product volume). The emission factor for PM from brewhouse operations is 0.52 lb/1000 barrels (finished product volume).

The VOC is reported as propane, due to the complex nature of the stream. For more detail on components of brewhouse vapors see the enclosed paper entitled "Condensation and Thermal Treatment of Brewhouse Vapors" by K. Muller and R. Meyer-Pittroff.

Applicability

All breweries must have brewhouse operations as part of their brewing process. This factor should apply to virtually any brewery, except where the emissions from brew kettles or other brewhouse vessels are controlled.

ENGINEERING CALCULATION SHEET
CI—2343-D

SUBJECT	PROJECT NUMBER	DATE
Emission factor - brewhouse		2/4/93

PREPARED BY	ENGINEERING TYPE	WORK PACKAGE NUMBER	PAGE
Jere Zimmerman	Ch. E.		1 OF 2

(1) Emission rates taken from 11/90 source test. See Stack Test results, Book 7.

(2) Three brewlines were operating during the source test.

VOC from brewkettles

$0.98 \frac{lb}{hr} \times 8760 \frac{hr}{yr} = 8585 \frac{lb}{yr}$ for three brewlines
(Book 7, p. 4)

VOC from other kettles (mash tun, etc.)

$0.08 \frac{lb}{hr} \times 8760 \frac{hr}{yr} = 701 \frac{lb}{yr}$ for three brewlines
(Book 7, p. 2)

Total VOC for three brewlines $= 8585 + 701 = 9286 \frac{lb}{yr}$

Each brewline can produce 3.3 million barrels of beer (on a finished product basis) per year.

$$9286 \frac{lb}{yr} \times \frac{}{3 \text{ brewlines}} \times \frac{\text{brewline}}{3.3 \times 10^6 \text{ bbl}}$$

$= 0.94$ lb VOC/10^3 bbl finished product produced for brewhouse (includes brewkettles, mash tuns, etc.)

ENGINEERING CALCULATION SHEET
CI—2343-D

SUBJECT	PROJECT NUMBER	DATE
Emission factor - brewhouse		2/4/93

PREPARED BY	ENGINEERING TYPE	WORK PACKAGE NUMBER	PAGE
Jere Zimmerman	Ch. E.		2 OF 2

PM from brewkettles

$0.46 \frac{lb}{hr} \times 8760 \frac{hr}{yr} = 4030 \frac{lb}{yr}$ for three brewlines

(Book 7, p. 4)

PM from other kettles

$0.13 \frac{lb}{hr} \times 8760 \frac{hr}{yr} = 1139 \frac{lb}{yr}$ for three brewlines

(Book 7, p. 2)

Total PM for three brewlines $= 4030 + 1139 = 5169 \frac{lb}{yr}$

Each brewline can produce 3.3 million barrels of beer (on a finished product basis) per year.

$$5169 \frac{lb}{yr} \times \frac{}{3 \text{ brewlines}} \times \frac{\text{brewline}}{3.3 \times 10^6 \text{ bbl}}$$

$= 0.522$ lb PM/10^3 bbl finished product for brewhouse (includes brewkettles, mash tuns, etc.)

WORT PROCESSING

General Process Description

Once boiled, the wort must be processed to remove protein solids called trub. Small amounts of VOC can be emitted as the wort holding tanks are filled. Emissions might also come from the cooling and aeration of the wort, which is necessary before the fermentation process begins.

Information Relating to Source Test

At the facility studied, the trub is removed from the hot wort in a vessel called a whirlpool. A source test was performed on the whirlpool vent July 3, 1992 by Clean Air Engineering. The results are reported in Stack Test Report No. 1. The test data was analyzed on a per batch basis, but the emissions came primarily during the filling of the vessel, in the first 20 minutes of a batch cycle. The emission factor for filling a wort holding vessel is 0.075 lb/1000 barrels beer produced (finished product volume).

The open plate wort coolers were source tested on July 3, 1992 by Clean Air Engineering (see Stack Test Report No. 1). In this process hot wort flows over a stainless steel plate filled with cooling liquid. Air is pulled in, filtered and blown countercurrently over the wort. Once contacting the wort this air is released to atmosphere. The stack test was performed on one cooler with a capacity of 22 barrels per minute (36 barrels per minute on a finished product volume basis). The emission factor for open wort cooling is 0.022 lb/1000 barrels (finished product volume).

Applicability

If a brewery removes the trub from the hot wort, the factor for the wort holding vessel should apply. Many breweries cool their wort using closed plate heat exchangers, so the wort cooling factor would not apply to them. However, where the wort aeration step is done as an open process, the open wort cooling factor gives a good approximation of emissions from that process.

ENGINEERING CALCULATION SHEET

CI—2343-D

SUBJECT		PROJECT NUMBER	DATE
Emission Factor - Wort Processing			2/4/93
PREPARED BY	ENGINEERING TYPE	WORK PACKAGE NUMBER	PAGE
Jere Zimmerman	Ch. E.		1 OF 1

Emission rates taken from 7/92 stack test, see Book 1.

<u>VOC emissions for filling trub settling tank:</u>

$$\frac{0.0616\ \text{lb}}{\text{batch}} \times \frac{\text{batch}}{820\ \text{bbl}} \times \frac{1000\ \text{bbl}}{1000\ \text{bbl}} = 0.075 \frac{\text{lb}}{1000\ \text{bbl finished product}}$$

(Book 1, p. 1-7) (Finished product volume)

<u>VOC emissions for open wort cooling or aeration:</u>

$$0.047 \frac{\text{lb}}{\text{hr}} \times \frac{\text{min}}{36\ \text{bbl}} \times \frac{\text{hr}}{60\ \text{min}} \times \frac{1000\ \text{bbl}}{1000\ \text{bbl}} = 0.022 \frac{\text{lb}}{1000\ \text{bbl finished product}}$$

(capacity, finished product basis)

BLENDING/FINISHING

General Process Description

Blending/Finishing is the process in which aged beer is filtered and blended into the final product. The beer is then stored in tanks prior to being packaged. There are two processes that occur during finishing/blending that cause the emission of ethanol (VOC) to the atmosphere. First is fill-on-vent (FOV) which occurs each time a clean empty tank is filled with beer. As the tank is filled, a CO_2 blanket is provided so that the beer does not come in contact with oxygen. The air (CO_2, O_2, and ethanol) above the blanket is displaced as the tank is filled and vented to atmosphere. The second process, known as evacuation, occurs after a tank has been emptied to allow tank cleaning by production personnel. The evacuation process draws outside air through the tank to atmosphere to increase the oxygen content within the tank.

Information Relating to Source Test

Stack testing was performed during an FOV process on an Aging Cellar (the Aging FOV process is similar to Finishing/Blending). Results from the test are summarized in Table 1 and the VOC emission factor has been calculated on the calculation sheet.

For the evacuation process, the emission rate was based on the peak VOC concentration measured during an evacuation process at one of the Fermenting and Aging Cellars. The emission factor calculation for this process is presented on the attached calculation sheet.

For the above calculations, both the vent/evacuation frequency and total tank volume must be known. On average, the blending/finishing process takes aged beer through three steps, each in a different tank. [redacted]

Applicability

All breweries have the finishing/blending process. The application of these emission factors will depend on the average number of steps (tanks) the beer is processed through prior to packaging. It is important to note that the frequency of venting and evacuation depends on several factors such as throughput and cleaning schedule.

Packaging

Operation	Emission Factor
Can Filling (1)	38 lb/ 1000 barrels filled
Bottle Filling (1)	37 lb/ 1000 barrels filled
Keg Filling	0.69 lb/ 1000 barrels filled
Defill (2)	3.0 lbs/ hour
Defill (3)	0.46 lbs/ hour
Bottlewash - VOC (4)	0.23 lb/ 1000 case

(1) Includes point and fugitive emissions, derived from sterile fill process.
(2) Defill system utilized a pneumatic crushed can transport system.
(3) Defill system utilized a mechanical system.
(4) Based on cases input into the system (case=24-12 oz. bottles)

PACKAGING - DEFILL

General Process Description

The defill operation is utilized to remove beer from containers (cans and bottles) for a variety of reasons, including rejects from beer filling operations. A defiller is typically comprised of a conveyor system which leads the containers to a grinder. Full cans and bottles are then crushed by the system's grinder to evacuate the contained beer. From this point the waste beer is pumped into a holding tank and the container material, which may still contain residual beer, is sent to recycling or the landfill for disposal.

Emission Factor

a) Can Defill (Pneumatic Conveying):

At the tested facility the can defiller was configured with an open system crusher and pneumatic conveyor which transported the crushed cans to a cyclone for collection. Emissions from the can defilling operation are generated when full cans are shredded and emptied.

An initial protocol stack test was performed on the open system crusher just prior to the cyclone which collects the crushed cans. Ethanol emission rates remained fairly steady independent of throughput in barrels per hour. This is believed to be due to the air stream being saturated with ethanol. The calculated emission factor resulting from this testing was 6.6 lbs/hour operation.

The can defilling system was studied and attempts were made to minimize emissions. The crusher roller speeds were changed as well as being modified, and watersprays were introduced to more thoroughly remove beer before the airveyor. In addition, control changes were made in order to deliver cans in batches to the system. A protocol source test was again conducted on the open system crusher. Results from this testing show a calculated emission factor from the upgraded defilling system of 3.0 lbs/hour of operation. The test uncovered that an erroneous assumption was made when determining the initial emission factor, that in fact the initial factor of 6.6 lbs/hour was double what the true factor should have been. After recalculating this emission factor, the test indicated that the adjustments made to the process had little effect on emissions.

b) Bottle Defill (Mechanical Conveying):

Filled bottles are dumped into the bottle crusher unit for crushing by the system's grinder to evacuate the contained beer. The crusher is a source of fugitive VOC emissions. Dumping into the crusher occurs in batches. After crushing, the waste beer and broken glass are passed over a screen for separation. Mechanical conveying is used to transport the broken glass to a truck trailer dump.

A protocol stack sampling test was performed at the bottle crusher unit by placing a temporary enclosure around the unit. Air was provided to the temporary room by a fan and the air was vented to the outside. The testing was conducted at the exhaust duct outside the room. The initial testing indicated a VOC factor of 1.4 lbs/hr of operation.

The bottle crusher unit was upgraded to include a larger dump bin in addition to installing water sprays at the bottle crusher. The water spay unit operates during the beginning of each batch dump. Another protocol stack test was conducted at the bottle crusher following original procedures. Results from this testing indicated a reduction in emission to a VOC factor of 0.46 lbs/hr of operation.

<u>Applicability</u>

Many breweries have defill operations for destruction of packaged beer. The purpose of this operation is to recover the alcohol taxes paid on the product. Typically, defilling is a fugitive VOC source. Additional sources of VOCs from defilling might include breathing and working losses from the waste beer storage tank. The emission factor will vary depending on the method of defilling and the conditions in the defill operation. Testing at the can defill facility and the bottle defill facility indicate that the use of pneumatic conveying promotes emissions from volatile organic compound, i.e., the airveyor acts as an airstripper.

PACKAGING - BOTTLEWASH

General Process Description

Bottlewash systems are used to clean returned long neck bottles prior to refilling with beer. The "as received" bottles are removed from their cases and loaded onto a conveyor system. As the bottles move through the system, they are tilted to allow residual liquid to pour out. The bottles are then given an interior and exterior warm-water prerinse. Residual liquid and rinse water are collected and filtered before disposal.

The bottlewash system is a source of VOC (ethanol and glycol ethers) and sodium hydroxide. Bottlewash systems also have several fugitive emission locations. For ethanol, the first is the trough where the residual liquid and prerinse spray are collected and the second is at the filtering system. For glycol ethers, the soaker (bottle label removal system) is the fugitive emission source due to the use of surfactants.

Emission Factor

A protocol source test was conducted on the bottle washing system. Testing was conducted to determine combined ethanol emissions from the trough and the filtering system. Results from testing indicate an emission factor of 0.00023 lb of VOC per case input. This emission factor was determined by dividing the cumulative quantity of ethanol released from the bottlewash unit over a specific period of time by the number of bottles processed over the same time frame. A mass balance approach was used to determine glycol ether emissions. They are a component of the surfactant used in the label removal process in the bottle soaker. Due to the low vapor pressure of the glycol ethers and the high temperature within the soaker, it was assumed that they completely volatilized out of solution. Glycol ether emission will greatly depend on the surfactant type. Consultation of the surfactant's MSDS for percent volatiles will provide the information required to perform the mass balance.

An emission factor for sodium hydroxide is available through the EPA's AIR CHIEF CD-ROM, version 2.0, Record number 21,858, May 1992. The factor is 9.0 lb/hour of operation.

Applicability

The emission factor for bottle washing should be applicable to any facility which utilizes a beer bottle return system. This would include most breweries. The factor is based on VOC emissions from the initial high temperature pre-rinse prior to entering the bottle washer.

PACKAGING - BOTTLE WASHER

General Process Description

Bottle wash systems are used to clean returned long neck bottles prior to refilling with beer. The "as received" bottles are removed from their cases and loaded onto a conveyor system. As the bottles move through the system, they are tilted to allow residual liquid to pour out. The bottles are then given an interior and exterior warm-water prerinse. Residual liquid and rinse water are collected and filtered before disposal.

The bottle wash system is a source of VOC (ethanol), glycolethers and sodium hydroxide. Bottle wash systems also have several fugitive emission locations. For ethanol, the first is the trough where the residual liquid and prerinse spray are collected and the second is at the filtering system. For glycolethers, the soaker (bottle label removal system) is the fugitive emission source due to the use of surfactants.

Information Relating to Source Test

A mass balance approach was utilized to calculate the bottle washer VOC emission factor. The calculation is based on bottle case input to the system. System output is not utilized due to bottle breakage at various steps within the bottle washer. VOC emissions are fugitive due to the prerinse process prior to the bottles entering the caustic wash. The high temperature water from the spray rinse (55-57 ^{o}C) is assumed to volatilize 100 percent of the ethanol out of solution.

Residual liquid volume was quantified by pulling random cases off the load-in conveyor and pouring the bottle contents into a container. Two separate tests were run with a resultant volumetric average of 3.2 ± 1.8 quarts of liquid per 40 cases of return bottles. A liquid sample was then analyzed for percent alcohol with a result of 1.82 percent by weight. The reduced alcohol content as compared to packaged beer is believed to be due to warehousing of the open bottles at ambient temperatures prior to being brought on-site for cleaning. The attached calculation sheet provides the emission factor calculation for VOC emissions.

A mass balance approach could also be used to determine glycolether emissions. They are a component of the surfactant used in the label removal process in the bottle soaker. Due to the low vapor pressure of the glycolethers and the high temperature within the soaker, it was assumed that they completely volatilized out of solution. Glycolether emission will greatly depend on the surfactant type. Consultation of the surfactant's MSDS for percent volatiles will provide the information required to perform the mass balance.

An emission factor for sodium hydroxide is available through the EPA's AIR CHIEF CD-ROM, Version 2.0, Record number 21,858, May 1992. The factor is 9.0 lb/hour of operation.

Applicability

The emission factor for bottle washing should be applicable to any facility which utilizes a beer bottle return system. This would include most breweries. The factor is based on fugitive VOC emissions from the initial high temperature pre-rinse prior to entering the bottle washer.

Packaging - Bottle Washer Emission Factor Calculation

$$EF = \left(\frac{3.2\ quarts}{40\ cases}\right)\left(\frac{gal}{4\ quarts}\right)\left(8.35\,\frac{lb}{gal}\right)(0.0182\ EtOH)$$

$$EF = 3.0\,\frac{lb\ VOC}{10^3\ cases}$$

Notes:

(1) Volume of residual liquid (3.2 quarts) measured by randomly pulling 40 cases off the input conveyor system over a 10 hour period. Two tests performed, average volume was 3.2 ± 1.8 quarts.
(2) Density of residual liquid collected (8.35 lb/gal).
(3) Alcohol content of residual liquid measured at 1.82 percent by weight with a SCABA Automated Beer Analyzer.

SPENT GRAIN DRYING SYSTEM

General Process Description

The spent grain drying system is used to dry spent grain and spent hops The grain that is filtered out of the liquid in the kettles is called spent grain. Spent hops are removed from the wort. Drying of the grain and hops produces VOCs, particulate matter, and carbon monoxide emissions. The composition of VOCs emitted during the drying process is similar to the composition of the VOCs emitted from the brew kettles. Ethanol is not emitted from the dryers, as the spent grain is removed from the brewing process prior to fermentation.

Information Relating to Source Test

At the facility studied, the spent grains are dried in nine, counterflow rotary steam-heated dryers equipped with wet scrubbers. The wet scrubbers are designed to remove particulate matter. The scrubbing water is recirculated making the scrubbers ineffective for VOC control.

The dryers operate continually and are operated near capacity. The feedrate of materials to the dryers is directly linked to the volume of beer produced, however, because beer is produced in batches, the feedrate to the drying system is not constant.

Exhaust from dryers 1 through 4 goes through a scrubber and stack unique to that dryer. Exhaust from dryers 5 through 8 is routed to three wet scrubbers and then vented through two stacks. Exhaust from dryer 9 goes through a separate scrubber and then is mixed with the exhaust from dryers 5 though 8.

Three separate source testing exercises have been conducted on the drying system. In February of 1991, Western Environmental Services and Testing, Inc. (WEST) performed a series of tests to determine VOC, particulate, and carbon monoxide emission rates for several of the dryers and to establish a particulate matter control efficiency for the wet scrubbers. In August of 1992, Clean Air Engineering (CAE) performed testing on Dryer 9 for total hydrocarbon emissions and to determine the particulate removal efficiency for the scrubber. Testing to determine the effect of overdrying on VOC emissions was conducted by Air Pollution Testing, Inc. (APT) on Dryer 4, in November of 1992. Copies of the source test reports are provided (Stack Test Report Nos. 9, 10, and 11).

WEST performed testing at four locations. Tests were run on the North NB4 stack ,the South NB4 stack, and at two locations in the exhaust system for Dryer 4. Measurements were taken at the inlet and outlet of the Dryer 4 wet scrubber. The NB4 North stack vents exhaust from dryers 5, 7, and 8. The South NB4 stack vents dryers 6 and 7. Dryer 9 was not installed at the time of this test, but vents through the south stack. During the testing on the North NB4 stack, two dryers were operating,. One dryer operated during the testing of the NB4 South stack.

CAE conducted testing on Dryer 9. This testing was necessary because Dryer 9 is equipped with a Roto-Clone, type W, size 20 wet scrubber rather than a custom built scrubber, and it was necessary to determine the particulate matter control efficiency of the Roto-Clone scrubber. Testing for VOC emissions was also conducted. The testing was conducted at a point in the ducting which conveys exhaust only from Dryer 9.

APT conducted testing as part of a program designed to determine if the degree to which the grain is dried affects VOC emissions. The tests were conducted on Dryer 4, at a point prior to the wet scrubber. Results from the test program indicate that the VOC emissions cannot be controlled by controlling the moisture content or temperature in the discharged grain.

The emission factor provided below is an average of all available test data. Because feed rate data was not included in the test reports, the factors were developed by correlating the tested emission rates with average feedrate data provided by plant engineering personnel. The emission factors are as follows: 2.6 lbs per 1000 barrels VOC (as propane), 0.94 lbs per 1000 barrels PM (controlled using wet scrubbers), 0.29 lbs per 1000 barrels PM10 (controlled using wet scrubbers), and 0.91 lbs per 1000 barrels CO. These emission factors are on a finished product volume basis.

Applicability

All breweries generate spent grain as a waste stream. Most breweries do not dry the spent grain on site. It is more typically transported wet and used as cattle feed. In some cases, especially at large facilities, more wet spent grain is generated than can be consumed by the local market. In those cases grains may be dried on-site. These factors apply to steam heated dryers. Gas fired dryers would also have emissions from combustion.

EMISSION FACTOR SUMMARY FOR SPENT GRAIN DRYING SYSTEM

Pollutant	Emission Factor (lbs/1000 barrels)
Volatile Organic Compounds	2.64
Particulate Matter	0.94 (controlled using wet scrubbers)
PM10	0.29 (controlled using wet scrubbers)
Carbon Monoxide	0.91

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO.

SIGNATURE K McDonnell DATE 2/9/93 CHECKED DATE

PROJECT Air Quality Mgmt Support JOB NO. 238-094

SUBJECT Spent Grain Dryer Emissions SHEET 1 OF 8 SHEETS

Convert the emission rates from the Spent Grain Dryer Source tests to an emission factor in lbs of pollutant per 1000 barrels of finished beer produced

Feedrates to the dryers during the periods when source testing was conducted are not available. Information on the average feedrates to the dryers has been provided by Plant Engineering personnel.

The average feedrate to the spent grain drying system is the grain from one brew per brewline every 2 hours.

There are now 8 brewlines. There were 7 brewlines when the WEST, Inc testing was done.

There are 820 finished barrels of beer per brew. (on a finished product volume basis)

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO.

SIGNATURE K. McDonnell DATE 2/9/93 CHECKED DATE

PROJECT Air Quality Mgmt Services JOB NO. 238-094

SUBJECT Spent Grain Dryer Emissions SHEET 2 OF 8 SHEETS

The feedrate to the spent grain drying system during the WEST, Inc. test can be calculated:

$$\frac{1 \text{ brew}/2 \text{ hours}}{\text{brewline}} \times 7 \text{ brewlines} = 3.5 \frac{\text{brews}}{\text{hour}}$$

On a per dryer basis (8 dryers were in place at that time):

$$3.5 \frac{\text{brews}}{\text{hour}} \times \frac{1}{8 \text{ dryers}} = 0.44 \frac{\text{brews/hour}}{\text{dryer}}$$

The feedrate after the 8^{th} brewline and 9^{th} dryer were installed is estimated as:

$$\frac{1 \text{ brew}/2 \text{ hours}}{\text{brewline}} \times 8 \text{ brewlines} = 4.0 \frac{\text{brews}}{\text{hour}}$$

On a per dryer basis:

$$4.0 \frac{\text{brews}}{\text{hour}} \times \frac{1}{9 \text{ dryers}} = 0.44 \frac{\text{brews/hour}}{\text{dryer}}$$

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APPENDIX C

REPORT EXCERPTS FROM REFERENCE 11

(Coors, November 1992)

Stack Test Report # 1

309 pp

Clean Air Engineering

REPORT ON COMPLIANCE TESTING

Performed for:
COORS BREWING COMPANY
GOLDEN, COLORADO

CAE Project No: 6265-1
November 25, 1992

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	75	78	76	
CAN	Moisture	%	1.7	0.8	0.8	
FILLER	Oxygen	%	20.7	20.9	20.9	
ROOM	Volumetric flow, actual	acfm	32060	33660	33160	
VENT	Volumetric flow, standard	dscfm	25410	26780	26460	26216.667
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	1.42983	1.52817	1.48063	
	Pollutant concentrations:					
	THC as propane	ppmdv	61	61	51	
	CO2	%	0.2	0.3	0.3	
	Pollutant mass flux rates:					
	THC as propane	lb/hr	10.6	11.2	9.2	
	THC as ethanol (CF = 2.36)	lb/hr	24.9	26.6	22.0	
	CO2	lb/hr	350	554	547	
Ratio: air in/ air out		unitless	2.34	2.34	2.34	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	17.4	17.1	14.6	16.3
	THC as ethanol	lb/1000 bbl	40.7	40.7	34.7	38.7
	CO2	lb/1000 bbl	572	847	863	761

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	73	75	75	
BOTTLE	Moisture	%	1	0.7	0.8	
FILLER	Oxygen	%	20	20	20.4	
ROOM	Volumetric flow, actual	acfm	25270	24870	25520	
VENT	Volumetric flow, standard	dscfm	20290	19960	20450	20233.333
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.52257	0.49596	0.53309	
	Pollutant concentrations:					
	THC as propane	ppmdv	40	47	44	
	CO2	%	0.8	0.8	0.9	
	Pollutant mass flux rates:					
	THC as propane	lb/hr	5.56	6.43	6.17	
	THC as ethanol (CF = 2.36)	lb/hr	13.1	15.2	14.5	
	CO2	lb/hr	1119	1101	1269	
Ratio: air in/ air out		unitless	1.39	1.39	1.39	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	14.8	18.0	16.0	16.3
	THC as ethanol	lb/1000 bbl	34.8	42.4	37.8	38.4
	CO2	lb/1000 bbl	2969	3078	3300	3116

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	83	85	84	
BOTTLE	Moisture	%	1.3	0.9	1.6	
& CAN	Oxygen	%	16.3	15.6	16.4	
FILLER	Volumetric flow, actual	acfm	1710	1685	1638	
BOWL CO2	Volumetric flow, standard	dscfm	1331	1311	1268	1303.3333
VENT	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	1.90214	1.88212	1.91824	
	Pollutant concentrations:					
	THC as propane	ppmdv	39	34	28	
	CO2	%	24.6	26.7	22.2	
	Pollutant mass flux rates:					
	THC as propane	lb/hr	0.36	0.31	0.24	
	THC as ethanol (CF = 2.36)	lb/hr	0.848	0.725	0.579	
	CO2	lb/hr	2257	2413	1941	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	0.187	0.162	0.127	0.159
	THC as ethanol	lb/1000 bbl	0.446	0.385	0.302	0.378
	CO2	lb/1000 bbl	1187	1282	1012	1160

Total can filling emission factors

THC as propane	lb/1000 bbl	17.5	17.3	14.7	16.5
THC as ethanol	lb/1000 bbl	41.1	41.0	35.1	39.1
CO2	lb/1000 bbl	1733	2007	2024	1921

Total bottle filling emission factors

THC as propane	lb/1000 bbl	14.9	18.1	16.2	16.4
THC as ethanol	lb/1000 bbl	35.2	42.8	38.2	38.7
CO2	lb/1000 bbl	4130	4238	4461	4276

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
4	Stack temperature	Deg F	77	71	72	
KEG LINE	Moisture	%	0.7	1.1	0.8	
#3--	Oxygen	%	20.3	20.3	20.3	
FILLER	Volumetric flow, actual	acfm	47	48	43	
EXHAUST	Volumetric flow, standard	dscfm	37	38	34	36.333333
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0	0.218	0.1925	
	Pollutant concentrations:					
	THC as propane	ppmdv	VOID	277	209	
	CO2	%	VOID	3.8	3.8	
	Pollutant mass flux rates:					
	THC as propane	lb/hr	VOID	0.0721	0.0487	
	THC as ethanol (CF = 2.36)	lb/hr	VOID	0.170	0.115	
	CO2	lb/hr	VOID	10.0	8.91	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	VOID	0.331	0.253	0.292
	THC as ethanol	lb/1000 bbl	VOID	0.781	0.597	0.689
	CO2	lb/1000 bbl	VOID	45.7	46.3	46.0

NOTE: KEGS WERE NOT BEING FILLED DURING RUN 1.

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
5	Stack temperature	Deg F	91	85	86	
CRUSHED	Moisture	%	0.8	1.2	0.5	
CAN	Oxygen	%	20.6	20.6	20.6	
CONVEYOR	Volumetric flow, actual	acfm	7503	8341	7405	
SYSTEM	Volumetric flow, standard	dscfm	5888	6578	5881	6115.6667
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		bbl/hr	ND	ND	ND	
	Pollutant concentrations:					
	THC as propane	ppmdv	53	71	76	
	CO2	%	0.2	0.2	0.2	
	Pollutant mass flux rates:					
	THC as propane	lb/hr	2.14	3.20	3.06	
	THC as ethanol (CF = 2.36)	lb/hr	5.05	7.55	7.23	
	CO2	lb/hr	81	91	81	
	Emission factors:					Average
	THC as propane	lb/bbl	ERR	ERR	ERR	ERR
	THC as ethanol	lb/bbl	ERR	ERR	ERR	ERR
	CO2	lb/bbl	ERR	ERR	ERR	ERR

Test ID	Parameter	Units	Values reported			
			Run 1	Run 1A	Run 2	Run 2A
6	Stack temperature	Deg F	114	111	117	132
WHIRLPOO	Moisture	%	9.8	11	12.3	11
VENT 7	Oxygen	%	20.9	20.9	20.9	20.9
	Volumetric flow, actual	acfm	2070	2114	1803	2845
	Volumetric flow, standard	dscfm	1396	1413	1175	1833
	Isokinetic variation	%	NA	NA	NA	NA
Circle: Production or feed rate Capacity:		1000 bbl/hr	1.343	1.343	1.343	1.343
	Pollutant concentrations:					
	THC as propane	ppmdv	1.18	9.23	3.82	5.57
	CO2	%	0	0	0	0
	Pollutant mass flux rates:					
	THC as propane	lb/hr	0.0113	0.0894	0.0308	0.0700
	CO2	lb/hr	0	0	0	0
	Emission factors:					
	THC as propane	lb/1000 bbl	8.40E-03	6.65E-02	2.29E-02	5.21E-02
	CO2	lb/1000 bbl	0.00	0.00	0.00	0.00

		RUN 1	RUN 2	AVERAGE
WHIRLPOOL VENT #7 TOTAL EMISSION FACTORS	lb/1000 bbl	0.0749	0.0750	0.0750

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
7	Stack temperature	Deg F	100	96	101	
WORT	Moisture	%	2.4	2	2.4	
COOLER	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	5042	4807	5302	
	Volumetric flow, standard	dscfm	3764	3631	3955	3783.3333
	Isokinetic variation	%	NA	NA	NA	
Process capacity Actual process rate not available		1000 bbl/hr	2.16	2.16	2.16	
	Pollutant concentrations:					
	THC as propane	ppmdv	0.698	2.29	2.51	CALC.
	CO2	%	0	0	0	
	Pollutant mass flux rates:					
	THC as propane	lb/hr	0.0180	0.0570	0.0680	
	CO2	lb/hr	0	0	0	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	0.00833	0.0264	0.0315	0.0221
	CO2	lb/1000 bbl	0.00	0.00	0.00	0.000

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
8	Stack temperature	Deg F	NA	NA	NA	
TRUB	Moisture	%	15.2	5.4	6	
VESSELS	Oxygen	%	21	20.6	20.7	
	Volumetric flow, actual		NA	NA	NA	
	Volumetric flow, standard	dscf/batch	113	110.7	122.1	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production rate Capacity:		1000 bbl per batch	0.02705	0.0265	0.02923	
	Pollutant concentrations:					
	THC as propane	ppmd	587	498	510	
	Pollutant mass flux rates:					
	THC as propane	lb/dscf	6.70E-05	5.69E-05	5.82E-05	
	Emission factors:					Average
	THC as propane	lb/batch	0.00757	0.00630	0.00711	0.00699
	THC as propane	lb/1000 bbl	0.280	0.238	0.243	0.254

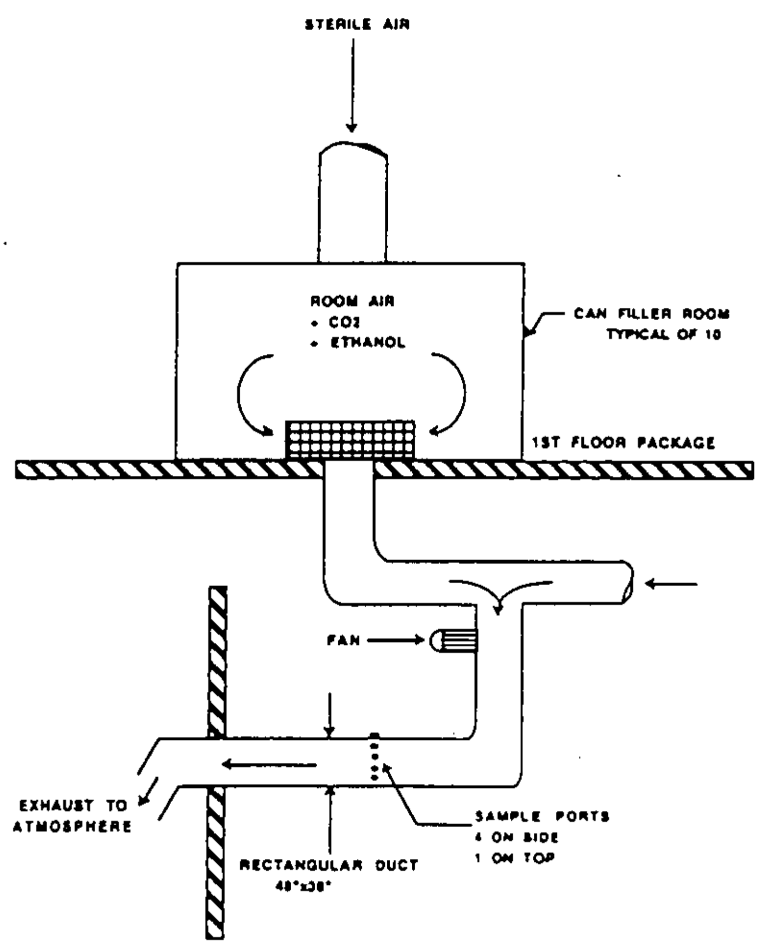
1 batch = 26.7 bbl

DESCRIPTION OF INSTALLATION

To keep beer from becoming contaminated during the bottling process, carbon dioxide is pumped into the cans/bottles before they are filled. Clean air is brought in from the outside and sent to the bottling areas. Exhaust ducts carry out the excess air which is laiden with alcohol from the beer.

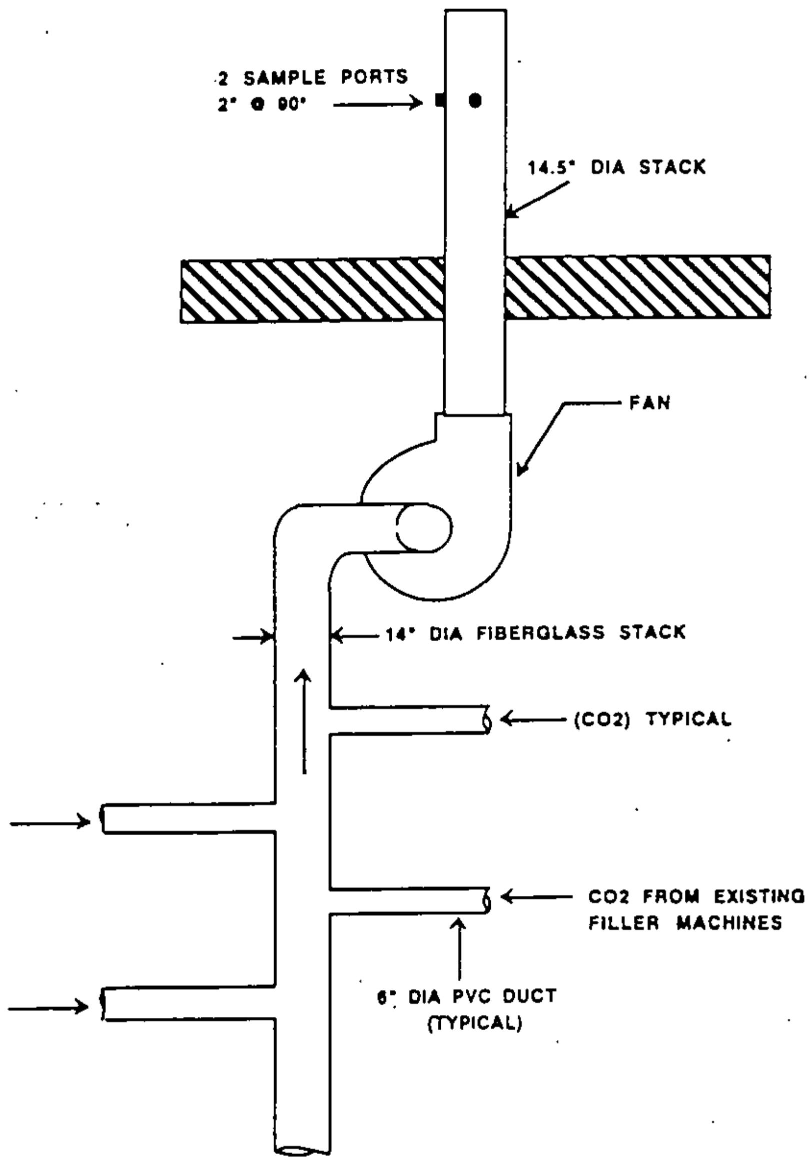
The testing took place at the Can Filler Room Vent on June 23, 1992; Bottle and Can CO_2 Bowl Vent on June 24; and the Bottle Filler Room Vent on June 25, 1992.

A schematic of the Can Filler Room Vent is shown below. A schematic of the Bottle and Can CO_2 Bowl Vent and the Bottle Filler Room Vent are found on pages 2-2 and 2-3, respectively.



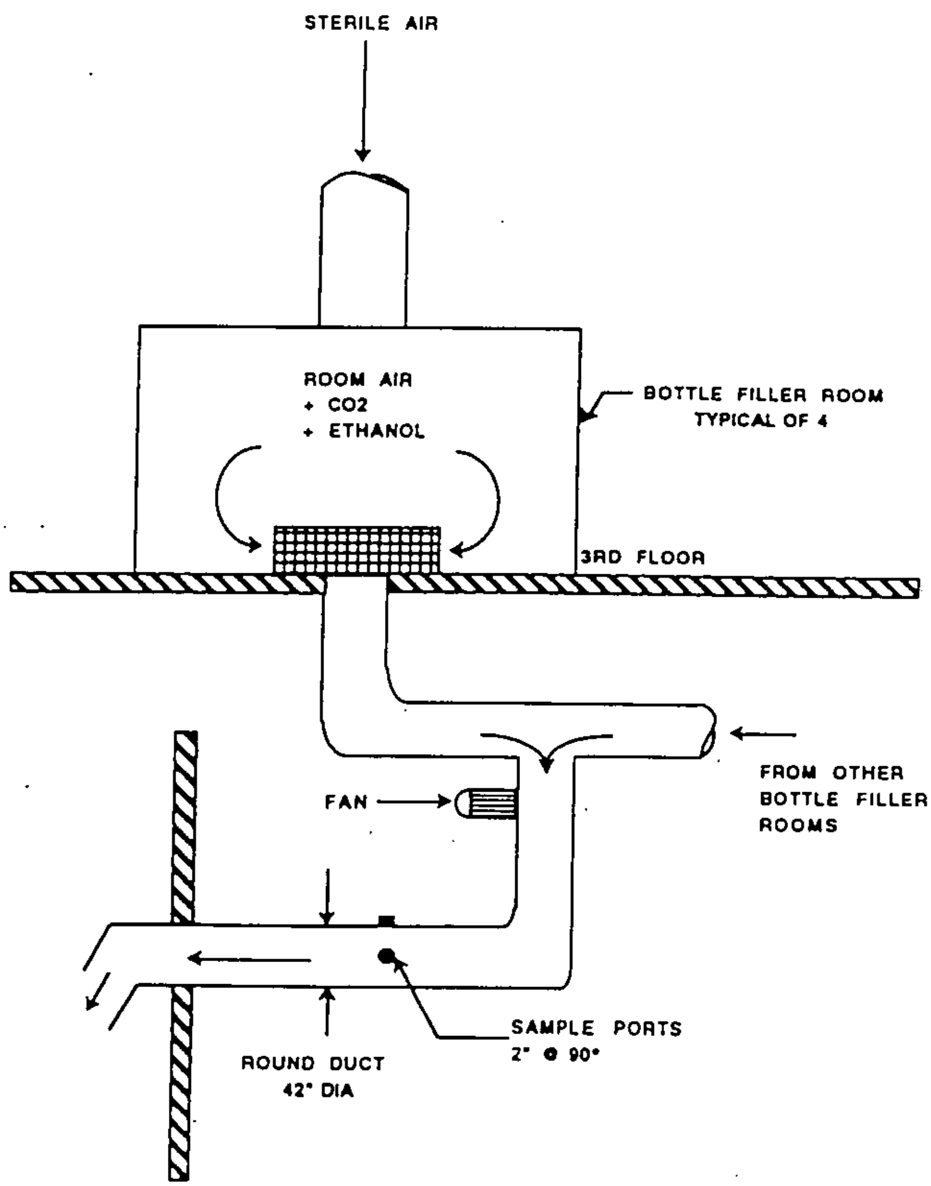
DESCRIPTION OF INSTALLATION

A schematic of the Bottle and Can CO_2 Bowl Vent is shown below.



DESCRIPTION OF INSTALLATION

A schematic the Bottle Filler Room Vent is shown below.

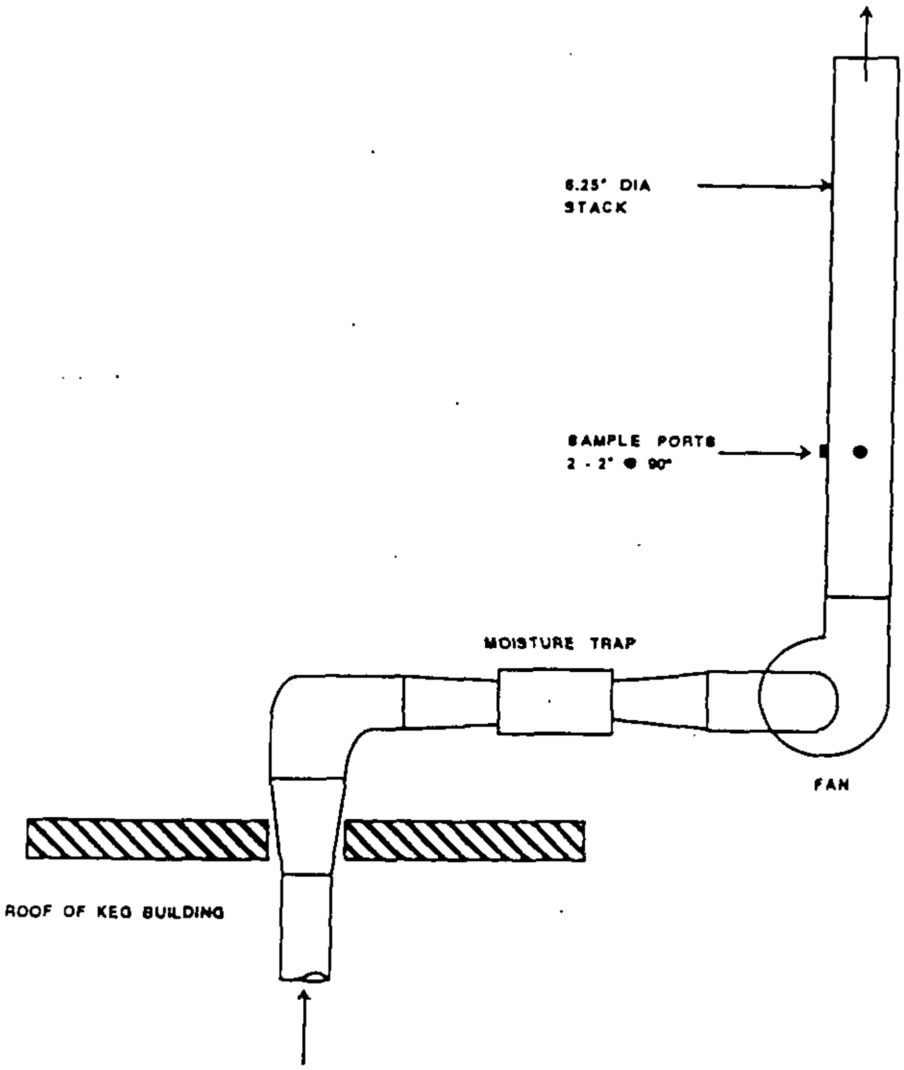


DESCRIPTION OF INSTALLATION

Kegs are filled with carbon dioxide prior to being filled with beer. As the kegs are filled, the carbon dioxide is vented out and the ethanol in the beer is released into the carbon dioxide.

The testing took place at the Keg Line No. 3 - Filler Exhaust on June 25, 1992.

A schematic of the Keg Line No. 3 - Filler Exhaust is shown below.

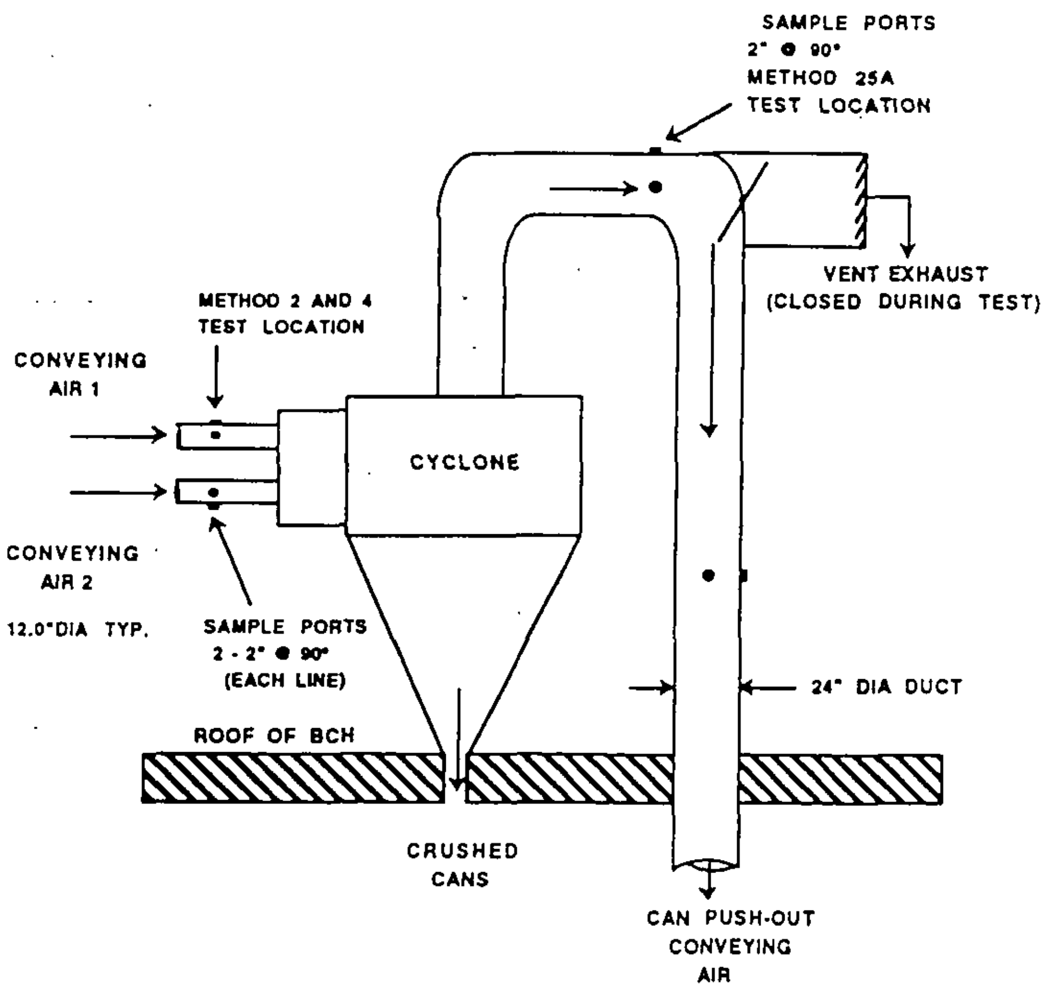


DESCRIPTION OF INSTALLATION

Cans damaged during the filling process are recycled. The damaged cans are sent to a cyclone with air conveyors, where the damaged cans are removed from the airstream and fall into a storage bin. Many of the cans have been filled with beer before they are crushed. Ethanol from the beer is released as the cans are conveyed to the cyclone.

The testing took place at the Crushed Can Conveyor System on June 26, 1992.

A schematic of the Crushed Can Conveyor System is shown below.



DESCRIPTION OF INSTALLATION

Wort is unfermented beer which may contain hydrocarbons. Hot wort was sent to the Whirlpool where TRUB (the unwanted byproducts in the wort) was separated out. TRUB was sent to the TRUB tank and the cleaned wort was sent to the wort cooler tank.

The testing took place at theWhirlpool Vent 7 on July 2; Wort Cooler on July 2; and the TRUB Vessels on July 7, 1992.

A schematic of the Whirlpool Vent 7, Wort Cooler and TRUB Vessels is shown below.

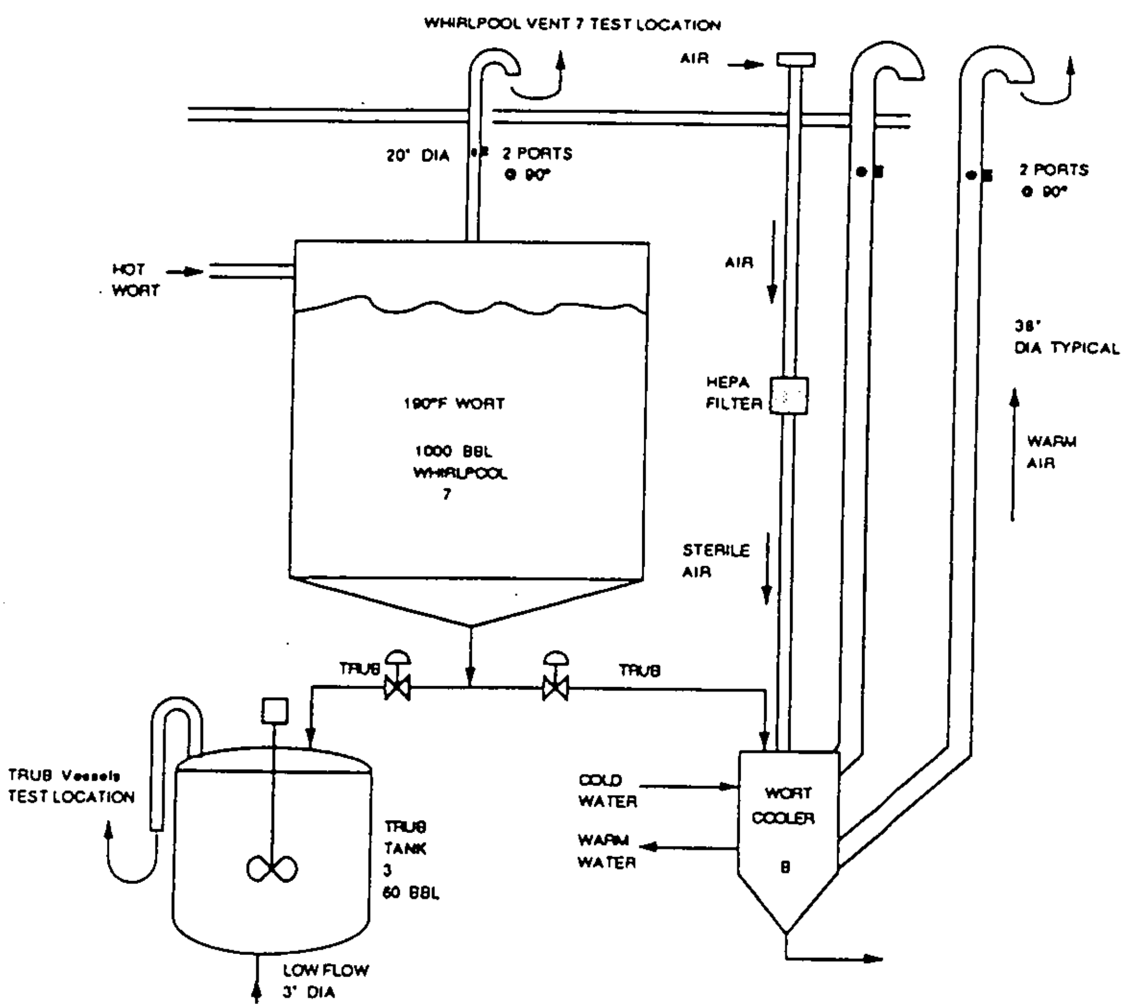


TABLE 1 - Summary of Test Results

EPA Method 25A
Can Filler Room Vent

Run No.	1	2	3	Average
Date (1992)	June 23	June 23	June 23	
Start Time (approx.)	2:00 PM	3:30 PM	5:00 PM	
Stop Time (approx.)	3:00 PM	4:30 PM	6:00 PM	
Gas Conditions				
Temperature (° F)	75	78	76	76
Moisture (volume %)	1.7	0.8	0.8	1.1
O_2 (dry volume %)	20.7	20.9	20.9	20.8
CO_2 (dry volume %)	0.2	0.3	0.3	0.3
Volumetric Flow Rate				
acfm	32,060	33,660	33,160	32,960
dscfm	25,410	26,780	26,460	26,220
For Solvent Corrected:				
Total Hydrocarbons				
lb/hr (as ethanol)	24.9	26.6	22.0	24.5
ton/yr (as ethanol)	109.1	116.4	96.4	107.3
For Non-Solvent Corrected:				
Total Hydrocarbons				
ppm, dry (as propane)	61	61	51	58
lb/hr (as propane)	10.6	11.3	9.32	10.4
ton/yr (as propane)	46.2	49.3	40.8	45.4

TABLE 3 - Summary of Test Results

EPA Method 25A
Bottle Filler Room Vent

Run No.	1	2	3	Average
Date (1992)	June 25	June 25	June 25	
Start Time (approx.)	9:03 AM	10:33 AM	11:57 AM	
Stop Time (approx.)	10:05 AM	11:37 AM	1:01 PM	
<u>Gas Conditions</u>				
Temperature (° F)	73	75	75	74
Moisture (volume %)	1.0	0.7	0.8	0.8
O_2 (dry volume %)	20.0	20.0	20.4	20.1
CO_2 (dry volume %)	0.8	0.8	0.9	0.8
<u>Volumetric Flow Rate</u>				
acfm	25,270	24,870	25,520	25,220
dscfm	20,290	19,960	20,450	20,230
For Solvent Corrected:				
<u>Total Hydrocarbons</u>				
lb/hr (as ethanol)	13.1	15.2	14.5	14.3
ton/yr (as ethanol)	57.4	66.6	63.7	62.6
For Non-Solvent Corrected:				
<u>Total Hydrocarbons</u>				
ppm, dry (as propane)	40	47	44	44
lb/hr (as propane)	5.55	6.44	6.16	6.05
ton/yr (as propane)	24.3	28.2	27.0	26.5

COORS BREWING COMPANY
CAE Project No: 6265-1

TABLE 2 - Summary of Test Results

EPA Method 25A
Bottle and Can Filler Bowl CO_2 Vent

Run No.	1	2	3	Average
Date (1992)	June 24	June 24	June 24	
Start Time (approx.)	10:04 AM	11:22 AM	1:58 PM	
Stop Time (approx.)	11:05 AM	12:23 PM	2:59 PM	
<u>Gas Conditions</u>				
Temperature (° F)	83	85	84	84
Moisture (volume %)	1.3	0.9	1.6	1.3
O_2 (dry volume %)	16.3	15.6	16.4	16.1
CO_2 (dry volume %)	24.6	26.7	22.2	24.5
<u>Volumetric Flow Rate</u>				
acfm	1,710	1,685	1,638	1,678
dscfm	1,331	1,311	1,268	1,303
For Solvent Corrected:				
<u>Total Hydrocarbons</u>				
lb/hr (as ethanol)	0.848	0.725	0.579	0.717
ton/yr (as ethanol)	3.71	3.18	2.54	3.14
For Non-Solvent Corrected:				
<u>Total Hydrocarbons</u>				
ppm, dry (as propane)	39	34	28	34
lb/hr (as propane)	0.359	0.307	0.245	0.304
ton/yr (as propane)	1.57	1.35	1.07	1.33

TABLE 4 - Summary of Test Results

EPA Method 25A
Keg line No. 3 - Filler Exhaust

Run No.	1	2	3	Average
Date (1992)	June 25	June 25	June 25	
Start Time (approx.)	7:04 PM	8:15 PM	9:38 PM	
Stop Time (approx.)	8:05 PM	9:17 PM	10:39 PM	
Gas Conditions				
Temperature (° F)	77	71	72	73
Moisture (volume %)	0.7	1.1	0.8	0.9
O_2 (dry volume %)1	20.3	20.3	20.3	20.3
CO_2 (dry volume %)1	3.8	3.8	3.8	3.8
Volumetric Flow Rate				
acfm	47	48	43	46
dscfm	37	38	34	36
For Solvent Corrected:				
Total Hydrocarbons				
lb/hr (as ethanol)	0.084	0.170	0.115	0.123
ton/yr (as ethanol)	0.367	0.744	0.503	0.538
For Non-Solvent Corrected:				
Total Hydrocarbons				
ppm, dry (as propane)	140	277	209	209
lb/hr (as propane)	0.036	0.072	0.049	0.052
ton/yr (as propane)	0.156	0.315	0.213	0.228

1 The average of two Orsat analysis were used for Runs 1, 2 and 3.

COORS BREWING COMPANY
CAE Project No: 6265-1

TABLE 5 - Summary of Test Results

EPA Method 25A
Crushed Can Conveyor System

Run No.	1	2	3	Average
Date (1992)	June 26	June 26	June 26	
Start Time (approx.)	12:30 PM	2:00 PM	3:10 PM	
Stop Time (approx.)	1:30 PM	3:00 PM	4:10 PM	
Gas Conditions[1]				
Temperature (° F)	91	85	86	87
Moisture (volume %)	0.8	1.2	0.5	0.8
O_2 (dry volume %)	20.6	20.6	20.6	20.6
CO_2 (dry volume %)	0.2	0.2	0.2	0.2
Volumetric Flow Rate[1]				
acfm	7,503	8,341	7,405	7,750
dscfm	5,888	6,578	5,881	6,116
For Solvent Corrected:				
Total Hydrocarbons				
lb/hr (as ethanol)	5.02	7.58	7.24	6.61
ton/yr (as ethanol)	22.0	33.2	31.7	29.0
For Non-Solvent Corrected:				
Total Hydrocarbons				
ppm, dry (as propane)	53	71	76	67
lb/hr (as propane)	2.13	3.21	3.07	2.80
ton/yr (as propane)	9.31	14.1	13.4	12.3

1 Gas Conditions and Velometric Flow Rate obtained from Conveying Air 1 Duct.

COORS BREWING COMPANY
CAE Project No: 6265-1

TABLE 6 - Summary of Test Results

EPA Method 25A
Whirlpool Vent 7

Run No.	Batch 1 Quiescent and Drain	Batch 1 Fill	Batch 2 Quiescent and Drain	Batch 2 Fill	Average
Date (1992)	July 2	July 2	July 2	July 2	
Start Time (approx.)	11:55 AM	12:20 PM	1:13 PM	4:20 PM	
Stop Time (approx.)	12:20 PM	12:40 PM	2:17 PM	4:40 PM	
Gas Conditions					
Temperature (° F)	114	111	117	132	114
Moisture (volume %)	9.8	11.0	12.3	11.0	11.0
O_2(dry volume %)	20.9	20.9	20.9	20.9	20.9
CO_2 (dry volume %)	0.0	0.0	0.0	0.0	0.0
Volumetric Flow Rate					
acfm	2,070	2,114	1,803	2,845	1,996
dscfm	1,396	1,413	1,175	1,833	1,328
For Non-Solvent Corrected:					
Total Hydrocarbons					
ppm, dry (as propane)	1.18	9.23	3.82	5.57	4.74
lb/hr (as propane)	0.0112	0.0894	0.0308	0.0699	0.0438
		Batch 1		Batch 2	
Total lb/batch		0.0485		0.0746	0.0616

TABLE 7 - Summary of Test Results

EPA Method 25A
Wort Cooler

Run No.1	1	2	3	Average
Date (1992)	July 2	July 2	July 2	
Start Time (approx.)	2:28 PM	5:26 PM	6:35 PM	
Stop Time (approx.)	3:28 PM	6:26 PM	7:35 PM	
<u>Gas Conditions</u>				
Temperature (° F)	100	96	101	99
Moisture (volume %)	2.4	2.0	2.4	2.3
O_2 (dry volume %)	20.9	20.9	20.9	20.9
CO_2 (dry volume %)	0.0	0.0	0.0	0.0
<u>Volumetric Flow Rate</u>				
acfm	5,042	4,807	5,302	5,050
dscfm	3,764	3,631	3,955	3,783
For Non-Solvent Corrected:				
<u>Total Hydrocarbons</u>				
ppm, dry (as propane)	1	2	2	2
lb/hr (as propane)	0.018	0.057	0.068	0.047
ton/yr (as propane)	0.077	0.249	0.297	0.208

1 See Comments on Page 4-1.

TABLE 8 - Summary of Test Results

EPA Method 25A
TRUB Vessels

Run No.	1	2	3	Average
Date (1992)	July 7	July 7	July 7	
Start Time (approx.)	1:50 PM	3:50 PM	5:15 PM	
Stop Time (approx.)	1:53 PM	3:58 PM	5:20 PM	
Gas Conditions				
Temperature (° F)	N/A	N/A	N/A	N/A
Moisture (volume %)	15.2	5.4	6.0	8.9
O_2 (dry volume %)	21.0	20.6	20.7	20.8
CO_2 (dry volume %)	0.7	0.2	0.2	0.4
Volumetric Flow Rate				
acfm	N/A	N/A	N/A	N/A
dscfm	N/A	N/A	N/A	N/A
For Non-Solvent Corrected:				
Total Hydrocarbons				
lb/batch[1]	0.0076	0.0063	0.0071	0.0070

1 See Comments on page 4-1.

APPENDIX D

REPORT EXCERPTS FROM REFERENCE 12

(Coors, April 1994)

REVISED ... REPORT #2

Clean ... Engineering

... W... St. • Palatine, IL 6006? • 708-991-...

REPORT ON
COMPLIANCE TESTING

Performed for:
COORS BREWING COMPANY
GOLDEN, COLORADO

CAE Project No: 6265-4
Revision 0: December 9, 1992
Revision 1: April 6, 1994

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4	
1	Stack temperature	Deg F	55	57	57	56	
FILL ON VENT	Moisture	%	1.8	0.6	0.6	1.8	
	Oxygen	%	21	20.4	20.4	13	
	Volumetric flow, actual	acfm	31	41	41	37	
	Volumetric flow, standard	dscfm	25	34	34	30	
	Isokinetic variation	%	NA	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.95	0.95	0.95	0.95	
	Pollutant concentrations:						
	THC as propane	ppmdv	83	110	558	1397	
	CO2	%	1.4	3.2	3.2	38.1	
	Pollutant mass flux rates: VALUES DOUBLED TO REPRESENT 6 TANKS						AVERAGE
	THC as propane	lb/hr	0.0284	0.0513	0.2600	0.5743	0.228
	THC as ethanol (CF = 2.36)	lb/hr	0.067	0.121	0.614	1.36	0.539
	CO2	lb/hr	4.83	7.50	7.50	78.8	24.7
	Emission factors:						AVERAGE
	THC as propane	lb/1000 bbl	0.0301	0.0542	0.275	0.607	0.242
	THC as ethanol	lb/1000 bbl	0.0709	0.1279	0.649	1.433	0.570
	CO2	lb/1000 bbl	5.10	7.93	7.93	83.3	26.1

Sect. A
Ref. 12

DESCRIPTION OF INSTALLATION

The Fill On Vent location is the ventilation system from six identical beer holding tanks. The combined capacity of the six tanks is 9,420 barrels. When empty after being cleaned, the tanks contain air. As beer fills the tanks, air, carbon dioxide and ethanol gases are displaced and are forced out the vent stack. Ductwork from three tanks combines in a common duct or stack before venting to the atmosphere. Identical ductwork is used for venting the remaining three tanks.

The testing took place at the Fill On Vent on August 19, 1992.

A schematic the Fill On Vent is shown below.

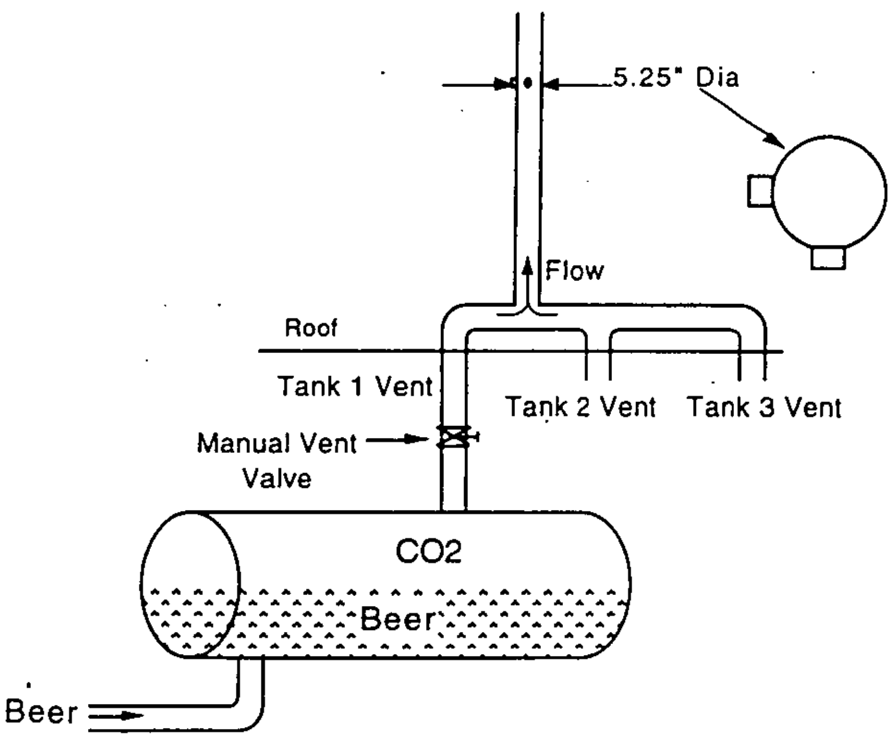


TABLE 1 - Summary of Test Results

EPA Method 25A
Fill On Vent

Run No.	1	2	3	4	Average
Date (1992)	August 19	August 19	August 19	August 19	
Start Time (approx.)	9:58 AM	11:39 AM	12:56 PM	2:16 PM	
Stop Time (approx.)	11:12 AM	12:45 PM	2:03 PM	3:36 PM	
Gas Conditions[1]					
Temperature (°F)	55	57	57	56	56
Moisture (volume %)	1.8	0.6	0.6	1.8	1.2
O_2 (dry volume %)	21.0	20.4	20.4	13.0	18.7
CO_2 (dry volume %)	1.4	3.2	3.2	38.1	11.5
Volumetric Flow Rate[1]					
acfm	31	41	41	37	38
dscfm	25	34	34	30	31
For Solvent Corrected:					
Total Hydrocarbons					
lb/hr, 6 tanks (as ethanol)[2]	0.067	0.121	0.614	1.35	0.539
ton/yr, 6 tanks (as ethanol)[2]	0.294	0.531	2.68	5.94	2.361
Total lb/fill, 6 tanks (as ethanol)					3.077
lb/fill, per tank (as ethanol)					0.5129
For Non-Solvent Corrected:					
Total Hydrocarbons					
ppm, dry, 3 tanks (as propane)	83	110	558	1,397	537
lb/hr, 6 tanks (as propane)[2]	0.028	0.052	0.260	0.574	0.229
ton/yr, 6 tanks (as propane)[2]	0.124	0.224	1.14	2.52	1.00

[1] Gas Conditions and Volumetric Flow Rate from Run 2 were used for Run 3.
[2] Value indicated is twice the 3 tank value calculated in the parameter section.

APPENDIX E

REPORT EXCERPTS FROM REFERENCE 14

(Coors, November 1992)

Stack Test Report # 4

Clean Air Engineering

REPORT ON
DIAGNOSTIC TESTING

Performed for:
COORS BREWING COMPANY
GOLDEN, COLORADO

CAE Project No: 6265-2
November 25, 1992

COORS BREWING COMPANY
CAE Project No: 6265-2

TABLE 1 - Summary of Test Results

EPA Method 25A
Cellar 9 B and C Floor

	Live yeast	Aging yeast (dead)	Aging yeast	Waste Beer		waste Beer	HPF (lysed) yeast	Ethanol condensate
Location	C9-2	C9-4	C9-6	C9-8	C9-9	C9-10	C9-12	C9-B
Run No.	5	3	3	3	3	2	1	5
Date (1992)	June 21	June 18	June 18	June 18	June 18	June 17	June 16	June 21
Start Time (approx.)	5:26 PM	9:41 AM	10:37 AM	9:41 AM	10:37 AM	12:11 PM	3:29 PM	5:26 PM
Stop Time (approx.)	8:55 PM	10:36 AM	2:17 PM	10:36 AM	2:17 PM	4:15 PM	6:54 PM	8:55 PM
Gas Conditions[1]								
Moisture (volume %)	5.4	4.0	4.0	4.1	5.6	2.6	13.7	4.8
O_2 (dry volume %)	19.9	19.9	19.9	20.4	20.0	20.7	20.1	N/A
CO_2 (dry volume %)	2.8	2.8	1.3	0.2	0.2	0.2	0.3	N/A
Volumetric Flow Rate[1]								
acfm	42	42	42	9.4	9.4	9.4	42	7.2
dscfm	33	33	33	7.4	7.5	7.3	33	5.6
For Solvent Corrected:								
Total Hydrocarbons								
lb/hr (as ethanol)	1.552	0.0	0.628	0.125	0.102	0.019	6.35	1.60
ton/yr (as ethanol)	6.80	0.0	2.75	0.549	0.445	0.083	27.8	7.01
For Non-Solvent Corrected:								
Total Hydrocarbons								
ppm, dry (as propane)	2,909	0	1,176	1,048	838	160	11,898	17,674
lb/hr (as propane)	0.66	0.0	0.27	0.05	0.04	0.01	2.69	0.68
ton/yr (as propane)	2.88	0.0	1.17	0.23	0.19	0.04	11.78	2.97

[1] Gas Conditions for Location C9-4 was taken from data obtained at location C9-2.
[1] Gas Conditions and Volumetric Flow Rates for Location C9-8 was taken from the average of data obtained at locations C9-9 and C9-10.
[1] Volumetric Flow Rates for Locations C9-2, C9-4 and C9-12 were taken from data obtained at location C9-2.

DESCRIPTION OF INSTALLATION

At the Coors Brewing Company facility, located in Golden, colorado, there are eight tanks on the Cellar 9 B Floor. These tanks receive ethanol condensate from the Waste Beer Condensor (WBC) or the Yeast Drying Press (YDP). All eight tanks are vented to a single three inch pipe. To keep particulate matter from settling, air is injected into the bottom of each tank, and the air flow is controlled with a rotometer.

There are a number of tanks on the Cellar 9 C Floor. These tanks receive waste beer products from the live yeast, aging yeast, HPF yeast and waste beer produced during the brewing process. To keep particulate matter from settling, air is injected into the bottom of each tank, and each tank has its own vent. The air flow to each tank is controlled with a rotometer.

The testing reported in this document was performed at the Cellar 9 B Floor and the Cellar C Floor, tanks C9-2, C9-4, C9-6, C9-8, C9-9, C9-10 and C9-12.

APPENDIX F

REPORT EXCERPTS FROM REFERENCE 15

(Coors, October 1992)

AIR POLLUTION TESTING, INC.
4535 West 68th Avenue Westminster, CO 80030 (303) 426-0402
FAX (303) 426-1922

Can and Bottle Filler Vent
Volatile Organic Compound Test
for
Coors Brewing Company

Table of Contents

Report prepared by:
Air Pollution Testing, Inc.
4535 West 68th Avenue
Westminster, Colorado 80030
(303) 426-0402
(303) 426-1922 (FAX)

Report reviewed by:
Paul Ottenstein
Paul Ottenstein
Project Manager

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	75	75		
CAN	Moisture	%	1.11	1.29		
FILLER	Oxygen	%	20.9	20.9		
ROOM	Volumetric flow, actual	acfm	32306	31777		
VENT	Volumetric flow, standard	dscfm	25932	25461		25696.5
	Isokinetic variation	%	NA	NA		
Circle: Production or feed rate Capacity:		1000 bbl/hr	1.245	1.108		
	Pollutant concentrations:					
	THC as propane	ppmwv	31.5	33.3		
	Pollutant mass flux rates:					
	THC as propane	lb/hr	5.67	5.90		
	THC as ethanol (CF = 2.36)	lb/hr	13.4	13.9		
	Emission factors:					Average
	THC as propane	lb/1000 bbl	4.56	5.32		4.94
	THC as ethanol	lb/1000 bbl	10.8	12.6		11.7

AIR FLOW RATIO FACTOR (61242/25696) = 2.383

THC as ethanol	lb/1000 bbl	25.6	29.9		27.8

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	72	72		
BOTTLE	Moisture	%	1.24	1.98		
FILLER	Oxygen	%	20.9	20.9		
ROOM	Volumetric flow, actual	acfm	12352	12096		
VENT	Volumetric flow, standard	dscfm	9970	9691		9830.5
	Isokinetic variation	%	NA	NA		
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.519	0.605		
	Pollutant concentrations:					
	THC as propane	ppmwv	42.2	52.1		
	Pollutant mass flux rates:					
	THC as propane	lb/hr	2.93	3.54		
	THC as ethanol (CF = 2.36)	lb/hr	6.9	8.3		
	Emission factors:					Average
	THC as propane	lb/1000 bbl	5.64	5.85		5.74
	THC as ethanol	lb/1000 bbl	13.3	13.8		13.5

AIR FLOW RATIO FACTOR (28056/9830) = 2.854

THC as ethanol	lb/1000 bbl	38.0	39.4		38.7

Results

The results of the testing are presented in the following tables. Any testing variables not presented here may be found in *Appendix 1 Testing Parameters / Sample Calculations.*

run #	1	2	averages
start time stop time	11:32 12:32	13:30 14:30	
stack temp. (°F)	72	72	72
stack moisture (vol. %)	1.24	1.98	1.61
gas velocity (ft/sec)	21.4	21.0	21.2
gas flow (acfm)	12352	12096	12224
gas flow (dscfm)	9970	9691	9830
volume beer (bbls)	519	605	562
VOC (ppm wet as propane)	42.2	52.1	47.2
VOC (lb/hr as propane)	2.93	3.62	3.27
VOC (lb/hr as ethanol)*	6.90	8.53	7.72
VOC (lb/bbl as ethanol)*	0.013	0.014	0.014

Table 1 - Bottle Filler Vent
VOC Testing Results
10-14-92

* - An empirical constant of 2.36 demonstrated in an earlier testing program was used to convert propane-calibrated analyzer data to ethanol. See Additional Notes (page 3) for more details.

Results (continued)

run #	1	2	averages
start time stop time	15:30 16:30	17:00 18:00	
stack temp. (°F)	75	75	75
stack moisture (vol. %)	1.11	1.29	1.20
gas velocity (ft/sec)	44.5	43.8	44.1
gas flow (acfm)	32306	31777	32041
gas flow (dscfm)	25932	25461	25697
volume beer (bbls)	1245	1108	1177
VOC (ppm wet as propane)	31.5	33.3	32.4
VOC (lb/hr as propane)	5.67	6.07	5.87
VOC (lb/hr as ethanol)*	13.38	14.33	13.86
VOC (lb/bbl as ethanol)*	0.011	0.013	0.012

Table 2 - Can Filler Vent
VOC Testing Results
10-14-92

* - An empirical constant of 2.36 demonstrated in an earlier testing program was used to convert propane-calibrated analyzer data to ethanol. See Additional Notes (page 3) for more details.

APPENDIX G

REPORT EXCERPTS FROM REFERENCE 16

(Coors, December 1992)

AIR POLLUTION TESTING, INC.

4535 West 68th Avenue Westminster, CO 80030 (303) 426-0402

FAX (303) 426-1922

Filler Rooms Diagnostic VOC Test Report for Coors Brewing Company

Table of Contents

Report prepared by:
Air Pollution Testing, Inc.
4535 West 68th Avenue
Westminster, Colorado 80030
(303) 426-0402
(303) 426-1922 (FAX)

Report reviewed by:
Paul Ottenstein
Project Manager

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	72	69	68	
#3 BOTTLE	Moisture	%	1.32	0.92	0.48	
FILLER	Oxygen	%	20.9	20.9	20.9	
EXHAUST	Volumetric flow, actual	acfm	1861	1837	1866	
VENT	Volumetric flow, OUTLET	dscfm	1499	1494	1528	1507
	Volumetric flow, INLET 1	dscfm	1874	2359	1923	
	Volumetric flow, INLET 2	dscfm	1871	1825	1879	
	Volumetric flow, INLET 3	dscfm	1829	2333	2646	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.0853	0.0853	0.0853	
	Pollutant concentrations:					
	THC as propane--OUTLET	ppmwv	28.6	30.3	30.6	
	THC as propane--INLET 1	ppmwv	2	3.5	3	
	THC as propane--INLET 2	ppmwv	2.5	1	1.5	
	THC as propane--INLET 3	ppmwv	3	3	3	
	Pollutant mass flux rates: THEORETICAL--USE TOTAL I FLOW RATE AND I-O CONC.					
	THC as propane	lb/hr	1.01	1.25	1.25	
	THC as ethanol (CF = 2.506)	lb/hr	2.54	3.13	3.13	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	11.9	14.7	14.6	13.7
	THC as ethanol	lb/1000 bbl	29.7	36.7	36.6	34.4

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	68	68	68	
#5 CAN	Moisture	%	0.9	0.92	1.02	
FILLER	Oxygen	%	20.9	20.9	20.9	
EXHAUST	Volumetric flow, actual	acfm	3894	3879	3750	
VENT	Volumetric flow, OUTLET	dscfm	3130	3116	3009	3085
	Volumetric flow, INLET 1	dscfm	2108	2129	2090	
	Volumetric flow, INLET 2	dscfm	2615	3059	2526	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.2077	0.2077	0.2077	
	Pollutant concentrations:					
	THC as propane--OUTLET	ppmwv	93.4	87.2	85.5	
	THC as propane--INLET 1	ppmwv	1	1	1.3	
	THC as propane--INLET 2	ppmwv	1	1	1.3	
	Pollutant mass flux rates: THEORETICAL--USE TOTAL I FLOW RATE AND I-O CONC.					
	THC as propane	lb/hr	3.02	3.10	2.70	
	THC as ethanol (CF = 2.506)	lb/hr	7.58	7.77	6.76	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	14.6	14.9	13.0	14.2
	THC as ethanol	lb/1000 bbl	36.5	37.4	32.5	35.5

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	68	68	72	
#6 CAN	Moisture	%	1.52	0.82	1.11	
FILLER	Oxygen	%	20.9	20.9	20.9	
EXHAUST	Volumetric flow, actual	acfm	2374	2366	2283	
VENT	Volumetric flow, OUTLET	dscfm	1927	1930	1847	1901.3333
	Volumetric flow, INLET 1	dscfm	3766	1660	1030	
	Volumetric flow, INLET 2	dscfm	1803	1643	2335	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.2167	0.2167	0.2167	
	Pollutant concentrations:					
	THC as propane--OUTLET	ppmwv	113.5	111.1	111.5	
	THC as propane--INLET 1	ppmwv	1.5	1.5	2.5	
	THC as propane--INLET 2	ppmwv	1	1	1	
	Pollutant mass flux rates: THEORETICAL--USE TOTAL I FLOW RATE AND I-O CONC.					
	THC as propane	lb/hr	4.36	2.51	2.57	
	THC as ethanol (CF = 2.506)	lb/hr	10.91	6.30	6.44	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	20.1	11.6	11.9	14.5
	THC as ethanol	lb/1000 bbl	50.4	29.0	29.7	36.4

Test ID	Parameter	Units	Values reported			
			Average for 33 hours			
4	Stack temperature	Deg F				
#9 CAN	Moisture	%	0.6			
FILLER	Oxygen	%	20.9			
EXHAUST	Volumetric flow, actual	acfm				
VENT	Volumetric flow, OUTLET	dscfm	2359			
	Volumetric flow, INLET 1	dscfm	6392			
	Volumetric flow, INLET 2	dscfm	2379			
	Isokinetic variation	%	NA			
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.1538			
	Pollutant concentrations:					
	THC as propane--OUTLET	ppmwv	42.1			
	THC as propane--INLET 1	ppmwv	2.5			
	THC as propane--INLET 2	ppmwv	2.7			
	Pollutant mass flux rates: THEORETICAL--USE TOTAL I FLOW RATE AND I-O CONC.					
	THC as propane	lb/hr	2.40			
	THC as ethanol (CF = 2.506)	lb/hr	6.00			
	Emission factors:					
	THC as propane	lb/1000 bbl	15.6			
	THC as ethanol	lb/1000 bbl	39.0			

Results

The results of the testing are presented in the following tables. Any testing parameters not presented in the tables may be found in Appendix 1 - Sample Calculations and Testing Parameters.

Coors Brewing Company
#3 Bottle Filler
12-2-92
VOC Mass Emission Rates

		Run #1	Run #2	Run #3	Averages
Field Data					
Outlet					
	VOC conc. (ppm wet)	28.6	30.3	30.6	29.8
	% H2O	1.3	0.9	0.5	0.9
	volumetric flow rate (dscfm)	1499	1494	1528	1507
Inlet #1					
	VOC conc. (ppm)	2.0	3.5	3.0	2.8
	volumetric flow rate (dscfm)	1874	2359	1923	2052
Inlet #2					
	VOC conc. (ppm)	2.5	1.0	1.5	1.7
	volumetric flow rate (dscfm)	1871	1825	1879	1858
Inlet #3					
	VOC conc. (ppm)	3.0	3.0	3.0	3.0
	volumetric flow rate (dscfm)	1829	2333	2646	2269
Production					
	beer filling (bbl/hr)	85.3	85.3	85.3	85.3
Calculations		Run #1	Run #2	Run #3	Averages
Theoretical Total					
	VOC lb/hr as propane	1.11	1.37	1.36	1.28
	VOC lb/hr as ethanol	2.78	3.43	3.41	3.21
	VOC lb/bbl as ethanol	0.0326	0.0402	0.0400	0.0376
Theoretical from Filling					
	VOC lb/hr as propane	1.01	1.25	1.25	1.17
	VOC lb/hr as ethanol	2.54	3.13	3.13	2.93
	VOC lb/bbl as ethanol	0.0298	0.0367	0.0367	0.0344

Table 1 - VOC Mass Emission Rates
#3 Bottle Filler

Results (continued)

		Run #1	Run #2	Run #3	Averages
Coors Brewing Company					
#5 Can Filler					
12-2-92					
VOC Mass Emission Rates					
Field Data		Run #1	Run #2	Run #3	Averages
Outlet					
	VOC conc. (ppm wet)	93.4	87.2	85.5	88.7
	% H2O	1.3	0.9	0.5	0.9
	volumetric flow rate (dscfm)	3130	3116	3009	3085
Inlet #1					
	VOC conc. (ppm)	1.0	1.0	1.3	1.1
	*volumetric flow rate (dscfm)**	2108	2129	2090	2109
Inlet #2					
	VOC conc. (ppm)**	1.0	1.0	1.3	1.1
	volumetric flow rate (dscfm)*	2615	3059	2526	2733
Production					
	beer filling (bbl/hr)	207.7	207.7	207.7	207.7
Calculations		Run #1	Run #2	Run #3	Averages
Theoretical Total					
	VOC lb/hr as propane	3.07	3.13	2.72	2.98
	VOC lb/hr as ethanol	7.69	7.86	6.82	7.46
	VOC lb/bbl as ethanol	0.0370	0.0378	0.0329	0.0359
Theoretical from Filling					
	VOC lb/hr as propane	3.04	3.10	2.68	2.94
	VOC lb/hr as ethanol	7.61	7.77	6.72	7.37
	VOC lb/bbl as ethanol	0.0366	0.0374	0.0324	0.0355

* - measured 1-27-93
** - not measured due to bag leak, inlet #1 data assumed

Table 2 - VOC Mass Emission Rates
#5 Can Filler

Two Tedlar bag samples collected under the filler room doors during run #3 measured 65.0 and 67.0 ppm as propane.

Results (continued)

Coors Brewing Company
#6 Can Filler
12-16-92
VOC Mass Emission Rates

Field Data		Run #1	Run #2	Run #3	Averages
Outlet					
	VOC conc. (ppm wet)	113.5	111.1	111.5	112.0
	% H2O	1.5	0.8	1.1	1.2
	volumetric flow rate (dscfm)	1927	1930	1847	1901
Inlet #1					
	VOC conc. (ppm)	1.5	1.5	2.5	1.8
	volumetric flow rate (dscfm)	3766	1660	1030	2152
Inlet #2					
	VOC conc. (ppm)*	1.0	1.0	1.0	1.0
	volumetric flow rate (dscfm)	1803	1643	2335	1927
Production					
	beer filling (bbl/hr)	216.7	216.7	216.7	216.7
Calculations		**Run #1**	**Run #2**	**Run #3**	**Averages**
Theoretical Total					
	VOC lb/hr as propane	4.41	2.54	2.61	3.18
	VOC lb/hr as ethanol	11.04	6.37	6.53	7.98
	VOC lb/bbl as ethanol	0.0510	0.0294	0.0301	0.0368
Theoretical from Filling					
	VOC lb/hr as propane	4.35	2.51	2.57	3.15
	VOC lb/hr as ethanol	10.91	6.29	6.44	7.88
	VOC lb/bbl as ethanol	0.0504	0.0290	0.0297	0.0364

* - run #1 not measured due to bag leak, average of runs 2 and 3 assumed

Table 3 - VOC Mass Emission Rates
#6 Can Filler

Three Tedlar gas bag samples collected under the filler room door during runs #1, #2, and #3 measured 144.0 ppm, 128.0 ppm, and 142.0 ppm as propane respectively.

Results (continued)

The #9 Can Filler was sampled continuously from 07:30 on 12-2-92 through 00:12 on 12-5-92. The results of the testing are presented as two hour averages in the following tables. Flow data are the averages of 5 sampling traverses. Production data is an average for the entire period.

Coors Brewing Company
#9 Can Filler
12-3-92 through 12-5-92
VOC Mass Emission Rates

Field Data		hrs 1-2	hrs 3-4	hrs 5-6	hrs 7-8	hrs 9-10	Averages
Outlet							
	VOC conc. (ppm wet)	7.6	8.6	12.0	14.8	39.6	16.5
	% H2O	0.6	0.6	0.6	0.6	0.6	0.6
	volumetric flow rate (dscfm)	2359	2359	2359	2359	2359	2359
Inlet #1							
	VOC conc. (ppm)	2.5	2.5	2.5	2.5	2.5	2.5
	volumetric flow rate (dscfm)	6392	6392	6392	6392	6392	6392
Inlet #2							
	VOC conc. (ppm)	2.7	2.7	2.7	2.7	2.7	2.7
	volumetric flow rate (dscfm)	2379	2379	2379	2379	2379	2379
Production							
	beer filling (bbl/hr)	*	*	*	*	153.8	153.8
Calculations		**hrs 1-2**	**hrs 3-4**	**hrs 5-6**	**hrs 7-8**	**hrs 9-10**	**Averages**
Theoretical Total							
	VOC lb/hr as propane	0.46	0.52	0.73	0.90	2.40	1.00
	VOC lb/hr as ethanol	1.15	1.31	1.82	2.25	6.01	2.51
	VOC lb/bbl as ethanol	*	*	*	*	0.0391	0.0391
Theoretical from Filling							
	VOC lb/hr as propane	0.31	0.37	0.57	0.74	2.24	0.85
	VOC lb/hr as ethanol	0.77	0.92	1.43	1.86	5.62	2.12
	VOC lb/bbl as ethanol	*	*	*	*	0.0366	0.0366

* - filler room sterilization was conducted for the first eight hours of sampling,
no beer filling took place during this time

Table 4 - VOC Mass Emission Rates
#9 Can Filler
(hours 1 through 10)

Results (continued)

Coors Brewing Company #9 Can Filler 12-3-92 through 12-5-92 VOC Mass Emission Rates							
Field Data		hrs 11-12	hrs 13-14	hrs 15-16	hrs 17-18	hrs 19-20	Averages
Outlet							
	VOC conc. (ppm wet)	43.0	42.9	33.4	49.1	46.3	42.9
	% H2O	0.6	0.6	0.6	0.6	0.6	0.6
	volumetric flow rate (dscfm)	2359	2359	2359	2359	2359	2359
Inlet #1							
	VOC conc. (ppm)	2.5	2.5	2.5	2.5	2.5	2.5
	volumetric flow rate (dscfm)	6392	6392	6392	6392	6392	6392
Inlet #2							
	VOC conc. (ppm)	2.7	2.7	2.7	2.7	2.7	2.7
	volumetric flow rate (dscfm)	2379	2379	2379	2379	2379	2379
Production							
	beer filling (bbl/hr)	153.8	153.8	153.8	153.8	153.8	153.8
Calculations		hrs 11-12	hrs 13-14	hrs 15-16	hrs 17-18	hrs 19-20	Averages
Theoretical Total							
	VOC lb/hr as propane	2.60	2.60	2.02	2.97	2.80	2.60
	VOC lb/hr as ethanol	6.53	6.51	5.07	7.45	7.03	6.52
	VOC lb/bbl as ethanol	0.0424	0.0423	0.0330	0.0484	0.0457	0.0424
Theoretical from Filling							
	VOC lb/hr as propane	2.45	2.44	1.87	2.82	2.65	2.45
	VOC lb/hr as ethanol	6.14	6.12	4.68	7.06	6.64	6.13
	VOC lb/bbl as ethanol	0.0399	0.0398	0.0304	0.0459	0.0432	0.0399

Table 5 - VOC Mass Emission Rates
#9 Can Filler
(hours 11 through 20)

Results (continued)

Coors Brewing Company #9 Can Filler 12-3-92 through 12-5-92 VOC Mass Emission Rates						
Field Data	hrs 21-22	hrs 23-24	hrs 25-26	hrs 27-28	hrs 29-30	Averages
Outlet						
VOC conc. (ppm wet)	48.4	39.5	35.7	36.3	41.2	40.2
% H2O	0.6	0.6	0.6	0.6	0.6	0.6
volumetric flow rate (dscfm)	2359	2359	2359	2359	2359	2359
Inlet #1						
VOC conc. (ppm)	2.5	2.5	2.5	2.5	2.5	2.5
volumetric flow rate (dscfm)	6392	6392	6392	6392	6392	6392
Inlet #2						
VOC conc. (ppm)	2.7	2.7	2.7	2.7	2.7	2.7
volumetric flow rate (dscfm)	2379	2379	2379	2379	2379	2379
Production						
beer filling (bbl/hr)	153.8	153.8	153.8	153.8	153.8	153.8
Calculations	hrs 21-22	hrs 23-24	hrs 25-26	hrs 27-28	hrs 29-30	Averages
Theoretical Total						
VOC lb/hr as propane	2.93	2.39	2.16	2.20	2.50	2.44
VOC lb/hr as ethanol	7.35	6.00	5.42	5.51	6.25	6.10
VOC lb/bbl as ethanol	0.0478	0.0390	0.0352	0.0358	0.0407	0.0397
Theoretical from Filling						
VOC lb/hr as propane	2.78	2.24	2.01	2.04	2.34	2.28
VOC lb/hr as ethanol	6.96	5.61	5.03	5.12	5.87	5.72
VOC lb/bbl as ethanol	0.0452	0.0365	0.0327	0.0333	0.0381	0.0372

Table 6 - VOC Mass Emission Rates
#9 Can Filler
(hours 21 through 30)

Two Tedlar gas bag samples collected under the filler room door during hour 27 measured 58.5 ppm and 69.0 ppm as propane.

Results (continued)

Coors Brewing Company #9 Can Filler 12-3-92 through 12-5-92 VOC Mass Emission Rates						
Field Data	hrs 31-32	hrs 33-34	hrs 35-36	hrs 37-38	hrs 39-40	Averages
Outlet						
VOC conc. (ppm wet)	37.9	50.6	35.9	45.2	49.7	43.9
% H2O	0.6	0.6	0.6	0.6	0.6	0.6
volumetric flow rate (dscfm)	2359	2359	2359	2359	2359	2359
Inlet #1						
VOC conc. (ppm)	2.5	2.5	2.5	2.5	2.5	2.5
volumetric flow rate (dscfm)	6392	6392	6392	6392	6392	6392
Inlet #2						
VOC conc. (ppm)	2.7	2.7	2.7	2.7	2.7	2.7
volumetric flow rate (dscfm)	2379	2379	2379	2379	2379	2379
Production						
beer filling (bbl/hr)	153.8	153.8	153.8	153.8	153.8	153.8
Calculations	hrs 31-32	hrs 33-34	hrs 35-36	hrs 37-38	hrs 39-40	Averages
Theoretical Total						
VOC lb/hr as propane	2.30	3.06	2.17	2.74	3.01	2.66
VOC lb/hr as ethanol	5.75	7.68	5.45	6.86	7.54	6.66
VOC lb/bbl as ethanol	0.0374	0.0499	0.0354	0.0446	0.0490	0.0433
Theoretical from Filling						
VOC lb/hr as propane	2.14	2.91	2.02	2.58	2.86	2.50
VOC lb/hr as ethanol	5.36	7.29	5.06	6.47	7.16	6.27
VOC lb/bbl as ethanol	0.0349	0.0474	0.0329	0.0421	0.0465	0.0408

Table 7 - VOC Mass Emission Rates
#9 Can Filler
(hours 31 through 40)

Two Tedlar gas bag samples collected under the filler room door during hour 33 measured 87.0 ppm and 83.0 ppm as propane.

Results (continued)

The 33 hour averages exclude the data collected during the first eight hours of sampling, when no beer filling was conducted.

Coors Brewing Company			
#9 Can Filler			
12-3-92 through 12-5-92			
VOC Mass Emission Rates			
Field Data		hour 41	33 hour Averages (exclude sterilization)
Outlet			
	VOC conc. (ppm wet)	39.8	42.1
	% H2O	0.6	0.6
	volumetric flow rate (dscfm)	2359	2359
Inlet #1			
	VOC conc. (ppm)	2.5	2.5
	volumetric flow rate (dscfm)	6392	6392
Inlet #2			
	VOC conc. (ppm)	2.7	2.7
	volumetric flow rate (dscfm)	2379	2379
Production			
	beer filling (bbl/hr)	153.8	153.8
Calculations		hour 41	33 hour Averages (exclude sterilization)
Theoretical Total			
	VOC lb/hr as propane	2.41	2.55
	VOC lb/hr as ethanol	6.04	6.39
	VOC lb/bbl as ethanol	0.0393	0.0416
Theoretical from Filling			
	VOC lb/hr as propane	2.26	2.40
	VOC lb/hr as ethanol	5.65	6.00
	VOC lb/bbl as ethanol	0.0368	0.0390

Table 8 - VOC Mass Emission Rates
#9 Can Filler
(hour 41 and 33 hour averages)

APPENDIX H

REPORT EXCERPTS FROM REFERENCE 17

(Coors, November 1990)

Stack Test Report # 7

139 pp.

STACK EMISSIONS SURVEY
ADOLPH COORS COMPANY
BREWERY COMPLEX
GOLDEN, COLORADO

NOVEMBER 1990

FILE NUMBER 9010-204

Prepared By:

Western Environmental Services and Testing, Inc.
6756 West Uranium Road
Casper, Wyoming 82604
(307) 234-5511

COORS REPORT 7 TEST DATA SUMMARY

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	105	108	114	
COMBINED	Moisture	%	7.45	8.82	12.23	
COOKER	Oxygen	%	20.9	20.9	20.9	
STACK	Volumetric flow, actual	acfm	5955	7104	6758	
	Volumetric flow, standard	dscfm	4187	4898	4432	4505.667
	Isokinetic variation	%	100.68	103.11	105.72	
Circle: Production or feed rate Capacity:		1000 bbl/hr	1.13	1.13	1.13	
	Pollutant concentrations:					
	TOC as propane	ppmdv	2	5	6	
	Filterable PM	gr/dscf	0.004	0.0019	0.0043	
	SO2	ppmdv	0.4	ND	ND	
	NOx	ppmdv	ND	ND	ND	
	Pollutant mass flux rates:					
	TOC as propane	lb/hr	0.05738	0.168	0.182	
	Filterable PM	lb/hr	0.144	0.0798	0.163	
	SO2	lb/hr	0.0171	ND	ND	
	NOx	lb/hr	ND	ND	ND	
	Emission factors:					Average
	TOC as propane	lb/1000 bbl	0.0508	0.148	0.161	0.120
	Filterable PM	lb/1000 bbl	0.127	0.071	0.145	0.114
	SO2	lb/1000 bbl	0.0151	ND	ND	ND
	NOx	lb/1000 bbl	ND	ND	ND	ND

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	136	130	138	
BREW	Moisture	%	20.46	18.82	21.45	
KETTLE	Oxygen	%	20.9	20.9	20.9	
STACK	Volumetric flow, actual	acfm	19241	20153	24127	
W/ HEAT	Volumetric flow, standard	dscfm	11019	11905	13610	12178
RECLAIM	Isokinetic variation	%	105.09	97.07	99.12	
Circle: Production or feed rate Capacity:		1000 bbl/hr	1.13	1.13	1.13	
	Pollutant concentrations:					
	TOC as propane	ppmdv	10	10	9	
	Filterable PM	gr/dscf	0.0029	0.0025	0.0013	
	SO2	ppmdv	0.4	0.4	0.2	
	NOx	ppmdv	ND	ND	ND	
	Pollutant mass flux rates:					
	TOC as propane	lb/hr	0.75500	0.816	0.839	
	Filterable PM	lb/hr	0.274	0.255	0.152	
	SO2	lb/hr	0.0450	0.0487	0.0278	
	NOx	lb/hr	ND	ND	ND	
	Emission factors:					Average
	TOC as propane	lb/1000 bbl	0.668	0.722	0.743	0.711
	Filterable PM	lb/1000 bbl	0.242	0.226	0.134	0.201
	SO2	lb/1000 bbl	0.0399	0.0431	0.0246	0.0358
	NOx	lb/1000 bbl	ND	ND	ND	ND

COORS REPORT 7 TEST DATA SUMMARY

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	140	147	148	
BREW KETTLE STACK	Moisture	%	23.34	27.54	29.24	
	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	25706	23022	21652	
	Volumetric flow, standard	dscfm	14086	11797	10810	12231
	Isokinetic variation	%	91.17	102.81	104.53	
Circle: Production or feed rate Capacity:		1000 bbl/hr	1.13	1.13	1.13	
	Pollutant concentrations:					
	TOC as propane	ppmdv	11	16	16	
	Filterable PM	gr/dscf	0.0039	0.0027	0.0068	
	SO2	ppmdv	ND	ND	ND	
	NOx	ppmdv	ND	ND	ND	
	Pollutant mass flux rates:					
	TOC as propane	lb/hr	1.06	1.29	1.19	
	Filterable PM	lb/hr	0.471	0.273	0.630	
	SO2	lb/hr	ND	ND	ND	
	NOx	lb/hr	ND	ND	ND	
	Emission factors:					Average
	TOC as propane	lb/1000 bbl	0.940	1.14	1.05	1.04
	Filterable PM	lb/1000 bbl	0.417	0.242	0.558	0.405
	SO2	lb/1000 bbl	ND	ND	ND	ND
	NOx	lb/1000 bbl	ND	ND	ND	ND

PROCESS RATE ESTIMATED FROM BREWLINE CAPACITY OF 3.3x10^6 BBL/YR PER BREWLINE, WITH 3 BREWLINES OPERATING FOR 8,760 HR/YR

SUMMARY OF RESULTS

Combined Cooker Stack

Run Number		1	2	3
Stack Flow Rate - ACFM		5955	7104	6758
Stack Flow Rate - DSCFM*		4187	4898	4432
% Water Vapor - % Volume		7.45	8.82	12.23
% CO2 - % Volume		<0.2	<0.2	<0.2
% O2 - % Volume		20.9	20.9	20.9
% Excess Air At Sampling Point		----	----	----
Particulates Probe, Cyclone & Filter Catch grains/dscf*	(Can)	0.0040	0.0019	0.0043
grains/cf at Stack Conditions	(Cat)	0.0028	0.0013	0.0028
lbs/hr	(Caw)	0.144	0.080	0.165
Oxides of Nitrogen	ppm	<1.0	<1.0	<1.0
	lbs/hr	<0.03	<0.04	<0.03
Total Hydrocarbons as Propane (less methane and ethane)	ppm	0.2	3.2	4.2
	lbs/hr	<0.01	0.11	0.13
Sulfur Dioxide	ppm	0.4	ND	ND
	lbs/hr	0.02	ND	ND

* 68 Deg. F., 29.92 "Hg (20 Deg. C., 760 mm Hg)

SUMMARY OF RESULTS

Brew Kettle Stack
(Heat Reclaim On)

Run Number		1	2	3
Stack Flow Rate - ACFM		19241	20153	24127
Stack Flow Rate - DSCFM*		11019	11905	13610
% Water Vapor - % Volume		20.46	18.82	21.45
% CO2 - % Volume		<0.2	<0.2	<0.2
% O2 - % Volume		20.9	20.9	20.9
% Excess Air At Sampling Point		-----	-----	-----
Particulates Probe, Cyclone & Filter Catch grains/dscf*	(Can)	0.0029	0.0025	0.0013
grains/cf at Stack Conditions	(Cat)	0.0017	0.0015	0.0007
lbs/hr	(Caw)	0.278	0.254	0.150
Oxides of Nitrogen	ppm	<1.0	<1.0	<1.0
	lbs/hr	<0.08	<0.08	<0.10
Total Hydrocarbons as Propane (less methane and ethane)	ppm	8.6	8.6	7.6
	lbs/hr	0.65	0.70	0.71
Sulfur Dioxide	ppm	0.4	0.4	0.2
	lbs/hr	0.04	0.05	0.03

* 68 Deg. F., 29.92 "Hg (20 Deg. C., 760 mm Hg)

SUMMARY OF RESULTS

Brew Kettle Stack
(Heat Reclaim Off)

Run Number		4	5	6
Stack Flow Rate - ACFM		25706	23022	21652
Stack Flow Rate - DSCFM*		14086	11797	10810
% Water Vapor - % Volume		23.34	27.54	29.24
% CO2 - % Volume		<0.2	<0.2	<0.2
% O2 - % Volume		20.9	20.9	20.9
% Excess Air At Sampling Point		-----	-----	-----
Particulates Probe, Cyclone & Filter Catch grains/dscf*	(Can)	0.0039	0.0027	0.0068
grains/cf at Stack Conditions	(Cat)	0.0021	0.0014	0.0034
lbs/hr	(Caw)	0.468	0.275	0.627
Oxides of Nitrogen	ppm	<1.0	<1.0	<1.0
	lbs/hr	0.10	<0.08	<0.08
Total Hydrocarbons as Propane (less methane and ethane)	ppm	8.6	13.6	13.6
	lbs/hr	0.83	1.10	1.01
Sulfur Dioxide	ppm	ND	ND	ND
	lbs/hr	ND	ND	ND

* 68 Deg. F., 29.92 "Hg (20 Deg. C., 760 mm Hg)

APPENDIX I

REPORT EXCERPTS FROM REFERENCE 19

(Coors, February 1991)

Stack Test Report # 9

300 p.

STACK EMISSIONS SURVEY
ADOLPH COORS COMPANY
BREWERY COMPLEX
GOLDEN, COLORADO

FEBRUARY 1991

FILE NUMBER 9110-111

Prepared By:

Western Environmental Services and Testing, Inc.
6756 West Uranium Road
Casper, Wyoming 82604
(307) 234-5511

COORS REPORT 9 TEST DATA SUMMARY

D. Emission Data/Mass Flux Rates/Emission Factors — Background Report Reference 19

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	170	173	175	
2 SPENT GRAIN	Moisture	%	47.65	48.17	50.52	
DRYERS WITH	Oxygen	%	20.8	21.0	20.8	
WET SCRUBBER	Volumetric flow, actual	acfm	19470	18661	16371	
	Volumetric flow, standard	dscfm	6984	6598	5508	
	Isokinetic variation	%	92.11	98.54	102	
Production rate: based on plant average 0.44 brews/hr/dryer*2 dryers*2.6315 tons dry grain/brew		ton/hr dry grain	2.31572	2.31572	2.31572	
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.0176	0.0171	0.0151	
	TOC as propane	ppmdv	50.7	41.3	68.6	
	CO2	%	0.2	0.2	0.2	
	CO	ppmdv	31	40	67	
	Filterable PM-10	% of PM	37.3%	51.1%	34.1%	
	Filterable PM-2.5	% of PM	18.7%	33.4%	15.8%	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	1.05	0.967	0.713	
	TOC as propane	lb/hr	2.43	1.87	2.59	
	CO2	lb/hr	95.7	90.4	75.5	
	CO	lb/hr	0.944	1.15	1.61	
	Filterable PM-10	lb/hr	0.393	0.494	0.243	
	Filterable PM-2.5	lb/hr	0.197	0.323	0.113	
	Emission factors:					Average
	Filterable PM	lb/ton	0.45	0.42	0.31	0.39
	TOC as propane	lb/ton	1.0	0.81	1.1	0.99
	CO2	lb/ton	41	39	33	38
	CO	lb/ton	0.41	0.50	0.69	0.53
	Filterable PM-10	lb/ton	0.17	0.21	0.10	0.16
	Filterable PM-2.5	lb/ton	0.085	0.14	0.049	0.091

PM-10 values from linear interpolation of cascade impactor data. Different from reported values.

COORS REPORT 9 TEST DATA SUMMARY

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	156	160	157	
SPENT GRAIN	Moisture	%	32.7	34.74	32.8	
DRYER WITH	Oxygen	%	21.2	21.0	20.8	
WET SCRUBBER	Volumetric flow, actual	acfm	7874	9249	8473	
	Volumetric flow, standard	dscfm	3710	4205	3984	
	Isokinetic variation	%	89.97	97.27	96.47	
Production rate: based on plant average 0.44 brews/hr/dryer*1 dryer*2.6315 tons dry grain/brew		ton/hr dry grain	1.15786	1.15786	1.15786	
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.0147	0.0098	0.0144	
	TOC as propane	ppmdv	25.5	19.1	19.6	
	CO2	%	0.4	0.2	0.4	
	CO	ppmdv	29	7	13	
	Filterable PM-10	% of PM	10.0%	18.3%	13.8%	
	Filterable PM-2.5	% of PM	5.2%	10.7%	6.8%	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	0.467	0.353	0.492	0.437
	TOC as propane	lb/hr	0.65	0.55	0.54	0.578
	CO2	lb/hr	102	57.6	109	89.5
	CO	lb/hr	0.469	0.128	0.226	0.274
	Filterable PM-10	lb/hr	0.0467	0.0646	0.0679	0.0597
	Filterable PM-2.5	lb/hr	0.0243	0.0378	0.0334	0.0318
	Emission factors:					Average
	Filterable PM	lb/ton	0.40	0.305	0.42	0.38
	TOC as propane	lb/ton	0.56	0.48	0.46	0.50
	CO2	lb/ton	88	50	94	77
	CO	lb/ton	0.41	0.111	0.195	0.24
	Filterable PM-10	lb/ton	0.040	0.056	0.059	0.052
	Filterable PM-2.5	lb/ton	0.021	0.033	0.029	0.028

PM-10 values from linear interpolation of cascade impactor data. Different from reported values.

COORS REPORT 9 TEST DATA SUMMARY

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	191	192	192	
K-1 SPENT GRAIN DRYER (uncontrolled)	Moisture	%	59.4	58.51	57.69	
	Oxygen	%	20.0	20.0	20.0	
	Volumetric flow, actual	acfm	5490	5369	5687	
	Volumetric flow, standard	dscfm	1484	1481	1600	
	Isokinetic variation	%	111.73	98.36	93.75	
Production rate: based on plant average 0.44 brews/hr/dryer*1 dryer*2.6315 tons dry grain/brew		ton/hr dry grain	1.15786	1.15786	1.15786	
	Pollutant concentrations:					
	Filterable PM	g/dscf	7.3178	9.4518	6.5563	
	TOC as propane	ppmdv	27.1	32.3	21.8	
	CO	ppmdv	4	4	2	
	Filterable PM-10	% of PM	0.75%	0.35%	0.37%	
	Filterable PM-2.5	% of PM	0.40%	0.10%	0.10%	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	93.1	120	89.9	
	TOC as propane	lb/hr	0.276	0.328	0.239	
	CO	lb/hr	0.0259	0.0258	0.0140	
	Filterable PM-10	lb/hr	0.698	0.420	0.333	
	Filterable PM-2.5	lb/hr	0.372	0.120	0.0899	
	Emission factors:					Average
	Filterable PM	lb/ton	VOID	104	78	91
	TOC as propane	lb/ton	0.238	0.283	0.206	0.242
	CO	lb/ton	0.0224	0.0223	0.0121	0.0189
	Filterable PM-10	lb/ton	VOID	0.36	0.287	0.33
	Filterable PM-2.5	lb/ton	VOID	0.104	0.078	0.091

PM-10 values from linear interpolation of cascade impactor data. Different from reported values.

COORS REPORT 9 TEST DATA SUMMARY

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
4	Stack temperature	Deg F	174	165	172	
K-1 SPENT	Moisture	%	49.47	40.08	48.57	
GRAIN DRYER	Oxygen	%	20.6	20.6	20.8	
WITH WET	Volumetric flow, actual	acfm	6193	6092	6124	
SCRUBBER	Volumetric flow, standard	dscfm	2123	2513	2144	
	Isokinetic variation	%	94.07	81.21	105.93	
Production rate: based on plant average 0.44 brews/hr/dryer*1 dryer*2.6315 tons dry grain/brew		ton/hr dry grain	1.15786	1.15786	1.15786	
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.0145	0.0082	0.0059	
	TOC as propane	ppmdv	49.6	29.2	47.4	
	CO	ppmdv	10	23	2	
	CO2	% DRY VOLUM	0.4	0.4	0.2	
	Filterable PM-10	% of PM	21.6%	16.0%	ND	
	Filterable PM-2.5	% of PM	11.8%	9.5%	ND	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	0.264	0.177	0.108	
	TOC as propane	lb/hr	0.722	0.503	0.696	
	CO	lb/hr	0.0926	0.252	0.0187	
	CO2	lb/hr	58.2	68.9	29.4	
	Filterable PM-10	lb/hr	0.0570	0.0283	ND	
	Filterable PM-2.5	lb/hr	0.0311	0.0168	ND	
	Emission factors:					Average
	Filterable PM	lb/ton	0.228	VOID	0.094	0.161
	TOC as propane	lb/ton	0.62	0.43	0.60	0.55
	CO	lb/ton	0.080	0.218	0.0161	0.105
	CO2	lb/ton	50	59	25.4	45
	Filterable PM-10	lb/ton	0.049	VOID	ND	VOID
	Filterable PM-2.5	lb/ton	0.0269	VOID	ND	VOID

PM-10 values from linear interpolation of cascade impactor data. Different from reported values.

SUMMARY OF RESULTS

NB4 North Dryer Stack

Run Number		1	2	3
Stack Flow Rate - ACFM		19470	18661	16371
Stack Flow Rate - DSCFM*		6984	6598	5508
% Water Vapor - % Volume		47.65	48.17	50.52
% CO_2 - % Volume		0.2	0.2	0.2
% O_2 - % Volume		20.8	21.0	20.8
% Excess Air At Sampling Point		-----	-----	-----
Particulates Probe, Cyclone & Filter Catch grains/dscf*	(C_{an})	0.0176	0.0171	0.0151
grains/cf at Stack Conditions	(C_{at})	0.0063	0.0060	0.0051
lbs/hr	(C_{aw})	1.051	0.970	0.714
Carbon Monoxide	ppm	31	40	67
	lbs/hr	0.944	1.151	1.609
Total Hydrocarbons as Propane (less methane and ethane)	ppm	49.3	39.8	67.2
	lbs/hr	2.361	1.800	2.538
PM - 10	lbs/hr	0.399	0.500	0.282

* 68 Deg. F., 29.92 "Hg (20 Deg. C., 760 mm Hg)

SUMMARY OF RESULTS

NB4 South Dryer Stack

Run Number		1	2	3
Stack Flow Rate - ACFM		7874	9249	8473
Stack Flow Rate - DSCFM*		3710	4205	3984
% Water Vapor - % Volume		32.70	34.74	32.80
% CO_2 - % Volume		0.4	0.2	0.4
% O_2 - % Volume		21.2	21.0	20.8
% Excess Air At Sampling Point		-----	-----	-----
Particulates				
Probe, Cyclone & Filter Catch grains/dscf*	(C_{an})	0.0147	0.0098	0.0144
grains/cf at Stack Conditions	(C_{at})	0.0069	0.0045	0.0068
lbs/hr	(C_{aw})	0.466	0.354	0.493
Carbon Monoxide	ppm	29	7	13
	lbs/hr	0.469	0.128	0.226
Total Hydrocarbons as Propane (less methane and ethane)	ppm	24.1	18.0	18.5
	lbs/hr	0.613	0.519	0.505
PM - 10	lbs/hr	0.055	0.069	0.085

* 68 Deg. F., 29.92 "Hg (20 Deg. C., 760 mm Hg)

SUMMARY OF RESULTS

K-1 Dryer Inlet

Run Number		1	2	3
Stack Flow Rate - ACFM		5490	5369	5687
Stack Flow Rate - DSCFM*		1484	1481	1600
% Water Vapor - % Volume		59.40	58.51	57.69
% CO_2 - % Volume		0.0	0.0	0.0
% O_2 - % Volume		20.0	20.0	20.0
% Excess Air At Sampling Point		-----	-----	-----
Particulates Probe, Cyclone & Filter Catch grains/dscf*	(C_{an})	7.3178	9.4518	6.5563
grains/cf at Stack Conditions	(C_{at})	1.9708	2.5986	1.8377
lbs/hr	(C_{aw})	93.056	119.983	89.875
Carbon Monoxide	ppm	4	4	2
	lbs/hr	0.026	0.026	0.014
Total Hydrocarbons as Propane (less methane and ethane)	ppm	25.9	31.2	20.7
	lbs/hr	0.264	0.317	0.227
PM - 10	lbs/hr	0.838	0.600	0.539

* 68 Deg. F., 29.92 "Hg (20 Deg. C., 760 mm Hg)

SUMMARY OF RESULTS

K-1 Dryer Outlet Stack

Run Number		1	2	3
Stack Flow Rate - ACFM		6193	6092	6124
Stack Flow Rate - DSCFM*		2123	2513	2144
% Water Vapor - % Volume		49.47	40.08	48.57
% CO_2 - % Volume		0.4	0.4	0.2
% O_2 - % Volume		20.6	20.6	20.8
% Excess Air At Sampling Point		----	----	----
Particulates Probe, Cyclone & Filter Catch grains/dscf*	(C_{an})	0.0145	0.0082	0.0059
grains/cf at Stack Conditions	(C_{at})	0.0050	0.0034	0.0021
lbs/hr	(C_{aw})	0.264	0.178	0.109
Carbon Monoxide	ppm	10	23	2
	lbs/hr	0.092	0.252	0.019
Total Hydrocarbons as Propane (less methane and ethane)	ppm	48.3	28.1	46.3
	lbs/hr	0.703	0.484	0.680
PM - 10	lbs/hr	0.058	0.031	-----

* 68 Deg. F., 29.92 "Hg (20 Deg. C., 760 mm Hg)

PARTICLE SIZE DATA

Run No: 1

Date: 02-13-91

Time: 1623-1630

Location: NB4 North

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.2133	0.2190	5.7	62.0	38.0 37.3	>11.0 10.0
1	0.1574	0.1577	0.3	3.3	34.7	6.6
2	0.1397	0.1403	0.6	6.5	28.2	4.4
3	0.1556	0.1562	0.6	6.5	21.7 18.7 %	3.0 2.5
4	0.1400	0.1406	0.6	6.5	15.2	1.9
5	0.1591	0.1593	0.2	2.2	13.0	0.95
6	0.1400	0.1401	0.1	1.1	11.9	0.59
7	0.1574	0.1575	0.1	1.1	10.8	0.38
F	0.3524	0.3534	1.0	10.8	0.0	---
			9.2	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.048	"H_2O ($\triangle P_s$)
Stack Temperature:	170	°F (T_s)
Molecular Weight:	23.69	lbs/lb-mole (MW)
Stack Pressure:	24.39	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	1.65	"H_2O (P_m)
Sample Volume:	5.888	ft^3 (V_m)
Meter Temperature:	108	°F (T_m)
Sampling Rate:	0.841	ACFM (Q_a)
% I:	89.83	%
Emissions:	0.0316	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 2

Date: 02-13-91

Time: 1813-1833

Location: NB4 North

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.0631	0.0690	5.9	48.5	51.5 51.1	>10.5 10
1	0.1566	0.1570	0.4	3.3	48.2	6.5
2	0.1396	0.1399	0.3	2.5	45.7	4.3
3	0.1554	0.1562	0.8	6.6	39.1 33.4	2.95 2.5
4	0.1382	0.1399	1.7	13.9	25.2	1.85
5	0.1566	0.1572	0.6	4.9	20.3	0.93
6	0.1400	0.1407	0.7	5.7	14.6	0.58
7	0.1571	0.1571	0.0	0.0	14.6	0.38
F	0.3569	0.3587	1.8	14.6	0.0	---
			12.2	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.044	"H_2O (ΔP_s)
Stack Temperature:	180	°F (T_s)
Molecular Weight:	23.64	lbs/lb-mole (MW)
Stack Pressure:	24.39	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	1.60	"H_2O (P_m)
Sample Volume:	17.229	ft^3 (V_m)
Meter Temperature:	107	°F (T_m)
Sampling Rate:	0.861	ACFM (Q_a)
% I:	97.87	%
Emissions:	0.0143	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 3

Date: 02-13-91

Time: 2009-2024

Location: NB4 North

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.6253	0.6299	4.6	60.5	39.5	>11.5
					34.1	10.0
1	0.1548	0.1560	1.2	15.8	23.7	7.1
2	0.1388	0.1390	0.2	2.6	21.1	4.8
3	0.1538	0.1540	0.2	2.6	18.5	3.3
					15.8	2.5
4	0.1400	0.1403	0.3	4.0	14.5	2.1
5	0.1543	0.1544	0.1	1.3	13.2	1.05
6	0.1398	0.1404	0.6	7.9	5.3	0.64
7	0.1575	0.1576	0.1	1.3	4.0	0.43
F	0.3565	0.3568	0.3	4.0	0.0	---
			7.6	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.032	"H_2O ($\triangle P_s$)
Stack Temperature:	171	°F (T_s)
Molecular Weight:	23.38	lbs/lb-mole (MW)
Stack Pressure:	24.39	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	1.15	"H_2O (P_m)
Sample Volume:	11.017	ft^3 (V_m)
Meter Temperature:	106	°F (T_m)
Sampling Rate:	0.734	ACFM (Q_a)
% I:	101.25	%
Emissions:	0.0139	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 1

Date: 02-14-91

Time: 1130-1200

Location: NB4 South

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.4589	0.4671	8.2	88.2	11.8	>14.5
					10.0	12.2
1	0.1579	0.1581	0.2	2.1	9.7	9.2
2	0.1375	0.1376	0.1	1.1	8.6	6.3
3	0.1569	0.1572	0.3	3.2	5.4	4.3
4	0.1382	0.1382	0.0	0.0	5.4	2.7
					5.2	2.5
5	0.1588	0.1589	0.1	1.1	4.3	1.35
6	0.1392	0.1393	0.1	1.1	3.2	0.84
7	0.1582	0.1583	0.1	1.1	2.1	0.57
F	0.3583	0.3585	0.2	2.1	0.0	---
			9.3	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.008	"H_2O ($\triangle P_s$)
Stack Temperature:	156	°F (T_s)
Molecular Weight:	25.34	lbs/lb-mole (MW)
Stack Pressure:	24.37	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	0.36	"H_2O (P_m)
Sample Volume:	12.868	ft^3 (V_m)
Meter Temperature:	103	°F (T_m)
Sampling Rate:	0.429	ACFM (Q_a)
% I:	89.69	%
Emissions:	0.0145	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 2

Date: 02-14-91

Time: 1358-1428

Location: NB4 South

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.7053	0.7099	4.6	80.6	19.4	>13.0
					18.3	10.0
1	0.1573	0.1574	0.1	1.8	17.6	8.1
2	0.1407	0.1409	0.2	3.4	14.2	5.6
3	0.1578	0.1579	0.1	1.8	12.4	3.75
					10.7	2.5
4	0.1372	0.1373	0.1	1.8	10.6	2.4
5	0.1570	0.1571	0.1	1.8	8.8	1.2
6	0.1375	0.1376	0.1	1.8	7.0	0.73
7	0.1552	0.1553	0.1	1.8	5.2	0.49
F	0.3533	0.3536	0.3	5.2	0.0	---
			5.7	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.012	"H_2O ($\triangle P_s$)
Stack Temperature:	159	°F (T_s)
Molecular Weight:	25.10	lbs/lb-mole (MW)
Stack Pressure:	24.37	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	0.66	"H_2O (P_m)
Sample Volume:	16.625	ft^3 (V_m)
Meter Temperature:	106	°F (T_m)
Sampling Rate:	0.554	ACFM (Q_a)
% I:	96.89	%
Emissions:	0.0069	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 3

Date: 02-14-91

Time: 1738-1808

Location: NB4 South

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.7978	0.8050	7.2	82.8	17.2	>13.8
					13.3	10.0
1	0.1587	0.1591	0.4	4.6	12.6	8.6
2	0.1390	0.1390	0.0	0.0	12.6	5.9
3	0.1586	0.1589	0.3	3.5	9.1	4.0
4	0.1404	0.1406	0.2	2.3	6.8	2.5
5	0.1598	0.1599	0.1	1.1	5.7	1.25
6	0.1400	0.1401	0.1	1.1	4.6	0.78
7	0.1588	0.1589	0.1	1.1	3.5	0.53
F	0.3581	0.3584	0.3	3.5	0.0	---
			8.7	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.010	"H_2O ($\triangle P_s$)
Stack Temperature:	160	°F (T_s)
Molecular Weight:	25.32	lbs/lb-mole (MW)
Stack Pressure:	24.37	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	0.55	"H_2O (P_m)
Sample Volume:	14.755	ft^3 (V_m)
Meter Temperature:	104	°F (T_m)
Sampling Rate:	0.492	ACFM (Q_m)
% I:	92.25	%
Emissions:	0.0119	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 1

Date: 02-15-91

Time: 1233-1242.5

Location: K-1 Inlet

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.5312	0.8519	320.7	99.1	0.9	>12.2
					0.75	10.0
1	0.1576	0.1585	0.9	0.3	0.6	7.7
2	0.1411	0.1413	0.2	0.1	0.5	5.2
3	0.1572	0.1575	0.3	0.1	0.4	3.5
					0.4	2.5
4	0.1400	0.1400	0.0	0.0	0.4	2.25
5	0.1588	0.1589	0.1	0.0	0.4	1.11
6	0.1411	0.1413	0.2	0.1	0.3	0.70
7	0.1592	0.1600	0.8	0.2	0.1	0.47
F	0.3559	0.3562	0.3	0.1	0.0	---
			323.5	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.020	"H_2O ($\triangle P_s$)
Stack Temperature:	191	°F (T_s)
Molecular Weight:	22.38	lbs/lb-mole (MW)
Stack Pressure:	24.48	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	0.64	"H_2O (P_m)
Sample Volume:	4.930	ft^3 (V_m)
Meter Temperature:	80	°F (T_m)
Sampling Rate:	0.519	ACFM (Q_a)
% I:	114.97	%
Emissions:	1.2596	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 2

Date: 02-15-91

Time: 1443-1450.5

Location: K-1 Inlet

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.2794	1.2405	961.1	99.5	0.5	>14.0
					0.35	10.0
1	0.1557	0.1574	1.7	0.2	0.3	8.8
2	0.1415	0.1421	0.6	0.1	0.2	5.9
3	0.1548	0.1550	0.2	0.0	0.2	4.0
4	0.1410	0.1415	0.5	0.1	0.1	2.55
					0.1	2.5
5	0.1568	0.1570	0.2	0.0	0.0	1.25
6	0.1403	0.1409	0.6	0.1	0.0	0.79
7	0.1566	0.1568	0.2	0.0	0.0	0.53
F	0.3548	0.3552	0.4	0.0	0.0	---
			965.5	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.018	"H_2O ($\triangle P_s$)
Stack Temperature:	190	°F (T_s)
Molecular Weight:	22.48	lbs/lb-mole (MW)
Stack Pressure:	24.48	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	0.50	"H_2O (P_m)
Sample Volume:	3.627	ft^3 (V_m)
Meter Temperature:	93	°F (T_m)
Sampling Rate:	0.484	ACFM (Q_a)
% I:	108.02	%
Emissions:	5.2355	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 3

Date: 02-15-91

Time: 1721-1729.5

Location: K-1 Inlet

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	7.9236	9.2004	1276.8	99.4	0.6	>14.0
					0.37	10.0
1	0.1563	0.1600	3.7	0.3	0.3	8.8
2	0.1400	0.1409	0.9	0.1	0.2	5.9
3	0.1558	0.1573	1.5	0.1	0.1	4.0
4	0.1399	0.1400	0.1	0.0	0.1	2.55
					0.1	2.5
5	0.1550	0.1555	0.5	0.1	0.0	1.25
6	0.1399	0.1400	0.1	0.0	0.0	0.79
7	0.1548	0.1549	0.1	0.0	0.0	0.53
F	0.3596	0.3599	0.3	0.0	0.0	---
			1284.0	100.0		

Particle Density*: 1.00 gm/cm^3

Velocity Head: 0.020 "H_2O ($\triangle P_s$)

Stack Temperature: 193 °F (T_s)

Molecular Weight: 22.57 lbs/lb-mole (MW)

Stack Pressure: 24.48 "Hg (P_s)

Nozzle Diameter: 0.618 inches (D_n)

Orifice Head: 0.48 "H_2O (P_m)

Sample Volume: 4.068 ft^3 (V_m)

Meter Temperature: 86 °F (T_m)

Sampling Rate: 0.479 ACFM (Q_a)

% I: 101.15 %

Emissions: 6.1294 gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 1

Date: 02-15-91

Time: 2239-2254

Location: K-1 Outlet

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.6461	0.6525	6.4	78.1	21.9	>11.0
					21.6	10.0
1	0.1584	0.1585	0.1	1.2	20.7	6.8
2	0.1387	0.1389	0.2	2.4	18.3	4.5
3	0.1581	0.1583	0.2	2.4	15.9	3.2
					11.8	2.5
4	0.1404	0.1410	0.6	7.4	8.5	1.95
5	0.1566	0.1567	0.1	1.2	7.3	0.97
6	0.1415	0.1417	0.2	2.4	4.9	0.60
7	0.1595	0.1595	0.0	0.0	4.1	0.40
F	0.3466	0.3470	0.4	4.9	0.0	---
			8.2	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.040	"H_2O ($\triangle P_s$)
Stack Temperature:	174	°F (T_s)
Molecular Weight:	23.50	lbs/lb-mole (MW)
Stack Pressure:	24.29	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	1.20	"H_2O (P_m)
Sample Volume:	5.980	ft^3 (V_m)
Meter Temperature:	55	°F (T_m)
Sampling Rate:	0.797	ACFM (Q_a)
% I:	104.23	%
Emissions:	0.0253	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

PARTICLE SIZE DATA

Run No: 2

Date: 02-16-91

Time: 0026-0046

Location: K-1 Outlet

Plate Number	Initial Weight (g)	Final Weight (g)	Increase (mg)	% of Total	Cum. % < Size Range	Effective Cut-Off Diameter* (microns)
0	0.7614	0.7704	9.0	82.6	17.4	>11.0
					16.0	10.0
1	0.1573	0.1579	0.6	5.5	11.9	7.0
2	0.1415	0.1416	0.1	0.9	11.0	4.7
3	0.1595	0.1596	0.1	0.9	10.1	3.3
					9.5	2.5
4	0.1408	0.1409	0.1	0.9	9.2	2.05
5	0.1582	0.1586	0.4	3.7	5.5	1.00
6	0.1393	0.1395	0.2	1.8	3.7	0.62
7	0.1573	0.1574	0.1	0.9	2.8	0.43
F	0.3532	0.3535	0.3	2.8	0.0	---
			10.9	100.0		

Particle Density*:	1.00	gm/cm^3
Velocity Head:	0.040	"H_2O ($\triangle P_s$)
Stack Temperature:	166	°F (T_s)
Molecular Weight:	24.52	lbs/lb-mole (MW)
Stack Pressure:	24.29	"Hg (P_s)
Nozzle Diameter:	0.618	inches (D_n)
Orifice Head:	1.20	"H_2O (P_m)
Sample Volume:	14.972	ft^3 (V_m)
Meter Temperature:	56	°F (T_m)
Sampling Rate:	0.749	ACFM (Q_a)
% I:	83.58	%
Emissions:	0.0134	gr/dscf (C_{an})

*Assumed Particle Density of 1.00 gm/cm^3

9110-111

APPENDIX J

REPORT EXCERPTS FROM REFERENCE 20

(Coors, November 1992)

AIR POLLUTION TESTING, INC.
4535 West 68th Avenue Westminster, CO 80030 (303) 426-0402
FAX (303) 426-1922

GC pp.

Grain Dryer Diagnostic VOC Report
for
Coors Brewing Company

Report prepared by:
Air Pollution Testing, Inc.
4535 West 68th Avenue
Westminster, Colorado 80030
(303) 426-0402
(303) 426-1922 (FAX)

Report reviewed by:
Paul Ottenstein
Project Manager

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported						
			Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	
1	Stack temperature	Deg F	174	175	174	183	180	178	
SPENT GRAIN	Moisture	%	56.6	56.4	57	56.3	57.1	56	
DRYER	Oxygen	%	20.9	20.9	20.9	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	4847	4968	4871	5051	4969	4957	
	Volumetric flow, standard	dscfm	1431	1474	1428	1485	1440	1476	
	Isokinetic variation	%	NA	NA	NA	NA	NA	NA	
Production rate: based on plant average 0.44 brews/hr/dryer*1 dryer*2.6315 tons dry grain/brew		ton/hr dry grain	1.158	1.158	1.158	1.158	1.158	1.158	
	Pollutant concentrations:								
	TOC as propane	ppmwv	28.8	27.6	37.9	31.2	25	31.3	
	Pollutant mass flux rates:								
	TOC as propane	lb/hr	0.652	0.641	0.864	0.728	0.576	0.721	
	Emission factors:								Average
	TOC as propane	lb/ton	0.56	0.55	0.75	0.63	0.50	0.62	0.60

Results

The results of the testing are presented in the following tables. Any testing variables not presented here may be found in *Appendix 1 - Testing Parameters / Sample Calculations.*

run #	1	2	3	averages
start time stop time	08:24 09:49 [1]	10:00 11:18 [1]	11:40 12:40	
stack temp. (°F)	174	175	174	174
stack moisture (vol %)	56.6	56.4	57.0	56.7
gas velocity (ft/sec)	9.3	9.6	9.4	9.4
gas flow (acfm)	4847	4968	4871	4895
gas flow (dscfm)	1431	1474	1428	1444
VOC (ppm wet as propane)	28.8	27.6	37.9	31.4
VOC (lb/hr as propane)	0.65	0.64	0.86	0.72

Table 1 - Grain Dryer VOC Results
Day 1 - 11/9/92

[1] - total sampling duration is greater than one hour due to mid-test calibration verifications.

Results (continued)

run #	1	2	3	averages
start time	07:42	08:57	10:14	
stop time	08:47 [1]	09:57	11:14	
stack temp. (°F)	183	180	178	180
stack moisture (vol %)	56.3	57.1	56.0	56.5
gas velocity (ft/sec)	9.7	9.6	9.5	9.6
gas flow (acfm)	5051	4969	4957	4992
gas flow (dscfm)	1485	1440	1476	1467
VOC (ppm wet as propane)	31.2	25.0	31.3	29.2
VOC (lb/hr as propane)	0.73	0.58	0.72	0.68

Table 2 - Grain Dryer VOC Results
Day 2 - 11/10/92

[1] - total sampling duration is greater than one hour due to strip chart paper change-over.

From 13:22 on 11-9-92 to 07:38 on 11-10-92, the analyzer was left running without re-calibration. The strip chart record was averaged and an average mass emission was calculated using the average stack volumetric flow from both days of sampling. The average emissions calculated were 23.9 ppm VOC (wet as propane) and 0.55 lb/hr (as propane). These numbers may be expected to understate the true average because the sampling probe tip became gradually clogged with particulate matter over the sampling period, and the post-test calibration check was conducted after this clog was accidentally dislodged. This gradual increase in sample pressure drop created a negative bias of unknown magnitude.

The overnight data averages do not include the periods from approximately 16:10 to 17:10 and 19:30 to 20:00. During these periods, the strip chart indicates that the emissions dropped off to near zero and spiked to off-scale values briefly at the end of the periods.

APPENDIX K

REPORT EXCERPTS FROM REFERENCE 21

(Coors, November 1992)

Clean Air Engineering

500 W Wood St • Palatine, IL 60067 • 708-991-3300

REPORT ON COMPLIANCE TESTING

Performed for:
COORS BREWING COMPANY
GOLDEN, COLORADO

CAE Project No: 6362-1
November 25, 1992

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	165	166	163	
SPENT	Moisture	%	37	39	40.8	
GRAIN DRYER	Oxygen	%	21.0	21.0	20.9	
(uncontrolled)	Volumetric flow, actual	acfm	10102	10058	10305	
	Volumetric flow, standard	dscfm	4323	4170	4166	
	Isokinetic variation	%	108	97.3	95	
Production rate: based on plant average 0.44 brews/hr/dryer*1 dryer*2.6315 tons dry grain/brew		ton/hr dry grain	1.15786	1.15786	1.15786	
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.2063	0.0774	0.2578	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	7.64	2.77	9.21	
	Emission factors:					Average
	Filterable PM	lb/ton	6.6	2.4	8.0	5.6

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	153	159	162	
SPENT	Moisture	%	33.5	38	40.5	
GRAIN DRYER	Oxygen	%	20.9	21.0	21.0	
WITH WET	Volumetric flow, actual	acfm	9516	9339	9206	
SCRUBBER	Volumetric flow, standard	dscfm	4435	4013	3781	
	Isokinetic variation	%	96.3	93.1	102.3	
Production rate: based on plant average 0.44 brews/hr/dryer*1 dryer*2.6315 tons dry grain/brew		ton/hr dry grain	1.15786	1.15786	1.15786	
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.0098	0.0069	0.0073	
	TOC as propane	ppmdv	44	77.0	74	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	0.373	0.237	0.237	
	TOC as propane	lb/hr	1.34	2.12	1.92	
	Emission factors:					Average
	Filterable PM	lb/ton	0.32	0.20	0.20	0.24
	TOC as propane	lb/ton	1.2	1.8	1.7	1.5

COORS BREWING COMPANY
CAE Project No: 6362-1

TABLE 1 - Summary of Test Results

EPA Methods 5 and 25A
Spent Grain Dryer No. 9 Inlet and Outlet

Run No.[1]	1	3	4	Average
Date (1992)	August 22	August 23	August 23	
Inlet				
Start Time (approx.)	12:10 PM	10:00 AM	12:10 PM	
Stop Time (approx.)	1:15 PM	11:22 AM	1:27 PM	
Gas Conditions				
Temperature (° F)	165	166	163	165
Moisture (volume %)	37.0	39.0	40.8	38.9
O_2 (dry volume %)	21.0	21.0	20.9	21.0
CO_2 (dry volume %)	0.0	0.0	0.0	0.0
Volumetric Flow Rate				
acfm	10,102	10,058	10,305	10,155
dscfm	4,323	4,170	4,166	4,220
Particulate				
gr/dscf	0.2063	0.0774	0.2578	0.1808
lb/hr	7.64	2.77	9.21	6.54
ton/yr	33.48	12.11	40.33	28.64
Outlet				
Start Time (approx.)	11:03 AM	9:55 AM	12:11 PM	
Stop Time (approx.)	1:32 PM	11:41 AM	1:38 PM	
Gas Conditions				
Temperature (° F)	153	159	162	158
Moisture (volume %)[2]	33.5	38.0	40.5	37.3
O_2 (dry volume %)	20.9	21.0	21.0	21.0
CO_2 (dry volume %)	0.0	0.0	0.0	0.0
Volumetric Flow Rate				
acfm	9,516	9,339	9,206	9,354
dscfm	4,435	4,013	3,781	4,076
Particulate				
gr/dscf	0.0098	0.0069	0.0073	0.0081
lb/hr	0.37	0.24	0.24	0.28
ton/yr	1.63	1.04	1.04	1.24
Total Hydrocarbons (as propane)				
ppm, dry	44	77	74	65
lb/hr	1.35	2.12	1.91	1.79
ton/yr	5.91	9.30	8.38	7.86
Particulate Removal Efficiency				
percent (based on gr/dscf)	95.2	91.1	97.2	94.5

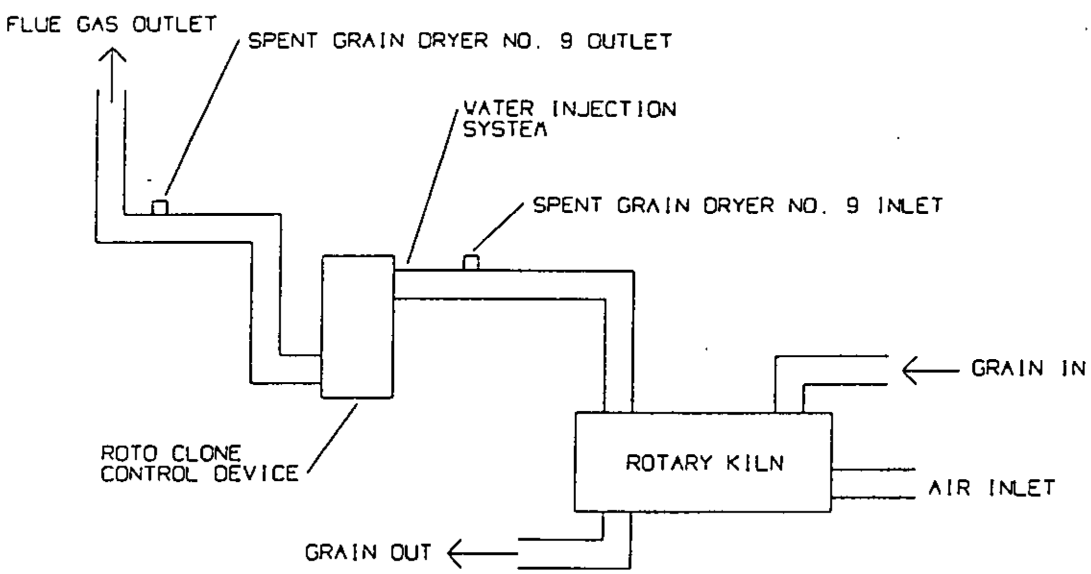
[1] Run 2 was not included because the unit was not operating.
[2] Run 1 at the Outlet had saturated moistures. The saturation moisture value was used in all calculations.

DESCRIPTION OF INSTALLATION

The Coors Brewing Company facility, located in Golden, Colorado, uses grain in the brewing process. Spent grain is sent to a steam heated rotary kiln to dry the grain. Any grain that is entrained in the air outlet of the rotary kiln is removed from the gas stream by a Roto Clone (Type W, Size 20). Hydrocarbons can be emitted from the grain during the drying process.

The testing reported in this document was performed at the Spent Grain Dryer No. 9 Inlet and Outlet.

A schematic of the process is shown below.



APPENDIX L

REPORT EXCERPTS FROM REFERENCE 22

(Coors, July 1993)

File Code #21409

Report Issued: July 12, 1993
Revision Number: 1

BOTTLE WASH SOAKER AREA ETHANOL EMISSIONS SOURCE TEST REPORT

Source Location:

Coors Brewing Company
Transload Bottle Wash
Golden, CO

Prepared for:

Coors Brewing Company
Golden, CO

Submitted by:

Acurex Environmental
Southwest Regional Office
4879 East La Palma Avenue, Suite 201
Anaheim, California, 92817

Acurex Environmental CORPORATION

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F				
BOTTLE SOAKE	Moisture	%				
AREA	Oxygen	%				
(OVERHEAD	Volumetric flow, actual	acfm				
SOAKER AREA)	Volumetric flow, standard	dslpm	484921	482897	477633	
	Isokinetic variation	%	NA	NA	NA	
Production rate: 1 case equals 24 bottles Based on # of bottles washed		cases/hr	2500	3125	3207	
	Pollutant concentrations:					
	Ethanol	mg/L	0.0080	0.0070	0.0108	
	Pollutant mass flux rates:					
	Ethanol	lb/hr	0.512	0.446	0.681	
	Emission factors:					Average
	Ethanol	lb/case	0.000205	0.000143	0.000212	0.000187

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F				
BOTTLE SOAKE	Moisture	%				
AREA	Oxygen	%				
(NORTH EAST	Volumetric flow, actual	acfm				
SOAKER AREA)	Volumetric flow, standard	dslpm	123756	139349	131199	
	Isokinetic variation	%	NA	NA	NA	
Production rate: 1 case equals 24 bottles Based on # of bottles washed		cases/hr	2500	3125	3207	
	Pollutant concentrations:					
	Ethanol	mg/L	0.0018	0.0023	0.0034	
	Pollutant mass flux rates:					
	Ethanol	lb/hr	0.029	0.042	0.059	
	Emission factors:					Average
	Ethanol	lb/case	0.000012	0.000014	0.000018	0.000015

TOTAL EMISSION RATES AND EMISSION FACTORS FOR BOTTLE SOAKER

	Ethanol	lb/hr	0.541	0.489	0.740	0.000
	Ethanol	lb/case	0.000217	0.000156	0.000231	0.000201

SECTION 2
SOURCE TEST RESULTS

2.1 Summary

The results of the bottle soaker area ethanol emission source test series conducted on April 28, 1993 are summarized in Table 2-1, which includes ethanol concentration measurement and emission calculation results.

Table 2-1. Bottle Wash Unit Ethanol Source Test Results

Location	Test/Time	Mass of Ethanol Collected (mg/train)	Sample Volume		Exhaust Flow Rate		Ethanol Emissions	
			(dscf)	(dsl)	(dscfm)	(dslpm)	(lb/hr)	(kg/hr)
Overhead Soaker Area Exhaust	1 1144-1214	3.30	14.60	413.2	17135	484921	0.511	0.232
	2 1243-1313	2.33	11.69	330.8	17063	482897	0.449	0.204
	2 (dup) 1243-1313	2.69	14.36	406.4	17063	482897	0.422 0.435 avg	0.192 0.197 avg
	3 1508-1538	4.36	14.33	405.5	16877	477633	0.678	0.308
Northeast Soaker Area Exhaust	1 1145-1215	0.71	14.04	397.3	4373	123756	0.029	0.0133
	2 1244-1314	0.89	13.83	391.4	4924	139349	0.042	0.0190
	3 1509-1539	1.68	13.67	386.9	4636	131199	0.075	0.0342
	3 (dup) 1509-1539	1.16	12.07	341.6	4636	131199	0.059 0.067 avg	0.0267 0.0305 avg

2.2 Discussion of Results

The ethanol emission source test results reported in Table 2-1 were combined with process data to derive an ethanol emission factor for the bottle soaker unit. The emission factor is determined by dividing the cumulative quantity of ethanol released from the soaker unit over a specific period of time by the number of bottles processed over the same time frame.

The bottle wash unit ethanol emission measurements were conducted in triplicate to ensure that a representative emission factor was determined. The results of the emission factor calculations are summarized in Table 2-2, which includes process data. The total ethanol emission rates reported in Table 2-2 were developed based on the average of duplicate measurements when applicable. A single ethanol emission rate measurement was also taken on April 29, 1993, one day after the bottle soaker area test series was complete. This sample was collected to assess the representativeness of the soaker area ethanol emission measurements. The result of this measurement is discussed in Section 5.

Table 2-2. Ethanol Emission Factor Calculation for the Bottle Soaker Unit

Test	Total Ethanol Emission Rate (lb/hour)	Bottle Case Throughput (cases/hour)	Soaker Ethanol Emission Factor (lb/case)
1	0.540	2500	0.00022
2	0.477	3125	0.00015
3	0.745	3207	0.00023
Average			0.00020

From the information presented in Table 2-2, a bottle soaker ethanol emission factor is derived by averaging the emission factors reported for each test. The resulting process emission factor (0.00020 lb of ethanol per case of bottles washed) is then applied to the annual bottle throughput rate to determine the annual ethanol emissions from the bottle soaker unit. Coors reports an annual 12,775,000 case throughput rate; therefore, the annual ethanol emissions estimated for the bottle soaker unit is 2,555 pounds (1.28 tons) per year.

APPENDIX M

REPORT EXCERPTS FROM REFERENCE 23

(Coors, August 1993)

AIR POLLUTION TESTING, INC.

Volatile Organic Compound Emissions
Source Test Report for
Coors Brewing Company

Bottle Crusher Unit

Report prepared for:
Coors Brewing Company
Bottle Crusher Unit
Golden, Colorado 80401

Report reviewed by:
Paul Ottenstein
Project Manager

Test Dates:
April 21, 1993
August 31, 1993

Project Code:
CB30141

7711 WEST 6TH AVE. SUITE I
LAKEWOOD, CO 80215
(303) 232-5213 · FAX 232-5313

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	
1	Stack temperature	Deg F				
BOTTLE CRUSHER	Moisture	%	ASSUMED 0			
	Oxygen	%	ASSUMED 20.9%			
	Volumetric flow, actual	acfm				
	Volumetric flow, standard	dscfm	1579	1610	1667	
	Isokinetic variation	%	NA	NA	NA	
Production rate: DATA ON LBS/CRUSH NOT PROVIDED		CRUSHES/HR	2.00	4.74	2.50	
	Pollutant concentrations:					
	TOC as propane	ppmwv	41.7	57.7	47.2	
	Pollutant mass emissions:					
	TOC as propane	lb/hr	0.452	0.638	0.540	
	Ethanol (conversion=2.506)	lb/hr	1.13	1.60	1.35	
	Emission factors:					Average
	TOC as propane	lb/crush	0.226	0.135	0.216	0.192
	ETHANOL	lb/crush	0.567	0.338	0.542	0.482

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	
2	Stack temperature	Deg F				
BOTTLE	Moisture	%	ASSUMED 0			
CRUSHER	Oxygen	%	ASSUMED 20.9%			
WITH WATER	Volumetric flow, actual	acfm				
SPRAYS AND	Volumetric flow, standard	dscfm	1198	1281	1343	
MODIFICATIONS	Isokinetic variation	%	NA	NA	NA	
Production rate: DATA ON LBS/CRUSH NOT PROVIDED		CRUSHES/HR	3.00	4.00	3.95	
	Pollutant concentrations:					
	TOC as propane	ppmwv	19.1	22.4	22	
	Pollutant mass emissions:					
	TOC as propane	lb/hr	0.157	0.197	0.203	
	Ethanol (conversion=2.506)	lb/hr	0.394	0.494	0.508	
	Emission factors:					Average
	TOC as propane	lb/crush	0.0524	0.0493	0.0514	0.0510
	ETHANOL	lb/crush	0.131	0.123	0.129	0.128

Results

The results of the testing are presented in the following table. Any testing parameters not found in the table may be found in *Appendix 1 - Testing Parameters / Sample Calculations.*

Coors Brewing Company
Bottle Crusher
4-21-93
VOC Mass Emission Rates

Field Data	Run #1	Run #2	Run #3	Averages
start time	07:15	09:23	11:45	
stop time	09:15	10:39	13:45	
VOC conc. (ppm wet)	41.7	57.7	47.2	48.9
% H2O*	0.0	0.0	0.0	0.0
volumetric flow rate (dscfm)**	1579	1610	1667	1619
Process Data				
# of crushes	4	6	5	5
# of crushes (daily average)***	33.8	33.8	33.8	33.8
Calculations				
VOC emissions (lb/hr as propane)	0.45	0.64	0.54	0.54
VOC emissions (lb/hr as ethanol)****	1.13	1.60	1.35	1.36
VOC emissions (lb/crush as ethanol)	0.57	0.34	0.54	0.48
VOC emissions (tons/year as ethanol)*****	3.50	2.08	3.34	2.97

* - negligible moisture content assumed
** - from concurrent methods 1 and 2 flow measurements
*** - average crushes per day for first 33 weeks of 1993
**** - empirical conversion factor of 2.506 demonstrated in earlier testing program
***** - tons/year based on lb per crush and average crushes per year

Table 1 - Bottle Crusher Baseline VOC Results
April 21, 1993

Results (continued)

Coors Brewing Company
Bottle Crusher
8-31-93
VOC Mass Emission Rates

Field Data

	Run #1	Run #2	Run #3	Averages
start time	09:43	10:52	11:57	
stop time	10:43	11:52	13:13	
VOC conc. (ppm wet)	19.1	22.4	22.0	21.2
% H2O*	0.0	0.0	0.0	0.0
volumetric flow rate (dscfm)**	1198	1281	1343	1274

Process Data

	Run #1	Run #2	Run #3	Averages
# of crushes	3	4	5	4
# of crushes (daily average)***	33.8	33.8	33.8	33.8

Calculations

	Run #1	Run #2	Run #3	Averages
VOC emissions (lb/hr as propane)	0.16	0.20	0.20	0.19
VOC emissions (lb/hr as ethanol)****	0.39	0.49	0.51	0.47
VOC emissions (lb/crush as ethanol)	0.13	0.12	0.13	0.13
VOC emissions (tons/year as ethanol)*****	0.81	0.76	0.80	0.79

* - negligible moisture content assumed
** - from concurrent methods 1 and 2 flow measurements
*** - average crushes per day for first 33 weeks of 1993
**** - empirical conversion factor of 2.506 demonstrated in earlier testing program
***** - tons/year based on lb per crush and average crushes per year

Table 2 - Bottle Crusher Post-modification VOC Results
August 31, 1993

APPENDIX N

REPORT EXCERPTS FROM REFERENCE 24

(Coors, October 1993)

AIR POLLUTION TESTING, INC.

Crushed Can Conveyor Unit Compliance VOC Test Report for Coors Brewing Company

Report prepared for:
Coors Brewing Company
Crushed Can Coveyor Unit
Golden, Colorado

Report reviewed by:
Paul Ottenstein
Project Manager

Test Dates:
October 21, 1993

Project Code:
CB30148

7711 WEST 6TH AVE., SUITE I
LAKEWOOD, CO 80215
(303) 232-5213 · FAX 232-5313

COORS REPORT 14 TEST DATA SUMMARY

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	
1	Stack temperature	Deg F				
CRUSHED CAN	Moisture	%		ASSUMED NEGLIGIBL		
CONVEYOR	Oxygen	%		ASSUMED 20.9%		
STACK #1	Volumetric flow, actual	acfm				
	Volumetric flow, standard	dscfm	1774	1860	1817	
	Isokinetic variation	%	NA	NA	NA	
Production rate: BEER RECOVERED???		gal/hr	383	15	337	
	Pollutant concentrations:					
	TOC as propane	ppmwv	6.2	7.7	8.5	
	Pollutant mass emissions:					Average
	TOC as propane	lb/hr	0.0755	0.0983	0.106	0.0933
	Ethanol (conversion=2.506)	lb/hr	0.189	0.246	0.266	0.234
	Emission factors:					Average
	TOC as propane	lb/gal	0.000197	0.00656	0.000315	0.00236
	ETHANOL	lb/gal	0.000494	0.0164	0.000789	0.00590

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	
2	Stack temperature	Deg F				
CRUSHED CAN	Moisture	%	0.95	0.74	1.16	
CONVEYOR	Oxygen	%	20.9	20.9	20.9	
STACK #2	Volumetric flow, actual	acfm				
	Volumetric flow, standard	dscfm	3670	3488	3579	
	Isokinetic variation	%	NA	NA	NA	
Production rate: BEER RECOVERED???		gal/hr	383	15	337	
	Pollutant concentrations:					
	TOC as propane	ppmwv	46.4	57.5	39.4	
	Pollutant mass emissions:					Average
	TOC as propane	lb/hr	1.18	1.39	0.980	1.18
	Ethanol (conversion=2.506)	lb/hr	2.96	3.48	2.45	2.96
	Emission factors:					Average
	TOC as propane	lb/gal	0.00308	0.0925	0.00291	0.0328
	ETHANOL	lb/gal	0.00772	0.232	0.00728	0.0823

TOTAL EMISSION RATES AND EMISSION FACTORS FOR BOTH STACKS

	TOC as propane	lb/hr	1.26	1.49	1.09	1.28
	ETHANOL	lb/hr	3.15	3.72	2.72	3.20
	TOC as propane	lb/gal	0.00328	0.0991	0.00322	0.0352
	ETHANOL	lb/gal	0.00821	0.248	0.00807	0.0882

Coors Brewing Company
Crushed Can Conveyor - Stack #1
10-21-93
VOC Mass Emission Rates

Field Data

	Run #1	Run #2	Run #3	Averages
start time	09:10	10:45	12:00	
stop time	10:10	11:45	13:00	
VOC conc. (ppm wet)	6.2	7.7	8.5	7.5
% H2O*	0.0	0.0	0.0	0.0
volumetric flow rate (dscfm)*	1774	1860	1817	1817
total time (min)	75	60	60	65
volume beer (gal)**	479	15	337	277
volume water (gal)**	71	2	54.6	43
volume beer + volume water (gal)	550	17	391.6	320

Calculations

	Run #1	Run #2	Run #3	Averages
VOC emissions (lb/hr as propane)	0.076	0.098	0.106	0.093
VOC emissions (tons/year as propane)****	0.331	0.431	0.464	0.409
VOC emissions (lb propane/gallon of beer)	0.0002	0.0066	0.0003	0.0024
VOC emissions (lb propane/gallon of mix)	0.0002	0.0058	0.0003	0.0021
VOC emissions (lb/hr as ethanol)***	0.189	0.246	0.266	0.234
VOC emissions (tons/year as ethanol)***	0.829	1.079	1.164	1.024
VOC emissions (lb ethanol/gal beer)***	0.0005	0.0164	0.0008	0.0059
VOC emissions (lb ethanol/gal mix)***	0.0004	0.0145	0.0007	0.0052

* - from concurrent flow data collected in accordance with methods 1-2 sampling.

** - provided by Coors Brewing Company personnel

***- mass emission calculations expressed as ethanol use empirical conversion factor of 2.506

**** - tons/year calculations use 8760 hours per year operation.

Coors Brewing Company
Crushed Can Conveyor - Stack #2
10-21-93
VOC Mass Emission Rates

Field Data

	Run #1	Run #2	Run #3	Averages
start time	09:10	10:45	12:00	
stop time	10:10	11:45	13:00	
VOC conc. (ppm wet)	46.4	57.5	39.4	47.8
% H2O*	0.95	0.74	1.16	0.95
volumetric flow rate (dscfm)*	3670	3488	3579	3579
total time (min)	75	60	60	65
volume beer (gal)**	479	15	337	277
volume water (gal)**	71	2	54.6	43
volume beer + volume water (gal)	550	17	391.6	320

Calculations

	Run #1	Run #2	Run #3	Averages
VOC emissions (lb/hr as propane)	1.18	1.39	0.98	1.18
VOC emissions (tons/year as propane)****	5.17	6.08	4.29	5.18
VOC emissions (lb propane/gallon of beer)	0.0031	0.0925	0.0029	0.0328
VOC emissions (lb propane/gallon of mix)	0.0027	0.0816	0.0025	0.0289
VOC emissions (lb/hr as ethanol)***	2.96	3.48	2.45	2.96
VOC emissions (tons/year as ethanol)***	13.0	15.2	10.8	13.0
VOC emissions (lb ethanol/gal beer)***	0.0077	0.2318	0.0073	0.0823
VOC emissions (lb ethanol/gal mix)***	0.0067	0.2045	0.0063	0.0725

* - from concurrent flow data collected in accordance with methods 1-4 sampling.
** - provided by Coors Brewing Company personnel
***- mass emission calculations expressed as ethanol use empirical conversion factor of 2.506
**** - tons/year calculations use 8760 hours per year operation.

APPENDIX O

REPORT EXCERPTS FROM REFERENCE 26

(Anheuser Busch, December 1983)

EMISSION TEST REPORT
DRYERS #1 AND #4
ANHEUSER BUSCH, INC.
COLUMBUS, OHIO

Prepared for:

ANHEUSER-BUSCH
1 Busch Place
St. Louis, MO 63118

by

POLLUTION CONTROL SCIENCE, INC.
6015 Manning Road
Miamisburg, OH 45342
(513) 866-5908

Craig R Jones

Craig R. Jones,
Manager, Air Sampling Services

Franklin Meadows

Franklin Meadows
Manager - Operations

December 20,1983
PCS PN 85.010

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 3	Run 5		Average
1	Stack temperature	Deg F	210	211		
SPENT	Moisture	%	16.55	15.64		
GRAIN DRYER	Oxygen	%	19.3	17.2		
(uncontrolled)	Volumetric flow, actual	acfm	32207	32679		
OPERATING	Volumetric flow, standard	dscfm	20684	21191		
NORMALLY	Isokinetic variation	%	90.8	98		
Production rate: based on dried grain produced		TPH	3.045	3.285		
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.0806	0.0584		
	CO_2	%	1.3	3.2		
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	14.3	10.6		
	CO_2	lb/hr	1842	4646		
	Emission factors:					Average
	Filterable PM	lb/ton	4.69	3.23		3.96
	CO_2	lb/ton	605	1414		1010

Test ID	Parameter	Units	Values reported			
			Run 3	Run 5		Average
2	Stack temperature	Deg F	136	130		
SPENT	Moisture	%	18	17.4		
GRAIN DRYER	Oxygen	%	19.8	20.0		
WITH WET	Volumetric flow, actual	acfm	39081	40112		
SCRUBBER	Volumetric flow, standard	dscfm	27762	29005		
(NORMAL OP.)	Isokinetic variation	%	97.2	98.6		
Production rate: based on dried grain produced		TPH	3.045	3.285		
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.013	0.0106		
	CO_2	%	1.3	1.0		
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	3.09	2.64		
	CO_2	lb/hr	2473	1987		
	Emission factors:					Average
	Filterable PM	lb/ton	1.02	0.802		0.909
	CO_2	lb/ton	812	605		709

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 4	Average
3	Stack temperature	Deg F	217	220	219	
SPENT	Moisture	%	37.2	36.6	34.7	
GRAIN DRYER	Oxygen	%	15.8	16.1	17.2	
(uncontrolled)	Volumetric flow, actual	acfm	35562	32570	32188	
OPERATING @	Volumetric flow, standard	dscfm	17157	15556	15934	
CAPACITY	Isokinetic variation	%	94.3	94.8	97.5	
Production rate:	based on dried grain produced	TPH	4.76	5.135	4.745	
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.2022	0.173	0.1623	
	CO2	%	3.0	4.7	3.2	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	29.7	23.1	22.2	
	CO2	lb/hr	3527	5010	3494	
	Emission factors:					Average
	Filterable PM	lb/ton	6.25	4.49	4.67	5.14
	CO2	lb/ton	741	976	736	818

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 4	Average
4	Stack temperature	Deg F	160	161	158	
SPENT	Moisture	%	32.3	32.9	32.4	
GRAIN DRYER	Oxygen	%	17.9	17.8	17.5	
W/WET SCRUBB	Volumetric flow, actual	acfm	36195	34487	33155	
OPERATING @	Volumetric flow, standard	dscfm	20574	19352	19828	
CAPACITY	Isokinetic variation	%	105.6	102.7	100.5	
Production rate:	based on dried grain produced	TPH	4.76	5.135	4.745	
	Pollutant concentrations:					
	Filterable PM	g/dscf	0.1262	0.0969	0.1105	
	CO2	%	2.8	3.3	2.8	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	22.3	16.1	18.8	
	CO2	lb/hr	3947	4376	3804	
	Emission factors:					Average
	Filterable PM	lb/ton	4.68	3.13	3.96	3.92
	CO2	lb/ton	829	852	802	828

TABLE 5.1 SUMMARY OF PROCESS WEIGHT RATE[a]

DRYER #	RUN #	REPORTED WEIGHT (lb/hr)	AVERAGE RATE (lb/hr)
1	1	28,100/30,375/26,516/27,000	28,000
1	2	32,779/27,700/27,639/29,000	29,280
1	3	13,865/15,429/17,657/16,500	15,860
1	4	27,148/26,900	27,020
1	5	14,900/15,545/15,618/16,438	15,630

a Refer to Appendix D for process rate certification

Table 5.2 SUMMARY OF STACK GAS CONDITIONS AT MAXIMUM OPERATING RATE

SITE/ RUN #	FLOW RATE (acfm)[a]	FLOW RATE (dscfm)[b]	TEMP. (°F)	MOISTURE %	O_2 %	CO_2 %
<u>INLET</u>						
1-I-1	35,562	17,157	217	37.2	15.8	3.0
1-I-2	32,399	15,~~157~~ 552	220	36.6	16.1	4.7
1-I-4	32,188	15,934	219	34.7	17.2	3.2
AVERAGE	33,383	16,083	219	36.2	16.4	3.6
<u>OUTLET</u>						
1-O-1	36,195	20,574	160	32.3	17.9	2.8
1-O-2	34,500	19,359	161	32.9	17.8	3.3
1-O-4	33,155	19,828	158	32.4	17.5	2.8
AVERAGE	34,617	19,920	160	32.5	17.7	3.0

[a] Actual cubic feet per minute at stack conditions

[b] Dry standard cubic feet per minute at 68°F and 29.92" Hg

Table 5.3 SUMMARY OF STACK GAS CONDITIONS AT NORMAL OPERATING RATE

SITE/ RUN #	FLOW RATE (acfm)[a]	FLOW RATE (dscfm)[b]	TEMP. (°F)	MOISTURE %	O_2 %	CO_2 %
INLET						
1-I-3	32,207	20,684	210	16.6	19.3	1.3
1-I-5	32,679	21,191	211	15.6	17.2	3.2
AVERAGE	32,443	20,938	211	16.1	18.3	2.3
OUTLET						
1-O-3	39,081	27,762	136	18.2	19.8	1.3
1-O-5	40,112	29,005	130	17.4	20.0	1.0
AVERAGE	39,597	28,384	133	17.8	19.9	1.2

[a] Actual cubic feet per minute at stack conditions

[b] Dry standard cubic feet per minute at 68°F and 29.92" Hg

Table 5.4 SUMMARY OF PARTICULATE EMISSIONS AT MAXIMUM OPERATING RATE

SITE RUN#	PROCESS WEIGHT (lb/hr)	CONCENTRATION (gr/dscf)	CONCENTRATION (lb/dscf)	MASS EMISSION RATE (lb/hr)	ALLOWABLE (lb/hr)[a]	EMISSION RATE (lb/hr)[b]
INLET						
1-I-1	28,000	0.2022	2.89 E-05	~~29.2~~ 29.7	----	---
1-I-2	29,280	0.1730	2.47 E-05	23.1	----	---
1-I-4	27,020	0.1623	2.32 E-05	22.2	----	---
AVERAGE	28,100	0.1792	2.56 E-05	25.0		
OUTLET						
1-O-1	28,000	0.1262	1.80 E-05	22.~~1~~2	24.0	5.9
1-O-2	29,280	0.0969	1.38 E-05	16.~~1~~0	24.8	4.6
1-O-4	27,020	0.1105	1.58 E-05	18.8	23.5	4.4
AVERAGE	28,100	0.1112	1.59 E-05	19.~~1~~0		

[a] Based on process weight: $E = 4.10\ (P)^{0.67}$, where E = emission rate, lb/hr and P = process weight, T/hr

[b] Based on uncontrolled emission rate: A = 0.20 U, where A = allowable emission rate, lb/hr and U = uncontrolled emission rate, lb/hr

TABLE 5.5 SUMMARY OF PARTICULATE EMISSIONS AT NORMAL OPERATING RATE

SITE RUN#	PROCESS WEIGHT (lb/hr)	CONCENTRATION (gr/dscf)	CONCENTRATION (lb/dscf)	MASS EMISSION RATE (lb/hr)	ALLOWABLE EMISSION RATE (lb/hr)[a]	ALLOWABLE EMISSION RATE (lb/hr)[b]
INLET						
1-I-3	15,860	0.0806	1.15 E-05	14.3	----	---
1-I-5	15,630	0.0584	8.35 E-06	10.6	----	---
AVERAGE	15,745	0.0695	9.93 E-06	12.5		
OUTLET						
1-O-3	15,860	0.0130	1.85 E-06	3.1	16.4	2.9
1-O-5	15,630	0.0106	1.51 E-06	2.6	16.3	2.1
AVERAGE	15,745	0.0118	1.68 E-06	2.9		

[a] Based on process weight: $E = 4.10\ (P)^{0.67}$, where E = emission rate, lb/hr and P = process weight, T/hr

[b] Based on uncontrolled emission rate: A = 0.20 U, where A = allowable emission rate, lb/hr and U = uncontrolled emission rate, lb/hr

APPENDIX P

REPORT EXCERPTS FROM REFERENCE 27

(Coors, April 1995)

AIR
POLLUTION
TESTING, INC.

Source Emissions Testing Report
for Coors Brewing Company:
Golden, Colorado Facility

FID / FTIR Ethanol Measurements
Can and Bottle Line Ducts

Report prepared for:
Coors Brewing Company
Mail Stop CE200
Golden, Colorado 80401

Report reviewed by:
Paul Ottenstein
Project Manager

Test Dates:
April 3 and 4, 1995

Project Number : CB50113

7711 WEST 6TH AVE. SUITE [redacted]
LAKEWOOD, CO 802[redacted]
(303) 232-5213 · FAX 232-53[redacted]

COORS REFERENCE 27 DATA SUMMARY

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	69	69	67	
BOTTLE	Moisture	%	0	0	0	
FILLER	Oxygen	%	20.9	20.9	20.9	
EXHAUST	Volumetric flow, actual	acfm	24513	24693	22479	
	Volumetric flow, standard	dscfm	20099	20272	18543	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.43548	0.46139	0.44274	
	Pollutant concentrations:					
	THC as propane	ppmwv	41.5	44.95	56	
	THC as ethanol (CF = 2.12)	ppmwv	88.0	95.3	118.7	
	Ethanol (FTIR)	ppmwv	92.57	108.59	125.79	
	Pollutant mass flux rates:					
	THC as propane	lb/hr	5.7	6.2	7.1	
	THC as ethanol	lb/hr	12.7	13.8	15.8	
	Ethanol (FTIR)	lb/hr	13.3	15.8	16.7	
Ratio: air in/ air out		unitless	1.43	1.43	1.43	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	18.7	19.3	23.0	20.3
	THC as ethanol	lb/1000 bbl	41.6	42.9	50.9	45.1
	Ethanol (FTIR)	lb/1000 bbl	43.7	48.9	53.9	48.8

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	72	72	77	
CAN	Moisture	%	0	0	0	
FILLER	Oxygen	%	20.9	20.9	20.9	
EXHAUST	Volumetric flow, actual	acfm	36347	35693	34697	
	Volumetric flow, standard	dscfm	29452	28820	27763	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.9678	1.002	0.9435	
	Pollutant concentrations:					
	THC as propane	ppmwv	33.7	27.4	33.6	
	THC as ethanol (CF = 2.12)	ppmwv	71.5	58.1	71.2	
	Ethanol (FTIR)	ppmwv	68.43	ND	77.65	
	Pollutant mass flux rates:					
	THC as propane	lb/hr	7.12	5.66	6.68	
	THC as ethanol	lb/hr	15.1	12.0	14.2	
	Ethanol (FTIR)	lb/hr	14.4	ND	15.5	
Ratio: air in/ air out		unitless	2.14	2.14	2.14	
	Emission factors:					Average
	THC as propane	lb/1000 bbl	16	12	15	14
	THC as ethanol	lb/1000 bbl	33	26	32	30
	Ethanol (FTIR)	lb/1000 bbl	32		35	33

Coors Brewing Company Bottle Filler Exhaust Ethanol Emissions				
	Run #1 [1]	*Run #2 [2]*	*Run #3*	***Average***
Date	4-3-95	4-3-95	4-3-95	
Start Time	17:45	19:34	21:53	
Stop Time	18:45	20:53	22:53	
Gas Temp. (°F)	69	69	67	**68**
Gas Flow (dscfm)	20099	20272	18543	**19638**
FID Ethanol Concentration (ppmv)	88.1	95.3	118.7	**100.7**
FID Ethanol Emissions (lb/hr)	12.7	13.8	15.8	**14.1**
FTIR Ethanol Concentration (ppmv)	92.6	108.6	125.8	**109.0**
FTIR Ethanol Emissions (lb/hr)	13.3	15.8	16.7	**15.3**
FID Relative Error (%)	-4.8	-12.2	-5.6	**-7.6**

Table 5.1 - Bottle Filler Exhaust Emissions Results

(1) - Run #1 is essentially an FID-only sampling period. FTIR data were collected for only 11 minutes of this period (from 17:45-17:56).

(2) - During Run #2, a total of 60 minutes of FTIR data were collected discontinuously (from 19:35-20:05 and again from 20:23-20:53).

Coors Brewing Company **Can Filler Exhaust** **Ethanol Emissions**				
	Run #1	*Run #2* [1]	*Run #3*	***Average***
Date	4-4-95	4-4-95	4-4-95	
Start Time	16:30	18:02	19:06	
Stop Time	17:30	19:02	20:03	
Gas Temp. (°F)	72	72	77	**74**
Gas Flow (dscfm)	29452	28820	27763	**28678**
FID Ethanol Concentration (ppmv)	71.5	58.1	71.2	**66.9**
FID Ethanol Emissions (lb/hr)	15.1	12.0	14.2	**13.8**
FTIR Ethanol Concentration (ppmv)	68.4	N/A	77.7	**73.0**
FTIR Ethanol Emissions (lb/hr)	14.4	N/A	15.5	**15.0**
FID Relative Error (%)	4.5	N/A	-8.3	**-1.9**

Table 5.2 - Can Filler Exhaust Emissions Results

[1] - Run #2 is an FID-only sampling period. No FTIR data were collected during this period.

APPENDIX Q

REPORT EXCERPTS FROM REFERENCE 28

(Miller, February 1994)

~~PRIVILEGED & CONFIDENTIAL~~

declassified 7-13-95 via 7-7-95 letter see custody receipts/LKS

~~CONFIDENTIAL~~

Miller Brewing Company
Fulton, New York

AIR EMISSIONS INVESTIGATION REPORT

Prepared for:

SBE Environmental Company
2 Penn Plaza
New York, New York 10001

Prepared by:

RTP Environmental Associates, Inc.
400 Post Avenue
Westbury, New York 11590

FEBRUARY, 1994

MILLER BREWING COMPANY EMISSIONS DATA--REFERENCE 28

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	142	134.5	112.7	
BREW KETTLE	Moisture	%				
	Oxygen	%				
	Process time	min	193	193	193	
	Volumetric flow, actual	acfm	16982	16599	13498	
	Sample volume	liters	79.3	74	70.3	
	Sample volume	ft^3	2.80	2.61	2.48	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl	1.1	1.1	1.1	
	Pollutant concentrations:					
	VOC as n-hexane	mg	0.034	0.064	0.015	
	VOC as toluene	ug/ml	5.2	0	0	
	VOC as propane***	mg/cf	0.0745	0.0250	0.0062	
	Pollutant mass flux rates:					
	VOC as propane	lb	0.538	0.177	0.035	
	Emission factors:					AVERAGE
	VOC as propane	lb/1000 bbl	0.49	0.16	0.032	0.23

***Includes both VOC as n-hexane and VOC as toluene converted to a propane basis
mg/cf = ((VOC as n-hexane, mg)*6*/86.18*44/3+(VOC as toluene, ug/ml)*10^-3*30*7/92.14*44/3)/(sample volume)

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F				
LAUTER TUN	Moisture	%				
	Oxygen	%				
	Process time	min	103	108	110	
	Volumetric flow, actual	acfm	1216	826	1180	
	Sample volume	liters	134.1	103.2	119.2	
	Sample volume	ft^3	4.74	3.64	4.21	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl	1.1	1.1	1.1	
	Pollutant concentrations:					
	VOC as n-hexane	mg	0.11	0.059	0.12	
	VOC as toluene	ug/ml	0	0	0	
	VOC as propane***	mg/cf	0.0237	0.0165	0.0291	
	Pollutant mass flux rates:					
	VOC as propane	lb	0.00655	0.00325	0.00833	
	Emission factors:					AVERAGE
	VOC as propane	lb/1000 bbl	0.0060	0.0030	0.0076	0.0055

***Includes both VOC as n-hexane and VOC as toluene converted to a propane basis
mg/cf = ((VOC as n-hexane, mg)*6*/86.18*44/3+(VOC as toluene, ug/ml)*10^-3*30*7/92.14*44/3)/(sample volume)

MILLER BREWING COMPANY EMISSIONS DATA--REFERENCE 28

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F				
MASH TUN	Moisture	%				
	Oxygen	%				
	Process time	min	94	94	94	
	Volumetric flow, actual	acfm	149	331	240	
	Sample volume	liters	44.1	41	39.1	
	Sample volume	ft^3	1.56	1.45	1.38	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl	1.1	1.1	1.1	
	Pollutant concentrations:					
	VOC as n-hexane	mg	2.1	1.9	1.2	
	VOC as toluene	ug/ml	0	0	0	
	VOC as propane***	mg/cf	1.38	1.34	0.887	
	Pollutant mass flux rates:					
	VOC as propane	lb	0.0425	0.0919	0.0441	
	Emission factors:					AVERAGE
	VOC as propane	lb/1000 bbl	0.039	0.084	0.040	0.054

***Includes both VOC as n-hexane and VOC as toluene converted to a propane basis

mg/cf = ((VOC as n-hexane, mg)*6*/86.18*44/3+(VOC as toluene, ug/ml)*10^-3*30*7/92.14*44/3)/(sample volume)

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
4	Stack temperature	Deg F				
CEREAL COOKER	Moisture	%				
	Oxygen	%				
	Process time	min	45	45	44	
	Volumetric flow, actual	acfm	1507	1507	1507	
	Sample volume	liters	172.1	176.9	172.1	
	Sample volume	ft^3	6.08	6.25	6.08	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl	1.1	1.1	1.1	
	Pollutant concentrations:					
	VOC as n-hexane	mg	0.14	0.18	0.35	
	VOC as toluene	ug/ml	9.8	0	0	
	VOC as propane***	mg/cf	0.077	0.029	0.059	
	Pollutant mass flux rates:					
	VOC as propane	lb	0.0116	0.0044	0.0086	
	Emission factors:					AVERAGE
	VOC as propane	lb/1000 bbl	0.011	0.0040	0.0078	0.0074

***Includes both VOC as n-hexane and VOC as toluene converted to a propane basis

mg/cf = ((VOC as n-hexane, mg)*6*/86.18*44/3+(VOC as toluene, ug/ml)*10^-3*30*7/92.14*44/3)/(sample volume)

Test ID	Parameter	Units	Values reported							
			Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	
5	Stack temperature	Deg F								
CARBON	Moisture	%								
BED	Oxygen	%								
REGEN.	Process time	min	2160	2160	2160	2160	2160	2160	2160	
	Volumetric flow, actual	acfm	360	360	360	353	360	265	461	
	Sample volume	liters	4.1	4.3	6.8	7.2	7.4	7.5	7.6	
	Isokinetic variation	%	NA	NA	NA	NA	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl	18.1	18.1	18.1	18.1	18.1	18.1	18.1	
	Pollutant concentrations:									
	Ethanol	mg	0.069	0.081	0.052	0.081	0.09	0.094	0.092	
	Ethanol	mg/l	0.0168	0.0188	0.0076	0.0113	0.0122	0.0125	0.0121	
	Pollutant mass flux rates:									
	Ethanol	lb	0.8170	0.9144	0.3712	0.5355	0.5904	0.4479	0.7525	
	Emission factors:									AVERAGE
	Ethanol	lb/1000 bbl	0.045	0.051	0.021	0.030	0.033	0.025	0.042	0.035

Brewhouse Emission Factor Calculations - VOCs

Sample ID	M (mg)	Sample Vol. (Liters)	Conc. (mg/l)	Actual Gas Flow Rate (acfm)	Test Release (mg/min)	Process Time (min)	Process Volume (bbl)	Test Emission Factor (lb/1000bbl)
VOC-BRH-K1	0.190(1)	79.3	0.0024	16982	1152	193	1100	0.446
VOC-BRH-K2	0.064	74.0	0.0009	16599	406.37	193	1100	0.157
VOC-BRH-K3	0.015	70.3	0.0002	13498	81.58	193	1100	0.032
Kettle Average								0.212
VOC-BRH-LT1	0.110	134.1	0.0008	1216	28.25	103	1100	0.006
VOC-BRH-LT2	0.059	103.2	0.0006	826	13.37	108	1100	0.003
VOC-BRH-LT3	0.120	119.2	0.0010	1180	33.64	110	1100	0.007
Lauter Tun Average								0.005
VOC-BRH-MT1	2.100	44.1	0.0476	149	201.3	94	1100	0.038
VOC-BRH-MT2	1.900	41.0	0.0464	331	435.2	94	1100	0.082
VOC-BRH-MT3	1.200	39.1	0.0307	240	209.1	94	1100	0.039
Mash Tun Average								0.053
VOC-BRH-C1	0.434(2)	172.1	0.0025	1507	107.6	45	1100	0.010
VOC-BRH-C2	0.180	176.9	0.0010	1507	43.43	45	1100	0.004
VOC-BRH-C3	0.350	172.1	0.0020	1507	86.80	44	1100	0.008
Cereal Cooker Average								0.007
VOC-CS-WT1	0.520	7.8	0.0663	228	428.3	20	1100	0.017

Notes:
M - mass of ethanol
Sample Volume (SV)

(1) 30 milliliter condensate sample VOC-BRH-K1C included.
(2) 30 milliliter condensate sample VOC-BRH-C1C included.

Ethanol Cold Services Emission Factor Calculations

Sample ID	M (mg)	Sample Vol. (Liters)	Conc. (mg/l)	Actual Gas Flow Rate (acfm)	Test Release (mg/min)	Test Emission Factor (lb/1000bbl)
Heat Wheel						
E-CS-HW.1	0.3200	16.0	0.0200	30500	17288.6	3.0384
E-CS-HW.2	0.1000	16.4	0.0061	30500	5260.6	0.9245
E-CS-HW.3	0.0850	16.4	0.0052	30500	446.7	0.7850
E-CS-HW.5	0.0800	16.3	0.0049	30500	4240.9	0.7453
E-CS-IV.1	0.0061	15.6	0.0004	37600	415.5	0.0730
E-CS-IV.2	0.0020	16.4	0.0001	37600	126.9	0.0223
E-CS-IV.3	0.0054	16.4	0.0003	37600	351.2	0.0617
E-CS-IV.5	0.0020	16.3	0.0001	37600	127.4	0.0224
Average					TEF Avg.	1.33
Fermentation*						
E-CS-FERM B3.1	0.6200	3.9	0.1572	1	4.45	
E-CS-FERM B3.2	0.6200	3.9	0.1572	1	4.45	0.0004
E-CS-FERM B3.3	0.4400	3.9	0.1115	2	6.32	0.0005
E-CS-FERM B3.4*	0.4950	3.9	0.1253	2	7.10	0.0006
E-CS-FERM B3.5	0.5500	4.0	0.1387	2	7.85	0.0007
E-CS-FERM B3.6	0.7000	4.0	0.1762	2	9.98	0.0008
E-CS-FERM B3.7	0.8100	3.9	0.2085	27	160.2	0.0155
E-CS-FERM B3.8	0.8100	3.0	0.2707	38	293.2	0.0201
E-CS-FERM B3.9	0.9400	3.0	0.3126	48	424.5	0.0450
					Sub-Total	0.0835
E-CS-FERM, displ.			0.0786		0.02	0.0203
E-CS-FC.1	0.0063	2.0	0.0031	1060	94.01	0.0056
					Total	0.1095
Other Sources						
E-CS-CFT 25.1	0.5300	3.7	0.1428			0.0003
E-CS-PFII.1	0.1900	2.0	0.0973			0.0016
E-CS-SYT 34.1	0.6100	3.9	0.1573	26	115.79	0.041
E-CS-2x2.1	0.0170	30.4	0.0006	3738	59.28	0.0205
EPR TANK HEAD	1.1000	1.9	0.5738			

APPENDIX R

REPORT EXCERPTS FROM REFERENCE 29

(Anheuser Busch, July 1994)

ENTROPY, INC.

Specialists in Air Emissions Technology

P.O. Box 12291 • Research Triangle Park, North Carolina 27709-2291
(919) 781-3550 • (800) 486-3550 • Fax (919) 787-8442

STATIONARY SOURCE SAMPLING REPORT
REFERENCE NO. 21691

Anheuser-Busch Brewery
Fort Collins, Colorado

EMISSIONS TESTING FOR:
ANHEUSER-BUSCH COMPANIES
ONE BUSCH PLACE
ST. LOUIS, MISSOURI
63118-1852

FILLING ROOM VENTS

PERFORMED FOR: ROBERT LANHAM

JULY 26-28, 1994

BUSCH REFERENCE 29 DATA SUMMARY

BOTTLE LINE EMISSION FACTORS

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
1	Stack temperature	Deg F	81	84	82	
BOTTLE	Moisture	%	1.3	2.7	2.2	
LINE 20	Pressure	in. Hg	25.27	25.27	25.27	
EXHAUST	Volumetric flow, actual	acfm	47531	48275	48594	
VENT 224	Volumetric flow, standard	dscfm	38670	38505	39102	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.1996	0.1996	0.1048	
	Pollutant concentrations:					
	Ethanol (Method 18)	ppmdv	8.2	7.3	5.1	
	THC as propane? (Method 25A)	ppmdv	3.7	6.8	6.1	
	Ethanol (FTIR)	ppmdv	5.5	3.8	3.9	
	Pollutant mass flux rates:					
	Ethanol (Method 18)	lb/hr	2.3	2.0	1.4	
	THC as propane? (Method 25A)	lb/hr	1.0	1.9	1.7	
	Ethanol (FTIR)	lb/hr	1.5	1.0	1.1	
	Emission factors:					Average
	Ethanol (Method 18)	lb/1000 bbl	11.4	10.1	13.6	11.7
	THC as propane? (Method 25A)	lb/1000 bbl	5.1	9.4	16.3	10.3
	Ethanol (FTIR)	lb/1000 bbl	7.6	5.3	10.4	7.8

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
2	Stack temperature	Deg F	74	82	80	
BOTTLE	Moisture	%	2.5	3.4	2.6	
LINE 20	Pressure	in. Hg	25.29	25.27	25.27	
EXHAUST	Volumetric flow, actual	acfm	46893	46893	47637	
VENT 227	Volumetric flow, standard	dscfm	38211	37270	38317	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.1397	0.2006	0.1985	
	Pollutant concentrations:					
	Ethanol (Method 18)	ppmdv	4.7	3.9	5.1	
	THC as propane? (Method 25A)	ppmdv	2	2.3	5.9	
	Ethanol (FTIR)	ppmdv	4.2	4.6	3.9	
	Pollutant mass flux rates:					
	Ethanol (Method 18)	lb/hr	1.3	1.0	1.4	
	THC as propane? (Method 25A)	lb/hr	0.5	0.6	1.6	
	Ethanol (FTIR)	lb/hr	1.2	1.2	1.1	
	Emission factors:					Average
	Ethanol (Method 18)	lb/1000 bbl	9.2	5.2	7.1	7.2
	THC as propane? (Method 25A)	lb/1000 bbl	3.9	3.1	8.2	5.1
	Ethanol (FTIR)	lb/1000 bbl	8.2	6.1	5.4	6.6

TOTAL	Emission factors:		Run 1	Run 2	Run 3	Average
BOTTLE	Ethanol (Method 18)	lb/1000 bbl	20.6	15.3	20.7	18.9
LINE	THC as propane? (Method 25A)	lb/1000 bbl	9.1	12.5	24.5	15.3
EFS	Ethanol (FTIR)	lb/1000 bbl	15.9	11.4	15.8	14.4
Ethanol (Avg. of M18 AND FTIR)		lb/1000 bbl	18.2	13.3	18.3	16.6

BUSCH REFERENCE 29 DATA SUMMARY

CAN LINE EMISSION FACTORS

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Average
3	Stack temperature	Deg F	79	86	85	
CAN	Moisture	%	2	2.3	2.4	
LINE 61	Pressure	in. Hg	25.17	25.18	25.17	
EXHAUST	Volumetric flow, actual	acfm	51146	50615	47956	
VENT 211	Volumetric flow, standard	dscfm	41305	40245	38146	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.3035	0.3188	0.3626	
	Pollutant concentrations:					
	Ethanol (Method 18)	ppmdv	7.3	10.6	7.7	
	THC as propane? (Method 25A)	ppmdv	8.7	12.5	10.6	
	Ethanol (FTIR)	ppmdv	6.2	8.1	8.0	
	Pollutant mass flux rates:					
	Ethanol (Method 18)	lb/hr	2.2	3.1	2.1	
	THC as propane? (Method 25A)	lb/hr	2.6	3.6	2.9	
	Ethanol (FTIR)	lb/hr	1.8	2.3	2.2	
	Emission factors:					Average
	Ethanol (Method 18)	lb/1000 bbl	7.1	9.6	5.8	7.5
	THC as propane? (Method 25A)	lb/1000 bbl	8.5	11.3	8.0	9.3
	Ethanol (FTIR)	lb/1000 bbl	6.1	7.3	6.0	6.5

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Average
4	Stack temperature	Deg F	79	89	88	
CAN	Moisture	%	2	2	2.3	
LINE 61	Pressure	in. Hg	25.17	25.18	25.17	
EXHAUST	Volumetric flow, actual	acfm	47637	47637	49020	
VENT 214	Volumetric flow, standard	dscfm	38471	37786	38819	
	Isokinetic variation	%	NA	NA	NA	
Circle: Production or feed rate Capacity:		1000 bbl/hr	0.2800	0.2569	0.3528	
	Pollutant concentrations:					
	Ethanol (Method 18)	ppmdv	8.5	6.9	9.0	
	THC as propane? (Method 25A)	ppmdv	10.2	9	10.5	
	Ethanol (FTIR)	ppmdv	6	5.4	6.6	
	Pollutant mass flux rates:					
	Ethanol (Method 18)	lb/hr	2.3	1.9	2.5	
	THC as propane? (Method 25A)	lb/hr	2.8	2.4	2.9	
	Ethanol (FTIR)	lb/hr	1.7	1.5	1.8	
	Emission factors:					Average
	Ethanol (Method 18)	lb/1000 bbl	8.4	7.3	7.1	7.6
	THC as propane? (Method 25A)	lb/1000 bbl	10.1	9.5	8.3	9.3
	Ethanol (FTIR)	lb/1000 bbl	5.9	5.7	5.2	5.6

TOTAL	Emission factors:		Run 1	Run 2	Run 3	Average
CAN	Ethanol (Method 18)	lb/1000 bbl	15.5	16.9	12.9	15.1
LINE	THC as propane? (Method 25A)	lb/1000 bbl	18.5	20.8	16.3	18.5
EFS	Ethanol (FTIR)	lb/1000 bbl	12.0	13.0	11.2	12.1
Ethanol (Avg. of M18 AND FTIR)		lb/1000 bbl	13.7	15.0	12.1	13.6

TABLE 2-2
ETHANOL TEST RESULTS: TEST METHOD 18, TEST METHOD 25A, AND FTIR

(Dry Basis Results)

Vent	Test	Flow Rate	Method 18		Method 25A		FTIR	
		DSCFM	ppm	lb/hour	ppm	lb/hour	ppm	lb/hour
227	RUN 1 AVERAGE	38212	4.7	1.3	2.0	0.5	4.2	1.2
	RUN 2 AVERAGE	37271	3.9	1.1	2.3	0.6	4.6	1.3
	RUN 3 AVERAGE	38371	5.1	1.4	5.9	1.6	3.9	1.1
	VENT AVERAGE	37951	4.57	1.27	3.40	0.90	4.23	1.20
224	RUN 1 AVERAGE	38670	8.2	2.3	3.7	1.0	5.5	1.5
	RUN 2 AVERAGE	38505	7.3	2.0	6.8	1.9	3.8	1.0
	RUN 3 AVERAGE	39103	5.1	1.4	6.1	1.7	3.9	1.1
	VENT AVERAGE	38759	6.87	1.90	5.53	1.53	4.40	1.20
211	RUN 1 AVERAGE	41306	7.3	2.2	8.7	2.6	6.2	1.8
	RUN 2 AVERAGE	40245	10.6	3.1	12.5	3.6	8.1	2.4
	RUN 3 AVERAGE	38147	7.7	2.1	10.6	2.9	8.0	2.2
	VENT AVERAGE	39899	8.53	2.47	10.60	3.03	7.43	2.13
214	RUN 1 AVERAGE	38472	8.5	2.4	10.2	2.9	6.0	1.7
	RUN 2 AVERAGE	37786	6.9	1.9	9.0	2.4	5.4	1.5
	RUN 3 AVERAGE	38819	9.0	2.5	10.5	2.9	6.6	1.9
	VENT AVERAGE	38359	8.13	2.27	9.90	2.73	6.00	1.70