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| Title: | Emission Factor Documentation for AP-42 Section 9.12.<br>Wines And Brandy Final Report<br><br>October 1995<br><br>APPENDICES ONLY |

# Emission Factor Documentation for AP-42
# Section 9.12.2

## Wines and Brandy

## Final Report

For U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Factor and Inventory Group
Research Triangle Park, NC 27711

Attn: Mr. Dallas Safriet (MD-14)

Appendices only

EPA Contract 68-D2-0159
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MRI Project No. 4602-03
and 4603-01-03

October 1995

# APPENDIX A.

Ec63

STATE OF CALIFORNIA
AIR RESOURCES BOARD

# EVALUATION TEST TO MEASURE ETHANOL EMISSIONS FROM A 106,000 GALLON FERMENTATION TANK

## Stationary Source Control Division

ENGINEERING EVALUATION BRANCH

REPORT NO. C-80-071

OCTOBER 1980

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Approved:

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## SUMMARY

A 106,000 gallon fermentation tank filled with 90,000 gallons of must to produce a white blending wine was tested for 159 hours during which ethanol emissions were continuously monitored. Carbon dioxide ($CO_2$), oxygen ($O_2$), temperature, and exhaust gas volumes were also measured.

Fermentation exhaust gas temperatures were a constant 53°F.

The average ethanol concentration was 3,640 parts per million (ppm). Based on this concentration and a total measured gas volume of 310,060 $ft^3$, the estimated mass of ethanol emitted to atmosphere was 137 lbs in 159 hours. This corresponds to a mass emission rate of approximately 0.86 lbs/hr. or, when expressed in terms of gallons of wine juice fermented, 1.52 lbs/$10^3$ gal.

Other exhaust gas components and their determined concentrations are:

| | |
|---|---|
| $CO_2$ | 99.6% |
| $H_2S$ | 1.1 ppm |
| $SO_2$ | <.2 ppm |
| $CH_3SH$ | <.006 ppm |

No oxygen was detected in the exhaust gas.

## IV. TEST METHODOLOGY & EQUIPMENT

All emission measurements were taken at the fermentation tank vent hatch. The hatch was fitted with an adaptor to which a turbine meter was attached. Ports on the adaptor accomodated (1) the sample line for continuous gaseous measurements, (2) a thermocouple for exhaust gas temperature measurements, and (3) a pitot tube for velocity pressure measurements. Exhaust gas volume was metered through the turbine and the volumetric rate determined by dividing the exhaust gas volume by the corresponding time interval during which the volume was measured. This was cross checked by pitot tube measurements and ARB Method 1-2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)." Oxygen ($O_2$), carbon dioxide ($CO_2$), and ethanol ($C_2H_5OH$) concentrations were continuously measured by analyzers located inside a mobile van parked at the base of the fermentation tank. A heated sample line was used to prevent condensation as the sampled gas was being drawn from the vent hatch to the van.

The evaluation test equipment used and the sampling site where the measurements were taken are identified in Figure 4. The arrangement of the turbine meter and the adaptor is illustrated in Figure 5.

The parameters monitored and the measurement methods used are listed below:

Total Hydrocarbons: A Beckman Model 400 continuous analyzer measured hydrocarbon concentrations with a flame ionization detector (FID). The analyzer was calibrated with propane and a response factor to ethanol was determined.

Oxygen: Oxygen was measured with a Beckman Model F-3 continuous $O_2$ analyzer equipped with a paramagnetic detection system.

Carbon Dioxide: An Anarad Model 500 analyzer with a nondispersive infrared detector (NDIR) continuously monitored $CO_2$ concentrations.

Grab Samples: Grab samples of the exhaust gas were taken in 2 liter glass flasks and analyzed for total hydrocarbon, ethanol, $CO_2$, $O_2$, sulfur dioxide ($SO_2$), hydrogen sulfide ($H_2S$), and methyl mercaptan.

## V. DISCUSSION OF RESULTS

The fermentation of 90,000 gallons of St. Emillion grape juice took 216.5 hours, starting on October 13, 1980 at 7:30 a.m. and ending on October 22, 1980 at 8:00 a.m. The fermentation process was initiated by the inoculation of the grape juice with yeast. The degrees Brix measured with a hygrometer at the time of inoculation was 20.5. The Brix scale is a measure of the concentration of sugar in solution as grams of sucrose per 100 grams of liquid. Two methods are typically used for making this determination: the hygrometer procedure and the refractometer procedure. The methodology involved with both procedures is presented in Appendix II. The fermentation was judged to be complete by United Vintner's winemaker when the degrees Brix was reduced to 2.

The ARB evaluation test began on October 15 at 5:00 p.m., 57.5 hours after the inoculum was introduced into the tanks. The duration of the evaluation test was 159 hours, representing data collection for 73 percent of the fermentation process. During the test period, the following parameters were monitored: $CO_2$, $O_2$, and ethanol concentrations in the exhaust gas; ambient and exhaust gas temperatures; exhaust gas volumetric flow rate.

The exhaust gas was predominantely composed of carbon dioxide and ethanol, with trace amounts of hydrogen sulfide, sulfur dioxide and mercaptans. As expected from an anerobic process, measurable amounts of oxygen were not present. Table II lists the exhaust gas components in descending order with respect to their measured concentrations averaged over the test period.

TABLE II

FERMENTATION TANK EXHAUST GAS COMPONENTS

| Exhaust Gas Component | Concentration |
|---|---|
| $CO_2$ | 99.6% |
| $C_2H_5OH$ | 0.4% |
| $H_2S$ | 1.1 ppm |
| $SO_2$ | < .2 ppm |
| $CH_3SH$ | < .006 ppm |

Analysis of the exhaust gas by continuous analyzers showed ethanol concentrations to increase steadily with respect to time while $CO_2$ remained constant. The ethanol concentration increased from 1,902 parts per million at the beginning of the test to 4,565 ppm at the end of the test. The end of the ARB's evaluation test coincided with the completion of the fermentation process. The average ethanol concentration over the 159 hour test period was approximately 3,640 ppm. Measured values of $CO_2$ concentration remained at over 99 percent throughout the test period while, in contrast, no oxygen was detected.

Based on an averaged ethanol concentration value of 3,640 ppm and a total measured exhaust gas volume of 310,060 $ft^3$, the estimated mass of ethanol emitted to atmosphere during the fermentation process was 137 pounds (lbs) in 159 hours. This corresponds to a mass emission rate of approximately 0.86 lbs/hr. Alternatively, when expressed in terms of gallons of wine juice fermented, the emission rate is approximately 1.52 lbs/$10^3$ gal. This compared closely with an ethanol emission factor of 1.45 lbs/$10^3$ gal. calculated per an equation cited in the Environmental Protection Agencies' publication entitled, "Compilation of Air Pollutant Emission Factors", commonly referred to as AP-42. The calculation and AP-42 equation are presented in Appendix III.

A composite plot of ethanol concentration and emission rate versus time is presented in Graph I. As previously mentioned, exhaust gas ethanol concentrations steadily increased during the test. Correspondingly, ethanol emission rates were decreasing. The diminishing emission rates were attributed to the dominance of declining exhaust gas volumetric flow over increasing concentrations as the fermentation process approached completion. Graph II illustrates the change in flow rates with respect to time.

Ambient and exhaust gas temperatures are plotted on Graph III. Ambient temperatures varied diurnally while the exhaust gas temperatures remained relatively constant. Exhaust gas temperatures reflected the constant tank temperatures to which the fermenting must was subjected.

APPENDIX B.

# FINAL REPORT

## *CHARACTERIZATION OF ETHANOL EMISSIONS FROM WINERIES*

Submitted to:

Research Division
California Air Resources Board

on

July 19, 1982

By:

EAL Corporation

Principal Investigators:

Mr. David R. Fielder (Technical Services Manager)
Mr. Philip A. Bumala (Air Program Manager)

Reference:

Mr. Joseph A. Pantalone (Contract Officer)
California Air Resources Board Agreement
No. A0-071-31

EAL Work Order No. 64-6003

# METHODS

## *Sample Collection*

An extraction method was employed in which a known volume of gas, withdrawn from the fermentation exhaust stream, was bubbled through a series of three large Greenburg-Smith impingers. The first two impinger collections were separated from the third in order to verify an acceptable collection efficiency.

EAL personnel had previously conducted a large scale emission test of an acetator tank in Oakland, California. The process involves heating a solution of 6% acetic acid and 6% ethanol to 86°F while blowing air through it at a rate of 170 $m^3$ per hour over a 32 hour period. Oxidation of the ethanol occurs to produce an end product containing 12% acetic acid and 0.5% ethanol. These conditions closely approximate those of a wine fermentation tank.

Our sampling train for the acetator test consisted of a set of three impingers containing 100 mL each of a 0.1M NaOH solution (NaOH added to assist acetic acid absorption). Subsequently, the contents of the first two impingers were analyzed separately from that of the third to check absorption (capture) efficiency. The first four samples collected, during the initial high alcohol content portion of the cycle, had an average collection efficiency of 92% in the first two impingers. This information, coupled with the statistical evaluation of impinger collection efficiences contained in the JAPCA article "Estimating Overall Sample Train Efficiency" demonstrates that for the complete three impinger train, an overall collection efficiency of greater than 99% was achieved(1).

A sample interface and all connections were made of glass and teflon. A thorough leak-check of the collection train was performed prior to each test at a 10" Hg vacuum for sixty seconds with a maximum tolerance of 0.02 $ft^3$ of volume change. The sampling rate (cubic feet/min, cfm) test duration and dry gas meter conditions were carefully monitored (Ref. Figure 1). All the procedural items considered, the collection method had the advantage of simplicity, proximity to the source (minimizing ethanol wall losses and chances of leaks with a long sample line), and virtually no problem with entrained moisture.

*Ethanol Analysis*

The determination of ethanol concentrations (ppm v/v (aq)) in the impinger collections was accomplished by gas chromatography. An aliquot was directly injected onto an FFAP column and ethanol was quantified with a flame ionization detector operating at a lower detection limit of 5 ppm by weight, (Ref. Sample Calculations in Appendix). This lower detection limit corresponds to a 0.4 ppm by volume concentration in the gaseous phase.

*Fermentation Exhaust Volumetric Flow Rate*

The fermentation exhaust flow rates for the red and white wine tanks were measured with a turbine meter (totalizer) provided by the California Air Resources Board (CARB). Hourly readings were taken throughout the duration of the fermentation periods.

*Quality Assurance*

Sample integrity was maintained by strictly controlling containment, identification, and shipping of the samples. Directly following each impinger collection, the absorbing solution was transferred to clean polyethylene bottles. Oxidation of ethanol was prevented by purging the minimal head-space with carbon dioxide. The sample bottles were then labeled as to run number, time, location and finally refrigerated and/or placed on ice for shipment to EAL for immediate analysis.

Impinger collection train efficiency was monitored in the field by periodically obtaining a gas grab bag from the train exhaust and analyzing the contents with a Draeger tube. Ethanol breakthrough was not indicated at a lower detection limit of 2 ppm by volume.

The sampling and exhaust monitoring methods called for the use of only two measurement devices, which were the gas turbine and dry gas meters.

*Fugitive Emissions*

Samples were collected for fugitive ethanol emissions using the same impinger train illustrated in Figure 1, omitting the sample line and locating the train in selected sites for area sampling.

Analytical procedures were identical to those mentioned for source sampling.

A number of process handling procedures were evaluated and ethanol fugitive emissions estimated based on building ventilation and production activity during testing.

The United Vintners Madera facility was chosen for initial source testing. Mr. Kaz Sanbongi was extremely helpful in providing fermenter tank fitting adapters to facilitate connection of our test apparatus. In addition, both Mr. Sanbongi and Mr. Joe Rossi, winemaker, were able to arrange fermentation schedules and procedures which assisted our personnel with their tests.

The first tank tested was for white wine in number 576, a stainless steel tank with a capacity of 350,136 gallons. The major problem encountered with this test was that the record breaking prematurity of the crushing season throughout California, coupled with an unusually small harvest, meant that it was almost too late to get any white wine grapes to test [6]. Also, the daily amount of grapes crushed was so low that must was typically being added to fermentation tanks throughout the fermentation period to achieve a reasonable final fermentation volume. Adding fresh must during a test would have seriously jeopardized the usefulness of the data. This scheduling/production volume problem was a factor throughout the white wine testing phase. The testing team was faced with both an unexpected schedule and the necessity, through lack of choice, to test fermentation batches that were less than ideal due to accessibility and mechanical arrangement or because the batch subsequently did not follow ideal fermentation behavior. With the assistance of the U.V. personnel mentioned, we obtained a full tank of must by combining some cold unfermented must stored from the previous day's crush with ambient temperature must obtained that day. Testing commenced at 7 a.m. on September 9, 1981, and was completed at 12 noon on September 16, 1981. All samples were successfully shipped and analyzed.

The red wine fermentation tank chosen for testing had a capacity of 128,000 gallons. The tank was filled and innoculated on September 14, 1981, and testing commenced immediately. Due to our desire to measure the total emission volume from this tank, we attached the 6-inch ARB turbine meter to one of the 4-inch sampling ports, closed the 2-foot manhole cover, and relied on the remaining 4-inch pressure relief valve to protect the tank in case of over pressurization. Normally, the manhole is left open throughout the fermentation process. Our procedures and installation were observed by

U.V. personnel with no objections. We believed that in the event that the turbine meter flowrate capacity was exceeded, excess exhaust gas would escape through the pressure relief valve. However, instead of a relatively harmless release of vent gases, the fermenting must foamed over and shot out through both the turbine meter and pressure relief valve at approximately midnight Tuesday evening, September 15, 1981. An estimated 1,000 gallons of must were lost and U.V. personnel aborted the fermentation, and our test, the next morning. Subsequently, it became apparent that with the sudden release in pressure caused by the relief valve opening, the must acted like champagne and essentially "boiled over." This mishap placed a serious strain on our relations with U.V. personnel, although no one had forseen this occurrence.

Joe Rossi felt committed to our achieving a successful red wine test and agreed to arrange a second attempt. A similar tank was fitted with both ARB turbine meters, one on the sampling port and one on the pressure relief valve port (with the valve removed). The second turbine meter had just become available due to completion of the white wine test. In addition, the manhole cover was to be opened periodically for a few seconds throughout the test to guard against the initiation of foaming. Exhaust flow measurements were taken frequently to allow interpolation of exhaust volumes over the brief periods that the hatch was lifted. This test was completed successfully.

Detailed results of these tests are contained in the following figures and tables.

TABLE 2

PHYSICAL PARAMETERS
Tank #576
White Wine Fermentation

Tank Material: Stainless Steel

Fermentation Tank Dimensions

12 inch bottom cone

24 inch top cone

480 inch shell (height)

Gallons per inch = 711.4

Total tank capacity = 350,110 gallons
Actual capacity = 280,000 gallons

Temperature Control

Chiller temperature set point (°F) = 57 in/56 out

Fermentation Period

Beginning September 9, 1981 ... through September 16, 1981

Total Hours = 172

Total volumetric exhaust flow = 1,549,940 actual cubic feet @ turbine meter.

TABLE 3

White Wine Fermentation Exhaust Ethanol Emissions

Tank No. 576
Capacity (gals): 350,110
Actual (gals): 280,000
Location: United Vintners (Madera facility)

| Run | Time (Day/hrs) | Exhaust Flow (acfm) | Ethanol ppm-vol | Ethanol Emissions (lbs/hr) | Cumulative (lbs) |
|---|---|---|---|---|---|
| 1 | 1/0800 | 0.0 | -- [1] | -- | 0 |
| 2 | 1/1123 | 0.0 | 27 | 0.0 | 0 |
| 3 | 1/1500 | 0.0 | 12 | 0.0 | 0 |
| 4 | 1/1730 | 0.0 | 36 | 0.0 | 0 |
| 5 | 1/2010 | 0.0 | 70 | 0.0 | 0 |
| 6 | 2/0019 | 0.0 | 152 | 0.0 | 0 |
| 7 | 2/0213 | 6.3 | 37 [1] | 0.0 | 0 |
| 8 | 2/0800 | 44.5 | 735 | 0.2 | 0.2 |
| 9 | 2/1000 | 61.2 | 563 | 0.2 | 0.8 |
| 10 | 2/1300 | 70.7 | 768 | 0.4 | 1.9 |
| 11 | 2/1600 | 82.5 | 745 | 0.4 | 3.4 |
| 12 | 2/2020 | 93.9 | 822 | 0.5 | 5.3 |
| 13 | 2/2300 | 118.7 | 1065 | 0.9 | 8.0 |
| 14 | 3/0200 | 138.1 | 1156 | 1.1 | 13.0 |
| 15 | 3/0800 | 156.6 | 1346 | 1.5 | 19.7 |
| 16 | 3/1123 | 176.3 | 1543 | 1.9 | 24.4 |
| 17 | 3/1300 | 192.5 | 2354 | 3.2 | 30.7 |
| 18 | 3/1621 | 177.3 | 1787 | 2.2 | 41.7 |
| 19 | 3/2048 | 190.8 | 2122 | 2.8 | 50.2 |
| 20 | 3/2300 | 198.6 | 2407 | 3.4 | 56.9 |
| 21 | 4/0220 | 222.0 | 2692 | 4.2 | 82.3 |
| 22 | 4/0913 | 232.2 | 3431 | 5.6 | 118.4 |
| 23 | 4/1050 | 242.2 | 3409 | 5.5 | 135.0 |
| 24 | 4/1300 | 248.7 | 600 [1] | 5.5 [2] | 151.6 [2] |
| 25 | 4/1600 | 231.3 | 3397 | 5.5 | 168.2 |

| Run | Time (Day/hrs) | Exhaust Flow (acfm) | Ethanol ppm-vol | Ethanol Emissions (lbs/hr) | Cumulative (lbs) |
|---|---|---|---|---|---|
| 26 | 4/2009 | 243.7 | 3625 | 6.2 | 183.6 |
| 27 | 4/2304 | 233.9 | 3882 | 6.3 | 205.6 |
| 28 | 5/0200 | 225.9 | 3632 | 5.8 | 234.4 |
| 29 | 5/0909 | 210.0 | 3582 | 5.3 | 255.5 |
| 30 | 5/1030 | 223.2 | 3409 | 5.3 | 266.[illegible] |
| 31 | 5/1306 | 218.5 | 3886 | 5.9 | 283.9 |
| 32 | 5/1600 | 223.8 | 3891 | 5.8 | 307.2 |
| 33 | 5/2052 | 209.8 | 3891 | 5.7 | 327.0 |
| 34 | 5/2300 | 208.6 | 3775 | 5.5 | 338.0 |
| 35 | 6/0200 | 182.6 | 3918 | 5.1 | 263.3 |
| 36 | 6/0834 | 198.3 | 4256 | 4.8 | 394.6 |
| 37 | 6/1214 | 186.0 | 3796 | 4.9 | 406.9 |
| 38 | 6/1341 | 209.2 | 5416 | 7.8 | 418.6 |
| 39 | 6/1600 | 216.0 | 5847 | 8.8 | 457.8 |
| 40 | 6/2000 | 247.0 | 5662 | 9.7 | 486.8 |
| 41 | 6/2300 | 198.2 | 6422 | 8.8 | 504.4 |
| 42 | 7/0200 | 218.9 | 6987 | 10.6 | 557.6 |
| 43 | 7/0830 | 188.1 | 5861 | 7.6 | 595.7 |
| 44 | 7/1100 | 175.7 | 6483 | 7.8 | 611.3 |
| 45 | 7/1304 | 169.3 | 5914 | 6.9 | 642.2 |
| 46 | 7/1945 | 153.2 | 6131 | 6.4 | 677.4 |
| 47 | 7/2300 | 141.4 | 6490 | 6.3 | 696.5 |
| 48 | 8/0300 | 55.8 | 6050 | 2.4 | 708.3 |
| 49 | 8/0833 | 28.8 | 5015 | 1.0 | 712.3 |
| 50 | 8/1200 | 19.8 | 4273 | 0.6 | 713.5 |

(1) Run is suspect.

(2) Although the sample run was suspect, the emissions rate (lbs/hr) and cumulative values were generated using the best estimate between runs 23 & 25.

TABLE 4

PHYSICAL PARAMETERS
Tank No. 5
Red Wine Fermentation

Tank Material: Stainless Steel

Tank Dimensions: 24 inch bottom cone
12 inch top cone
480 inch shell (height)
gallons per inch = 288

Tank Capacity: 128,000 gallons

Actual Capacity: 44,000 gallons

Temperature Control: 1st 4 hrs @ 82°F
2nd 4 hrs @ 72°F
remaining 18 hrs 85°F

Fermentation Period:

Beginning September 17, 1981 through September 18, 1981

Total Hours = 26

Total Volumetric Exhaust Flow = 197380 actual cubic feet @ turbine meter

TABLE 5

*Red Wine Fermentation Exhaust Ethanol Emissions*

*Tank No. 5*
*Capacity (gals): 128,000*
*Actual: 44,000*
*Location: United Vintners, Madera*

| Run | Time Day/Hours | Exhaust Flow (acfm) | Ethanol (ppm.vol) | Ethanol Emissions (lbs/hr) | Cumulative (lbs) |
|---|---|---|---|---|---|
| 1 | 1/1400 | 0.0 | 579 | 0.0 | 0.0 |
| 2 | 1/1600 | 71.0 | 1271 | 0.6 | 0.6 |
| 3 | 1/1945 | 144.0 | 1098 | 1.1 | 4.4 |
| 4 | 1/2300 | 225.0 | 3186 | 4.9 | 19.2 |
| 5 | 2/0200 | 250.0 | 10,094 | 16.5 | 101.7 |
| 6 | 2/0900 | 270.0 | 17,932 | 31 | 256.7 |
| 7 | 2/1145 | 209.0 | 14,916 | 20.4 | 307.7 |
| 8 | 2/1418 | 155.0 | 13,177 | 13.4 | 334.5 |
| 9 | 2/1609 | 94.0 | 11,147 | 7.1 | 341.6 |

sugar free, eliminating any further significant fermentation. The dried lees/ pomace are sold for fertilizer or cattle feed. White wine must is extracted prior to fermentation to reduce skin contact. However, similar extraction procedures are employed and the final product is again dry and non-fermentable.

Because of the crushing season problems discussed earlier, it was vital to immediately commence fermentation tests at the Napa Valley winery. Mr. Al Del Bondio of United Vintner's Oakville facility had prepared suitable tank adapter fittings for our equipment. We arrived on site September 24, 1981. Mr. Del Bondio said that U.V. Oakville could not obtain sufficient white wine grapes to fill a tank prior to fermentation. Thus we would be required to use a tank being added to throughout the test. In addition, the expected fermentation period for white wines at this facility was 3-4 weeks and could not be significantly reduced. Those two factors prompted us, with the encouragement of our contract officer, to attempt to perform the white wine test at the Robert Mondavi winery located nearby.

The U.V. Oakville winery test program included two complete red wine fermentation tests. The first test failed to obtain measurable exhaust flow data, invalidating the test results. The second test was a Cabernet Sauvignon fermentation in a 9,000 gallons concrete tank. The tank was fitted with a gasketed hatch. During the two-day fermentation period, the hatch seal was supplemented by placing lead bricks on the hatch. The hatch was opened twice a day for pumping over the pomace cap. Testing was discontinued at those times until the hatch was replaced and pressurized conditions again obtained.

Fugitive emission testing was performed for various locations and processes at U.V. Oakville. Ambient ethanol levels in a barrel storage building were measured. In addition, a combined storage/fermentation building was monitored. Drag screen separation equipment, similar to that utilized at U.V. Madera, was monitored during operation as well as a conveyor assembly transporting fermented lees to the press. A bottling operation at the U.V. Inglenook Rutherford Winery was monitored for fugitive ethanol emissions. That facility was tested because U.V. Oakville does not have a bottling facility and R. Mondavi's was shut down for the season.

Detailed results of the United Vinters, Oakville source and fugitive emission tests are contained in the following figures and tables.

TABLE 6

PHYSICAL PARAMETERS
Tank No. 198
Red Wine Fermentation
United Vintners (Oakville)

Tank Material: Concrete

Tank Dimensions: 144 inch height
140 gallons per inch
Tank Capacity: 9000 gallons
Actual Capacity: 8100 gallons

Temperature Control: 72°F Average

Fermentation Period:

Beginning October 7, 1981 through October 9, 1981

Total Hours: 77

Total volumetric exhaust flow = 80490 actual cubic feet @ turbine meter

TABLE 7

Red Wine Fermentation Exhaust Ethanol Emissions

Tank Number 198
Capacity (gals) : 9000
Actual (gals) : 8100
Location: United Vintners (Oakville Facility)

| Run | Time (Day/Hrs) | Exhaust Flow (adcfm) | Ethanol (ppm-vol) | Ethanol Emissions (lbs/hr) | Cumulative (lbs) |
|---|---|---|---|---|---|
| 1 | 1/1000 | 53.5 | 5846 | 2.1 | 2.1 |
| 2 | 1/1400 | 65.5 | 5950 | 2.6 | 12.5 |
| 3 | 1/1800 | 57.5 | 12548 | 4.7 | 31.3 |
| 4 | 2/1020 | 21.0 | 13390 | 1.9 | 74.6 |
| 5 | 2/1210 | 19.0 | 13907 | 1.7 | 79.7 |
| 6 | 2/1610 | 14.5 | 14618 | 1.4 | 85.3 |
| 7 | 3/1100 | 0.0 (1) | 10893 | 0.0 | -- (1) |
| 8 | 3/1600 | 0.0 (1) | 10730 | 0.0 | -- (1) |

(1) volumetric flow undetectable.

TABLE 8

FUGITIVE EMISSIONS

UNITED VINTNERS (Oakville)

| LOCATION | DATE, TIME (Hrs) | ETHANOL ($mg/m^3$) | (grams/hr) | (ppm by vol) | COMMENTS |
|---|---|---|---|---|---|
| No. 1 | 9/25, 1000 | 0.04 | 0.003 | 0.02 | Barrel Aging Area Samples (See Figure 8) |
| 2 | 9/25, 1000 | 0.05 | 0.004 | 0.03 | " |
| 1 | 9/25, 1500 | 0.05 | 0.004 | 0.03 | " |
| 2 | 9/25, 1500 | 0.05 | 0.004 | 0.03 | " |
| 3 | 9/25, 1645 | 2.2 | 0.4 | 1.2 | Fermentation area, Approx. 50,000 gals active, 20,000 being "racked out" |
| 4 | 9/25, 1800 | 6.5 (1) | 1 | 3.4 | |
| 5 | 9/26, 1300 | 0.04 | 0.003 | 0.02 | Cold room storage (no fermentation) |
| 6 | 9/26, 1430 | 0.08 | 0.007 | 0.04 | |
| 7 | 10/4, 1100 | 5429 | 923 | 2888 | Drag Screen |
| 8 | 10/6, 1000 | 1134 | 193 | 603 | Pomace Press |

(1) Area approximately 3 ft. away from lees drag screen.

Sample Calculation: $$\text{Ethanol(grams/hr)} = \text{ETOH}\,mg/m^3 \times \frac{1\ g}{1000mg} \times acfm \times \frac{60\ min}{1\ hr} \times \frac{1\ m^3}{35.31\ cf}$$

acfm = actual cubic feet per minute

Dr. James Vahl assisted us in obtaining a tank with fittings suitable for the adapter Mr. Del Bondio had loaned to us. Also, a supply of Chardonnay grapes, requiring a shorter fermentation period, was available (the last of the season). Testing of a 6,000 gallon tank commenced on Saturday, September 26, 1981 and extended over a twenty-one day period. That test length resulted from the fermentation process "sticking" near the end, resulting in an unusually slow decrease in sugar content. In addition to the fermentation test, storage facility fugitive emissions were monitored as well as the process of aeration, used by quality vintners to remove undesired volatile flavor compounds such as excess $H_2S$ or $SO_2$. The fermented juice is allowed to splash from a hose into an open trough prior to storage.

Exhaust volumetric flow was undetectable with the turbine meter during the first four days of the twenty-one day fermentation period as a result of the comparatively small volume of fermenting juice (5,800 gals). Consequently, a method was employed in which the top of the meter was sealed, restricting exhaust release to the existing turbine meter sample ports (Ref. Figure 9). Gas flow was measured with a more sensitive dry test meter. Two dry test meters were used in order to provide twice the pressure relief during greater flow activity (Day 5 through Day 10). The tank headspace was permitted to reach a stable temperature/pressure condition before measuring gas flow per unit time (dry cubic feet/min). This procedure permitted reliable measurements while avoiding the "foaming-over" problem encountered at U.V. Madera. At peak fermentation activity, the juice is saturated or super-saturated with carbon dioxide. Increased pressure placed on the system (tank) may cause foaming-over in the event of an abrupt agitation. Although flow was measured on an actual dry basis with the dry test meters, moisture percent was negligible due to the small volume of juice and comparable to typical white wine fermentation exhaust data.

Detailed results of the Robert Mondavi source and fugitive emission tests are contained in the following figures and tables.

TABLE 10

PHYSICAL PARAMETERS
Tank #289
White Wine Fermentation
Robert Mondavi (Oakville)

Tank Material: Stainless Steel

Fermentation Tank Capacity:

Total Tank Capacity = 5,955 gallons

Actual Tank Capacity = 5,800 gallons

Temperature "Control"

Ambient (i.e., tank located outdoors)

Fermentation Period:

Beginning September 26, 1981 through October 16, 1981

Total Hours = 512

Total Volumetric Exhaust Flow = 149 cubic feet

Table 11

White Wine Fermentation Exhaust Ethanol Emissions

Tank No. 289
Capacity (gal): 5,955
Actual (gal): 5,800
Location: Robert Mondavi (Oakville)
Test Start Date: 9/26/81

| RUN | Time (Day/Hours) | Exhaust Flow (adcfm)[1] | Ethanol ppm-vol | Ethanol Emissions (lbs/hr) | Cumulative (lbs) |
|---|---|---|---|---|---|
| 1 | 1/1027 | 0.0[2] | 9 | -- | 0.00 |
| 2 | 2/0200 | 0.0 | 4 | -- | 0.00 |
| 3 | 2/0900 | 0.0 | 4 | -- | 0.00 |
| 4 | 2/1214 | 0.0 | 6 | -- | 0.00 |
| 5 | 2/1400 | 0.0 | 7 | -- | 0.00 |
| 6 | 2/1624 | 0.0 | 31 | -- | 0.00 |
| 7 | 2/2000 | 0.0 | 527 | -- | 0.00 |
| 8 | 2/2200 | 0.0 | 650 | -- | 0.00 |
| 9 | 3/0200 | 0.0 | 676 | -- | 0.00 |
| 10 | 3/1000 | 0.0 | 663 | -- | 0.00 |
| 11 | 3/1200 | 0.0 | 793 | -- | 0.00 |
| 12 | 3/1600 | 0.0 | 765 | -- | 0.00 |
| 13 | 3/1800 | 0.0 | 782 | -- | 0.00 |
| 14 | 3/2200 | 0.0 | 833 | -- | 0.00 |
| 15 | 4/0200 | 0.0 | 858 | 0.000[5] | 0.00 |
| 16 | 4/0800 | 0.0 | 1696 | 0.001 | 0.00 |
| 17 | 4/1200 | 0.0 | 2882 | 0.002 | 0.01 |
| 18 | 4/1610 | 0.0 | 2110 | 0.004 | 0.03 |
| 19 | 4/2000 | 0.0 | 3511 | 0.005 | 0.05 |
| 20 | 4/2300 | 0.0 | 1780 | 0.006 | 0.06 |

(1) Actual dry cubic feet per minute
(2) Exhaust flow undetectable with turbine meter.
(5) Interpolated values from chart, (Runs 15-20).

Table 11 (continued)

| RUN | Time (Day/Hours) | Exhaust Flow (adcfm)(1) | Ethanol ppm-vol | Ethanol Emissions (lbs/hr) | Cumulative (lbs) |
|---|---|---|---|---|---|
| 21 | 5/0200 | 0.0 | 1817 | 0.008(5) | 0.11 |
| 22 | 5/1042 | 0.0 | 2810(3) | 0.011 | 0.17 |
| 23 | 5/1240 | 0.5 | 3416 | 0.012(6) | 0.19 |
| 24 | 5/1450 | 0.5 | 4071 | 0.014 | 0.23 |
| 25 | 5/1726 | 0.5 | 3484 | 0.013 | 0.26 |
| 26 | 5/2000 | 0.5 | 2660 | 0.010 | 0.29 |
| 27 | 5/2400 | 0.6 | 2888 | 0.011 | 0.34 |
| 28 | 6/0400 | 0.8 | 3337 | 0.014 | 0.42 |
| 29 | 6/1218 | 0.8 | 3895 | 0.021 | 0.56 |
| 30 | 6/1637 | 0.8 | 3701 | 0.020 | 0.65 |
| 31 | 6/2203 | 0.8 | 8089 | 0.042 | 0.86 |
| 32 | 7/0220 | 0.8 | 3313 | 0.018 | 0.98 |
| 33 | 7/1123 | 0.8 | 8684 | 0.045 | 1.23 |
| 34 | 7/1336 | 0.8 | 8440 | 0.041 | 1.37 |
| 35 | 7/1758 | 0.8 | 8986 | 0.046 | 1.57 |
| 36 | 7/2207 | 0.7 | 5733 | 0.028 | 1.68 |
| 37 | 8/0200 | 0.7 | 4286 | 0.020 | 1.79 |
| 38 | 8/0923 | 0.7 | 7282 | 0.031 | 1.91 |
| 39 | 8/1330 | 0.7 | 9129 | 0.042 | 2.04 |
| 40 | 8/1530 | 0.7 | 14568(3) | 0.063 | 2.39 |
| 41 | 8/2048 | 0.7 | 5631 | 0.026 | 2.50 |
| 42 | 8/2400 | 0.7 | 5717 | 0.026 | 2.58 |
| 43 | 9/0300 | 0.7 | 5762 | 0.025 | 2.74 |
| 44 | 9/1306 | 0.7 | 6984 | 0.031 | 2.94 |
| 45 | 9/1552 | 0.7 | 9046 | 0.040 | 3.09 |
| 46(4) | 9/2050 | 0.7 | 6891 | 0.034 | 3.23 |
| 47 | 9/2350 | 0.7 | 6765 | 0.034 | 3.32 |
| 48 | 10/0200 | 0.8 | 4210 | 0.022 | 3.45 |
| 49 | 10/1106 | 0.8 | 8895 | 0.050 | 3.73 |
| 50 | 10/1330 | 0.8 | 8013 | 0.045 | 3.86 |

(1) Actual dry cubic feet per minute.
(2) Exhaust flow undetectable with turbine meter.
(3) Run is suspect.
(4) Average of two samples taken simultaneously for Quality Assurance.
(5) Interpolated values from graph, (Runs 21-22).
(6) Measured values, (Runs 23-75).

Table 11 (continued)

| RUN | Time (Day/Hours) | Exhaust Flow (adcfm) (1) | Ethanol ppm-vol | Ethanol Emissions (lbs/hr) | Cumulative (lbs) |
|---|---|---|---|---|---|
| 51 | 10/1650 | 0.8 | 8700 | 0.048 | 4.03 |
| 52 | 10/2030 | 0.8 | 6646 | 0.035 | 4.14 |
| 53 | 10/2308 | 0.8 | 6451 | 0.032 | 4.23 |
| 54 | 11/0200 | 0.8 | 6608 | 0.030 | 4.46 |
| 55 | 11/1447 | 0.4 | 8446 | 0.024 | 4.64 |
| 56 | 11/1646 | 0.4 | 8123 | 0.023 | 4.73 |
| 57 | 11/2232 | 0.4 | 6415 | 0.018 | 4.83 |
| 58 | 12/0338 | 0.4 | 6021 | 0.017 | 4.94 |
| 59 | 12/1200 | 0.4 | 9871 | 0.028 | 5.09 |
| 60 | 12/1400 | 0.4 | 8216 | 0.022 | 5.16 |
| 61 | 12/1900 | 0.3 | 7030 | 0.015 | 5.32 |
| 62 | 13/1130 | 0.2 | 9676 | 0.017 | 5.49 |
| 63 | 13/1413 | 0.3 | 9155 | 0.019 | 5.55 |
| 64 | 13/1749 | 0.3 | 8705 | 0.018 | 5.76 |
| 65 | 14/1407 | 0.2 | 6827 | 0.010 | 5.87 |
| 66 | 14/1540 | 0.2 | 8118 | 0.012 | 6.03 |
| 67 | 15/1648 | 0.3 | 6968 | 0.015 | 6.41 |
| 68 | 16/1729 | 0.3 | 8616 | 0.018 | 6.84 |
| 69 | 17/1721 | 0.2 | 8335 | 0.009 | 7.05 |
| 70 | 18/1545 | 0.2 | 7409 | 0.013 | 7.36 |
| 71 | 19/1625 | 0.3 | 9246 | 0.018 | 7.79 |
| 72 | 20/1530 | 0.2 | 9316 | 0.012 | 7.93 |
| 73 | 20/1700 | 0.2 | 5382 | 0.007 | 8.02 |
| 74 | 21/1500 | 0.2 | 8968 | 0.013 | 8.17 |
| 75 | 21/1637 | 0.2 | 9532 | 0.012 | 8.18 |

(1) Actual dry cubic feet per minute.

# SECTION III
## SUMMARY AND CONCLUSIONS

Ethanol emission factors have been determined for the fermentation process. Additional measurements of ethanol fugitive emissions, generated from storage and handling during production, have been completed. Four fermentation tanks were monitored throughout their complete fermentation periods. The choice of tank location and type was made in an attempt to represent some of the variations in California wine production, given the time and budgetary limitations of the project. Final results listing ethanol fermentation emissions and emission factors are found in Table 13. Results for fugitive ethanol emissions and emission factors are detailed in Table 14.

The tabulated ethanol fermentation emissions (maximum lbs/hr and total lbs emitted) indicate a simple relationship between the volume of fermenting juice and wine type (i.e., red vs. white). Ethanol losses during red wine fermentation were higher than losses during white wine fermentation. The larger the volume of fermenting juice, the larger was the maximum quantity of ethanol emitted per unit time, or quantitatively, at the peak fermentation more $CO_2$ was produced and exhausted per unit time and thus more ethanol emitted through entrainment.

Ethanol emissions have been related to fermentation process conditions in order to generate emission factors, which in turn may be compared to historical data and theoretical attempts to characterize ethanol losses during fermentation.

Historical data representing ethanol emission factors as percent of total ethanol emitted versus fermentation temperature are graphed in Figure 13. Emission factors determined by EAL have been included in the graph and are in good agreement. In general, white wine fermentation emission factors are found at the lower end of the temperature range and red wine factors at the upper end. Comparison of EAL data to that of the California Air Resources Board (CARB) shows agreement for two separate white wine fermentations at approximately the same fermentation interval activity. Specifically, CARB reported an "ethanol concentration increase from 1,902 parts

TABLE 13

ETHANOL FERMENTATION EMISSIONS AND EMISSION FACTORS

| | | FERMENTATION PARAMETERS | | | | EMISSIONS | | EMISSION FACTORS | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Source | Location | Juice Volume (gal) | Average Temp. (°F) | Yeast Type | Duration (hours) | Maximum Ethanol Emission Rate (Lbs/Hr) | Total Ethanol Emitted (Lbs) | Ethanol Emitted (Lbs) / $10^3$ Gal Juice | Ethanol[1] Emitted (Lbs) / Ton Grapes | % Ethanol Emitted Per Ethanol Produced |
| White Wine Fermentation Exhaust | United Vintners (Madera) | 280,000 | 56 | Montrachet | 172 | 10.6 | 714 | 2.6 | 0.56 | 0.35 |
| White Wine Fermentation Exhaust | Robert Mondavi (Oakville) | 5,800 | 60 | Montrachet | 512 | 0.05 | 8.2 | 1.4 | 0.31 | 0.2 |
| Red Wine Fermentation Exhaust | United Vintners (Madera) | 44,000 | 83 | Sacromices Servicia | 26 | 31.0 | 342 | 7.8 | 1.7 | 1.3 |
| Red Wine Fermentation Exhaust | United Vintners (Oakville) | 8,100 | 72 | Montrachet | 77 | 4.7 | 85.3 | 10.5 | 2.3 | 0.82 |

(1) 220 Gallons Juice/Ton Grapes

TABLE 14

ETHANOL FUGITIVE EMISSIONS AND EMISSION FACTORS

Location: United Vintners, Oakville

| Area | ($mg/m^3$) | (grams/hr) | (ppm by vol.) |
|---|---|---|---|
| Storage (Locations 1, 2, 5, 6) Ref. Figure | 0.04-0.08 | 0.003-0.007 | 0.02-0.04 |
| Handling (Location 3) | 2.2 | 0.4 | 1.4 |
| Handling (Location 4, adjacent to drag screen) | 6.5 | 1.0 | 3.4 |
| Handling (Location 7, immediately above drag screen) | 5429 | 923 | 2888 |
| Handling (Location 8, immediately above pomace press) | 1134 | 193 | 603 |

Location: Robert Mondavi, Oakville*

| Area | | | |
|---|---|---|---|
| Handling (Location 1) | 56 | 4.8 | 30 |
| Storage (Location 2) | 43 | 3.7 | 23 |
| Storage (Location 3) | 15 | 1.3 | 8 |

*The storage and handling areas at Robert Mondavi (Oakville) were undergoing final clean up operations of the crush season, possibly explaining the relatively higher ethanol values compared to those at United Vintners(Oakville).

TABLE 14 (continued)

Location: Inglenook (Rutherford), bottling process (i.e., handling)

| Area | ($mg/m^3$) | (grams/hr) | (ppm by vol.) |
|---|---|---|---|
| Room Air | 32 | -- * | 17 |
| Source, Corking Vent Outlet | 654 | 1.8 | 348 |
| Source, Filling Vent Outlet | 3536 | 27.2 | 1881 |

ETHANOL FUGITIVE EMISSION FACTORS

HANDLING PROCESSES

| Process | Ethanol |
|---|---|
| Drag Screen | 0.5 lbs ethanol/$10^{-3}$ gal juice |
| Pomace Press | 0.02 lbs ethanol/ton of pomace |
| Wine Bottling | 0.1 lbs ethanol/$10^{-3}$ gal wine (white) |

*No significant turbulence or air movement (i.e., ethanol dispersion).

# APPENDIX C.

7 duplicate

State of California
AIR RESOURCES BOARD

# ETHANOL EMISSIONS AND CONTROL FOR WINE FERMENTATION TANKS

Engineering Evaluation Branch
Test Report

C-87-041

Report Date: April, 1988

APPROVED

David F. Todd, Project Engr.
Testing Section

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Engineering Evaluation Branch

TABLE S.1

ETHANOL MASS EMISSION SUMMARY

| FERMENTATION | TANK 1 CATALYTIC INCINERATOR | | | TANK 2 CARBON ADSORPTION UNIT | | | TANK 3 WATER SCRUBBER | | | TANK 4 |
|---|---|---|---|---|---|---|---|---|---|---|
| | POUNDS IN | POUNDS OUT | OVERALL EFF | POUNDS IN | POUNDS OUT | OVERALL EFF | POUNDS IN | POUNDS OUT | OVERALL EFF | POUNDS OUT |
| White Wine I [a/] | 1.32 | 0.29 | 78% | 1.48 | 0.15 | 90% | 0.67 | 0.12 | 82% | 0.58 |
| Red Wine I [b/] | 5.65 | 1.46 | 74% | 8.92 | 3.91 | 56% | 2.13 | 0.04 | 98% | 1.33 |
| Red Wine II | 4.92 | 0.15 | 97% | 4.64 | 0.27 | 94% | 3.76 | 0.04 | 99% | 2.56 |
| White Wine II | 3.71 | 0.04 | 99% | 4.24 | 0.10 | 98% | 3.71 | 0.06 | 98% | 3.71 |

C-87-041

a/ Catalytic incinerator experienced start-up difficulties during White Wine I

b/ Red Wine I data is limited due to foamover problems

TABLE 4.1

SUMMARY OF SAMPLING AND ANALYTICAL METHODS

| COMPONENT TO BE ANALYZED | SAMPLING METHOD | ANALYTICAL METHOD or DETECTION PRINCIPLE |
|---|---|---|
| $O_2$ | Continous Analyzer | Paramagnetic |
| $CO_2$ | Continous Analyzer | NDIR |
| CO | Continous Analyzer | NDIR |
| Ethanol | Continous Analyzer | FID |
| Moisture Content | Method 4 | Volumetric |
| Volatile Organics | Grab Bag | GC/FID, GC/ECD |
| Liquid Catches | Grab (Specimen Jar) | GC/FID, GC/ECD |

C-87-041

## V. TEST RESULTS

The test results are presented as follows:

A. Continuous analyzer data and calculated control efficiency

B. Flow rate and moisture content data

C. Bag sample data

D. Aqueous sample data

E. Carbon tube data

F. Calculation of Alcohol Loss

### A. CONTINUOUS ANALYZER DATA

The continuous analyzer data for ethanol (EtOH), oxygen (O2), and carbon dioxide (CO2) gas concentrations is presented separately for each of the four fermentations. Each data point represents a time-averaged value for the time sampled at that tank. The continuous hydrocarbon analyzer measured the ethanol emissions as ppm propane. This has been converted to ppm ethanol based on a factor of 1.72 ppm EtOH = 1 ppm propane. This factor was obtained by observing the hydrocarbon analyzer response to a known EtOH concentration.

The percent ethanol control efficiency is calculated as follows:

$$\frac{(\text{EtOH in} - \text{EtOH out})}{(\text{EtOH in})} \times 100$$

Due to the difficulties inherent in measuring and comparing low ppm ethanol concentrations, the calculated control efficiencies near the start of the fermentations may not be representative of actual conditions.

F. CALCULATION OF ALCOHOL LOSS

Table 5.23 gives a summary of the mass of ethanol entering and leaving each control device for each fermentation. These values were obtained by integrating the ethanol concentration curves over the course of the fermentation. Details of this calculation can be found in Appendix B. Though the total amount of ethanol emitted may seem low, it should be kept in mind that only about 1000 gallons of grape must per tank were fermented in this pilot program.

Table 5.24 gives a summary of the data used to calculate the percent of ethanol lost by each tank. The data used to calculate the amount of total ethanol produced over the fermentation (gallons, % EtOH) were obtained from CSUF data summaries. The data for each tank is plotted in Figure 5.30 as a function of fermentation temperature. Also shown on Figure 5.30 are results from similar studies on fermentation tank emissions. The references are listed below the graph.

Most of the Phase I data are in fair agreement with previous work. Data scatter from Red Wine I is probably due to the limited number of data points available for this fermentation due to foamover problems. When the data from Red Wine I are removed from the graph, as in Figure 5.31, the plot shows an improved correlation.

Table 5.23

ETHANOL MASS EMISSION SUMMARY

| | TANK 1 | | | TANK 2 | | | TANK 3 | | | TANK 4 |
|---|---|---|---|---|---|---|---|---|---|---|
| ERMENTATION | POUNDS IN | POUNDS OUT | OVERALL EFF | POUNDS IN | POUNDS OUT | OVERALL EFF | POUNDS IN | POUNDS OUT | OVERALL EFF | POUNDS OUT |
| ite Wine I | 1.32 | 0.29 | 78% | 1.48 | 0.15 | 90% | 0.67 | 0.12 | 82% | 0.58 |
| Red Wine I | 5.65 | 1.46 | 74% | 8.92 | 3.91 | 56% | 2.13 | 0.04 | 98% | 1.33 |
| Red Wine II | 4.92 | 0.15 | 97% | 4.64 | 0.27 | 94% | 3.76 | 0.04 | 99% | 2.56 |
| ite Wine II | 3.71 | 0.04 | 99% | 4.24 | 0.10 | 98% | 3.71 | 0.06 | 98% | 3.71 |

C-7

| | TANK 1 | | | TANK 2 | | | TANK 3 | | | TANK 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ERMENTATION | # DATA POINTS | HOURS COVERED BY DATA COLLETION | PERCENT OF FERM COVERED | # DATA POINTS | HOURS COVERED BY DATA COLLETION | PERCENT OF FERM COVERED | # DATA POINTS | HOURS COVERED BY DATA COLLETION | PERCENT OF FERM COVERED | # DATA POINTS | HOURS COVERED BY DATA COLLETION | PERCENT OF FERM COVERED |
| ite Wine I | 19 | 185.8 | 79% | 23 | 209.2 | 88% | 23 | 190.7 | 81% | 13 | 190.7 | 81% |
| Red Wine I | 6 | 64.7 | 67% | 5 | 63.1 | 68% | 4 | 46.7 | 51% | 3 | 46.0 | 52% |
| Red Wine II | 15 | 70.1 | 72% | 13 | 73.1 | 73% | 13 | 71.7 | 71% | 15 | 68.6 | 89% |
| ite Wine II | 23 | 183.5 | 86% | 21 | 156.2 | 73% | 12 | 150.5 | 71% | 28 | 185.8 | 87% |

Table 5.24

SUMMARY OF DATA USED TO CALCULATE PERCENT ETHANOL LOST

| FERM | TANK | GALLONS | % ETOH | INITIAL SUGAR (DEG BRIX) | TEMP (DEG F) | AVAIL GALLONS ETOH | AVAIL GRAMS ETOH | GRAMS ETOH LOST | % OF TOTAL ETOH LOST |
|---|---|---|---|---|---|---|---|---|---|
| WW I | 1 | 1086 | 10.3 | 20.1 | 59 | 112 | 3.3E+05 | 601 | 0.18 |
| | 2 | 1086 | 10.3 | 20.1 | 59 | 112 | 3.3E+05 | 672 | 0.20 |
| | 3 | 1086 | 10.3 | 20.1 | 57 | 112 | 3.3E+05 | 306 | 0.09 |
| | 4 | 1086 | 8.6 | 20.1 | 59 | 93 | 2.8E+05 | 264 | 0.09 |
| RW I | 1 | 736 | 14.11 | 24.1 | 78 | 104 | 3.1E+05 | 2567 | 0.83 |
| | 2 | 736 | 14.17 | 23.9 | 78 | 104 | 3.1E+05 | 4054 | 1.30 |
| | 3 | 736 | 14.3 | 23.9 | 79 | 105 | 3.1E+05 | 969 | 0.31 |
| | 4 | 736 | 13.65 | 24.3 | 75 | 100 | 3.0E+05 | 605 | 0.20 |
| RW II | 1 | 701 | 11.83 | 25.4 | 80 | 83 | 2.5E+05 | 2238 | 0.90 |
| | 2 | 701 | 13.00 | 24.8 | 78 | 91 | 2.7E+05 | 2108 | 0.77 |
| | 3 | 701 | 12.44 | 25.1 | 76 | 87 | 2.6E+05 | 1708 | 0.66 |
| | 4 | 701 | 12.54 | 25.5 | 81 | 88 | 2.6E+05 | 1162 | 0.44 |
| WW II | 1 | 1083 | 10.83 | 22.3 | 57 | 117 | 3.5E+05 | 1688 | 0.48 |
| | 2 | 1083 | 10.73 | 22.3 | 57 | 116 | 3.5E+05 | 1926 | 0.55 |
| | 3 | 1083 | 11.27 | 22.3 | 57 | 122 | 3.6E+05 | 1688 | 0.46 |
| | 4 | 1083 | 9.95 | 22.3 | 57 | 108 | 3.2E+05 | 1688 | 0.52 |

C-87-041

TABLE

WHITE WINE 1 - EMISSION DATA FOR CATALYTIC HEATER

| TANK | DATE | TIME | HOURS | ETOH IN (PPM) | ETOH OUT (PPM) | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 19-Aug-87 | 11:30 | 0.0 | | | | | | | | | | |
| | 20-Aug-87 | 13:00 | 25.5 | 3.44 | 3.44 | 25.5 | 1.7 | 43.9 | 1.7 | 43.9 | 7 | 1.0 | 1.0 |
| | 20-Aug-87 | 16:30 | 29.0 | 1.72 | 20.64 | 3.5 | 2.6 | 9.0 | 12.0 | 42.1 | 7 | 0.2 | 0.9 |
| | 21-Aug-87 | 07:00 | 43.5 | 86 | 1.72 | 14.5 | 43.9 | 636.0 | 11.2 | 162.1 | 7 | 14.2 | 3.6 |
| | 21-Aug-87 | 11:00 | 47.5 | 48.16 | 25.8 | 4.0 | 67.1 | 268.3 | 13.8 | 55.0 | 7 | 6.0 | 1.2 |
| | 21-Aug-87 | 14:30 | 51.0 | 34.4 | 20.64 | 3.5 | 41.3 | 144.5 | 23.2 | 81.3 | 7 | 3.2 | 1.8 |
| | 22-Aug-87 | 08:00 | 68.5 | 15.48 | 6.88 | 17.5 | 24.9 | 436.4 | 13.8 | 240.8 | 7 | 9.7 | 5.4 |
| | 22-Aug-87 | 10:00 | 70.5 | 25.8 | 15.48 | 2.0 | 20.6 | 41.3 | 11.2 | 22.4 | 7.25 | 1.0 | 0.5 |
| | 22-Aug-87 | 14:30 | 75.0 | 25.8 | 27.52 | 4.5 | 25.8 | 116.1 | 21.5 | 96.8 | 7 | 2.6 | 2.2 |
| | 23-Aug-87 | 10:30 | 95.0 | 189.2 | 149.64 | 20.0 | 107.5 | 2150.0 | 88.6 | 1771.6 | 7 | 48.0 | 39.6 |
| | 23-Aug-87 | 15:20 | 99.8 | 232.2 | 154.8 | 4.8 | 210.7 | 1018.4 | 152.2 | 735.7 | 7 | 22.7 | 16.4 |
| | 24-Aug-97 | 10:00 | 118.5 | 258 | 0 | 18.7 | 245.1 | 4575.2 | 77.4 | 1444.8 | 6.75 | 98.5 | 31.1 |
| | 24-Aug-87 | 13:15 | 121.7 | 412.8 | 51.6 | 3.2 | 335.4 | 1090.0 | 25.8 | 83.8 | 6.75 | 23.5 | 1.8 |
| | 24-Aug-87 | 17:10 | 125.7 | 430 | 43 | 3.9 | 421.4 | 1650.5 | 47.3 | 185.3 | 7 | 36.9 | 4.1 |
| | 26-Aug-87 | 07:00 | 163.5 | 86 | 3.44 | 37.8 | 258.0 | 9761.0 | 23.2 | 878.5 | 7 | 218.0 | 19.6 |
| | 26-Aug-87 | 17:00 | 173.5 | 146.2 | 1.72 | 10.0 | 116.1 | 1161.0 | 2.6 | 25.8 | 7 | 25.9 | 0.6 |
| | 27-Aug-87 | 08:30 | 189.0 | 68.8 | 1.72 | 15.5 | 107.5 | 1666.3 | 1.7 | 26.7 | 7 | 37.2 | 0.6 |
| | 27-Aug-87 | 17:00 | 197.5 | 120.4 | 8.6 | 8.5 | 94.6 | 804.1 | 5.2 | 43.9 | 7 | 18.0 | 1.0 |
| | 28-Aug-87 | 06:50 | 211.3 | 103.2 | 5.16 | 13.8 | 111.8 | 1546.6 | 6.9 | 95.2 | 7 | 34.5 | 2.1 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 601.1 | 133.6 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 77.8% |

WHITE WINE 1 - EMISSION DATA FOR CARBON ADSORPTION UNIT

| TANK | DATE | TIME | HOURS | ETOH IN | ETOH OUT | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 19-Aug-87 | 11:30 | 0.0 | | | | | | | | | | |
| | 19-Aug-87 | 14:30 | 3.0 | 1.72 | 0 | 3.0 | 0.9 | 2.6 | 0.0 | 0.0 | 7 | 0.1 | 0.0 |
| | 20-Aug-87 | 14:00 | 26.5 | 3.44 | 1.72 | 23.5 | 2.6 | 60.6 | 0.9 | 20.2 | 7 | 1.4 | 0.5 |
| | 20-Aug-87 | 17:00 | 29.5 | 3.44 | 5.16 | 3.0 | 3.4 | 10.3 | 3.4 | 10.3 | 7 | 0.2 | 0.2 |
| | 21-Aug-87 | 08:00 | 44.5 | 86 | 1.72 | 15.0 | 44.7 | 670.8 | 3.4 | 51.6 | 7 | 15.0 | 1.2 |
| | 21-Aug-97 | 10:30 | 47.0 | 51.6 | 5.16 | 2.5 | 68.8 | 172.0 | 3.4 | 8.6 | 7 | 3.8 | 0.2 |
| | 21-Aug-87 | 11:30 | 48.0 | 60.2 | 12.04 | 1.0 | 55.9 | 55.9 | 8.6 | 8.6 | 7 | 1.2 | 0.2 |
| | 21-Aug-87 | 15:00 | 51.5 | 34.4 | 6.88 | 3.5 | 47.3 | 165.6 | 9.5 | 33.1 | 7 | 3.7 | 0.7 |
| | 21-Aug-87 | 17:00 | 53.5 | 13.76 | 8.6 | 2.0 | 24.1 | 48.2 | 7.7 | 15.5 | 7 | 1.1 | 0.3 |
| | 22-Aug-87 | 09:00 | 69.5 | 13.76 | 1.72 | 16.0 | 13.8 | 220.2 | 5.2 | 82.6 | 7 | 4.9 | 1.8 |
| | 22-Aug-87 | 10:45 | 71.2 | 24.08 | 0.86 | 1.7 | 18.9 | 33.1 | 1.3 | 2.3 | 7 | 0.7 | 0.1 |
| | 22-Aug-87 | 15:00 | 75.5 | 25.8 | 3.44 | 4.3 | 24.9 | 106.0 | 2.2 | 9.1 | 7 | 2.4 | 0.2 |
| | 23-Aug-87 | 07:30 | 92.0 | 103.2 | 0 | 16.5 | 64.5 | 1064.3 | 1.7 | 28.4 | 7 | 23.8 | 0.6 |
| | 23-Aug-87 | 11:15 | 95.7 | 232.2 | 6.88 | 3.8 | 167.7 | 628.9 | 3.4 | 12.9 | 7 | 14.0 | 0.3 |
| | 23-Aug-87 | 16:55 | 101.4 | 283.8 | 1.72 | 5.7 | 258.0 | 1462.0 | 4.3 | 24.4 | 7 | 32.6 | 0.5 |
| | 24-Aug-87 | 14:55 | 123.4 | 473 | 8.6 | 22.0 | 378.4 | 8324.8 | 5.2 | 113.5 | 7 | 185.9 | 2.5 |
| | 25-Aug-87 | 06:50 | 139.3 | 261.44 | 154.8 | 15.9 | 367.2 | 5844.9 | 81.7 | 1300.4 | 7 | 130.5 | 29.0 |
| | 25-Aug-87 | 11:45 | 144.2 | 275.2 | 1.72 | 4.9 | 268.3 | 1319.2 | 78.3 | 384.8 | 7 | 29.5 | 8.6 |
| | 26-Aug-87 | 08:00 | 164.5 | 154.8 | 2.58 | 20.3 | 215.0 | 4353.8 | 2.2 | 43.5 | 7 | 97.2 | 1.0 |
| | 26-Aug-87 | 14:30 | 171.0 | 189.2 | 3.44 | 6.5 | 172.0 | 1118.0 | 3.0 | 19.6 | 7 | 25.0 | 0.4 |
| | 27-Aug-87 | 11:00 | 191.5 | 120.4 | 72.24 | 20.5 | 154.8 | 3173.4 | 37.8 | 775.7 | 7 | 70.9 | 17.3 |
| | 27-Aug-87 | 11:30 | 192.0 | 120.4 | 1.72 | 0.5 | 120.4 | 60.2 | 37.0 | 18.5 | 7 | 1.3 | 0.4 |
| | 27-Aug-87 | 17:50 | 198.3 | 129 | 5.16 | 6.3 | 124.7 | 789.8 | 3.4 | 21.8 | 7 | 17.6 | 0.5 |
| | 28-Aug-87 | 07:40 | 212.2 | 60.2 | 1.72 | 13.8 | 94.6 | 1308.6 | 3.4 | 47.6 | 7 | 29.2 | 1.1 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 671.6 | 65.7 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 90.2% |

C-87-041

TABLE

WHITE WINE I - EMISSION DATA FOR WATER SCRUBBER

| TANK | DATE | TIME | HOURS | ETOH IN | ETOH OUT | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 19-Aug-87 | 11:30 | 0.0 | | | | | | | | | | |
| | 19-Aug-87 | 15:00 | 3.5 | 2 | 0 | 3.5 | 0.9 | 3.0 | 0.0 | 0.0 | 4.6 | 0.0 | 0.0 |
| | 20-Aug-87 | 09:30 | 22.0 | 2 | 2 | 18.5 | 1.7 | 31.8 | 0.9 | 15.9 | 4.0 | 0.4 | 0.0 |
| | 20-Aug-87 | 14:30 | 27.0 | 5 | 3 | 5.0 | 3.4 | 17.2 | 2.6 | 12.9 | 3.5 | 0.2 | 0.0 |
| | 20-Aug-87 | 17:30 | 30.0 | 5 | 3 | 3.0 | 5.2 | 15.5 | 3.4 | 10.3 | 3.3 | 0.2 | 0.0 |
| | 21-Aug-87 | 08:30 | 45.0 | 258 | 3 | 15.0 | 131.6 | 1973.7 | 3.4 | 51.6 | 2.8 | 17.3 | 2.9 |
| | 21-Aug-87 | 12:30 | 49.0 | 103 | 7 | 4.0 | 180.6 | 722.4 | 5.2 | 20.6 | 3.8 | 8.6 | 0.6 |
| | 21-Aug-87 | 15:30 | 52.0 | 38 | 7 | 3.0 | 70.5 | 211.6 | 6.9 | 20.6 | 3.3 | 2.2 | 0.1 |
| | 21-Aug-87 | 17:30 | 54.0 | 15 | 9 | 2.0 | 26.7 | 53.3 | 7.7 | 15.5 | 3.3 | 0.6 | 0.0 |
| | 22-Aug-87 | 09:30 | 70.0 | 15 | 2 | 16.0 | 15.5 | 247.7 | 5.2 | 82.6 | 3.0 | 2.4 | 0.6 |
| | 22-Aug-87 | 11:30 | 72.0 | 28 | 0 | 2.0 | 21.5 | 43.0 | 0.9 | 1.7 | 3.0 | 0.4 | 0.0 |
| | 22-Aug-87 | 15:30 | 76.0 | 38 | 3 | 4.0 | 32.7 | 130.7 | 1.7 | 6.9 | 3.5 | 1.5 | 0.0 |
| | 23-Aug-87 | 08:30 | 93.0 | 120 | 2 | 17.0 | 79.1 | 1345.0 | 2.6 | 43.9 | 2.3 | 9.7 | 1.4 |
| | 23-Aug-87 | 11:48 | 96.3 | 258 | 7 | 3.3 | 189.2 | 624.4 | 4.3 | 14.2 | 2.8 | 5.5 | 0.2 |
| | 24-Aug-87 | 08:30 | 117.0 | 292 | 0 | 20.7 | 275.2 | 5696.6 | 3.4 | 71.2 | 2.5 | 45.4 | 10.3 |
| | 24-Aug-87 | 11:15 | 119.7 | 378 | 5 | 2.8 | 335.4 | 922.4 | 2.6 | 7.1 | 2.5 | 7.4 | 0.2 |
| | 24-Aug-87 | 15:45 | 124.2 | 564 | 4 | 4.5 | 471.3 | 2120.8 | 4.7 | 21.3 | 3.3 | 22.0 | 1.5 |
| | 25-Aug-87 | 08:00 | 140.5 | 550 | 10 | 16.2 | 557.3 | 9055.8 | 7.3 | 118.8 | 2.1 | 60.7 | 23.0 |
| | 25-Aug-87 | 14:00 | 146.5 | 433 | 3 | 6.0 | 491.9 | 2951.5 | 6.9 | 41.3 | 3.0 | 28.2 | 3.7 |
| | 26-Aug-87 | 09:00 | 165.5 | 52 | 2 | 19.0 | 242.5 | 4607.9 | 2.6 | 49.0 | 3.3 | 48.5 | 7.6 |
| | 26-Aug-87 | 15:30 | 172.0 | 258 | 2 | 6.5 | 154.8 | 1006.2 | 1.7 | 11.2 | 2.8 | 8.8 | 0.3 |
| | 27-Aug-87 | 06:30 | 187.0 | 172 | 3 | 15.0 | 215.0 | 3225.0 | 2.6 | 38.7 | 2.3 | 23.1 | 2.9 |
| | 27-Aug-87 | 13:00 | 193.5 | 120 | 3 | 6.5 | 146.2 | 950.3 | 3.4 | 22.4 | 4.3 | 12.9 | 0.9 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 305.9 | 56.2 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 81.6% |

WHITE WINE I - NO CONTROL EQUIPMENT

| TANK | DATE | TIME | HOURS | ETOH | TIME INTERVAL (HOURS) | ETOH PPM AVG | ETOH PPM-HOUR | FLOW (SCFM) | MASS ETOH (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 19-Aug-87 | 11:30 | 0 | | | | | | |
| | 19-Aug-87 | 15:30 | 4.0 | 36 | 4.0 | 18.1 | 72.2 | 0.0 | 0.0 |
| | 20-Aug-87 | 16:00 | 28.5 | 636 | 24.5 | 336.3 | 8238.4 | 0.0 | 0.0 |
| | 21-Aug-87 | 09:15 | 45.7 | 1462 | 17.3 | 1049.2 | 18098.7 | 0.0 | 0.0 |
| | 21-Aug-87 | 13:30 | 50.0 | 1720 | 4.3 | 1591.0 | 6761.8 | 0.0 | 0.0 |
| | 21-Aug-87 | 21:00 | 57.5 | 69 | 7.5 | 894.4 | 6708.0 | 0.0 | 0.0 |
| | 22-Aug-87 | 13:45 | 74.2 | 146 | 16.7 | 107.5 | 1800.6 | 0.1 | 0.7 |
| | 22-Aug-87 | 16:00 | 76.5 | 181 | 2.3 | 163.4 | 367.7 | 0.1 | 0.2 |
| | 24-Aug-87 | 12:00 | 120.5 | 860 | 44.0 | 520.3 | 22893.2 | 1.1 | 80.3 |
| | 24-Aug-87 | 16:25 | 124.9 | 1032 | 4.4 | 946.0 | 4178.2 | 1.0 | 13.3 |
| | 25-Aug-87 | 09:15 | 141.7 | 860 | 16.8 | 946.0 | 15924.3 | 0.8 | 40.6 |
| | 25-Aug-87 | 15:45 | 148.2 | 1032 | 6.5 | 946.0 | 6149.0 | 0.8 | 15.7 |
| | 26-Aug-87 | 10:45 | 167.2 | 3354 | 19.0 | 2193.0 | 41667.0 | 0.5 | 66.5 |
| | 27-Aug-87 | 14:15 | 194.7 | 1032 | 27.5 | 2193.0 | 60307.5 | 0.2 | 46.2 |
| | | | | | | | | TOTAL GRAMS ETOH: | 263.5 |

TABLE

RED WINE I - EMISSION DATA FOR CATALYTIC HEATER

| TANK | DATE | TIME | HOURS | ETOH IN | ETOH OUT | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 31-Aug-87 | 12:00 | 0.0 | | | | | | | | | | |
| | 01-Sep-87 | 19:00 | 31.0 | 2881 | 1075 | 31.0 | 1440.5 | 44655.5 | 537.5 | 16662.5 | 6.0 | 854.7 | 318.9 |
| | 02-Sep-87 | 18:40 | 54.7 | 860 | 43 | 23.7 | 1870.5 | 44268.5 | 559.0 | 13229.7 | 7.8 | 1094.4 | 327.1 |
| | 03-Sep-87 | 08:35 | 68.6 | 344 | 12 | 13.9 | 602.0 | 8377.8 | 27.5 | 383.0 | 7.0 | 187.1 | 8.6 |
| | 03-Sep-87 | 14:50 | 74.8 | 1290 | 17 | 6.3 | 817.0 | 5106.3 | 14.6 | 91.4 | 7.0 | 114.0 | 2.0 |
| | 04-Sep-87 | 06:45 | 90.8 | 292 | 10 | 15.9 | 791.2 | 12593.3 | 13.8 | 219.0 | 7.0 | 281.2 | 4.9 |
| | 04-Sep-87 | 11:45 | 95.7 | 344 | 17 | 5.0 | 318.2 | 1591.0 | 13.8 | 68.8 | 7.0 | 35.5 | 1.5 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 2567.0 | 663.0 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 74.2% |

RED WINE I - EMISSION DATA FOR CARBON ADSORPTION UNIT

| TANK | DATE | TIME | HOURS | ETOH IN | ETOH OUT | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 31-Aug-87 | 15:00 | 0 | | | | | | | | | | |
| | 01-Sep-87 | 16:30 | 25.5 | 3784 | 1075 | 25.5 | 1892.0 | 48246.0 | 537.5 | 13706.3 | 7.0 | 1077.3 | 306.1 |
| | 02-Sep-87 | 13:15 | 46.2 | 3354 | 2580 | 20.7 | 3569.0 | 74056.7 | 1827.5 | 37920.6 | 7.0 | 1653.7 | 846.8 |
| | 03-Sep-87 | 09:10 | 66.2 | 722 | 163 | 19.9 | 2038.2 | 40594.1 | 1371.7 | 27319.7 | 7.0 | 906.5 | 610.0 |
| | 03-Sep-87 | 13:35 | 70.6 | 1247 | 5 | 4.4 | 984.7 | 4349.1 | 84.3 | 372.2 | 7.0 | 97.1 | 8.3 |
| | 04-Sep-87 | 07:35 | 88.6 | 344 | 26 | 18.0 | 795.5 | 14319.0 | 15.5 | 278.6 | 7.0 | 319.7 | 6.2 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 4054.3 | 1777.4 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 56.2% |

RED WINE I - EMISSION DATA FOR WATER SCRUBBER

| TANK | DATE | TIME | HOURS | ETOH IN | ETOH OUT | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 31-Aug-87 | 17:00 | 0 | | | | | | | | | | |
| | 02-Sep-87 | 09:20 | 40.3 | 860 | 0 | 40.3 | 430.0 | 17343.3 | 0.0 | 0.0 | 5.5 | 304.3 | 0.0 |
| | 02-Sep-87 | 16:05 | 47.1 | 1600 | 17 | 6.8 | 1229.8 | 8301.2 | 8.6 | 58.1 | 4.5 | 119.2 | 0.8 |
| | 03-Sep-87 | 12:00 | 67.0 | 826 | 52 | 19.9 | 1212.6 | 24151.0 | 34.4 | 685.1 | 4.8 | 365.9 | 10.4 |
| | 04-Sep-87 | 08:00 | 87.0 | 301 | 5 | 20.0 | 563.3 | 11266.0 | 28.4 | 567.6 | 5.0 | 179.7 | 9.1 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 969.1 | 20.3 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 97.9% |

RED WINE I - NO CONTROLS

| TANK | DATE | TIME | HOURS | ETOH | TIME INTERVAL (HOURS) | ETOH PPM AVG | ETOH PPM-HOUR | FLOW (SCFM) | MASS ETOH (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 31-Aug-87 | 19:15 | 0 | | | | | | |
| | 02-Sep-87 | 12:00 | 40.8 | 6880 | 40.8 | 3440.0 | 140180.0 | 1.6 | 715.5 |
| | 03-Sep-87 | 16:30 | 69.3 | 7740 | 28.5 | 7310.0 | 208335.0 | 0.9 | 604.8 |
| | 04-Sep-87 | 10:00 | 86.8 | 4300 | 17.5 | 6020.0 | 105350.0 | 0.6 | 198.3 |
| | | | | | | | | TOTAL GRAMS ETOH: | 1518.5 |

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TABLE 5.6

RED WINE II - EMISSION DATA FOR CATLYTIC HEATER

| TANK | DATE | TIME | HOURS | ETOH IN (PPM) | ETOH OUT (PPM) | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10-Sep-87 | 13:00 | 0.0 | | | | | | | | | | |
| | 11-Sep-87 | 11:20 | 22.3 | 1593 | 83 | 22.3 | 796.7 | 17792.7 | 41.7 | 930.4 | 7.0 | 397.3 | 20.8 |
| | 11-Sep-87 | 15:10 | 26.2 | 1044 | 64 | 3.8 | 1318.5 | 5054.3 | 73.9 | 283.2 | 7.0 | 112.9 | 6.3 |
| | 11-Sep-87 | 19:50 | 30.8 | 3194 | 53 | 4.7 | 2118.7 | 9887.2 | 58.6 | 273.3 | 7.0 | 220.8 | 6.1 |
| | 12-Sep-87 | 08:30 | 43.5 | 1781 | 18 | 12.7 | 2487.3 | 31505.9 | 35.1 | 445.2 | 7.0 | 703.5 | 9.9 |
| | 12-Sep-87 | 12:50 | 47.8 | 1932 | 49 | 4.3 | 1856.4 | 8044.5 | 33.2 | 143.9 | 7.0 | 179.6 | 3.2 |
| | 12-Sep-87 | 22:00 | 57.0 | 1093 | 65 | 9.2 | 1512.7 | 13866.2 | 56.9 | 521.9 | 7.0 | 309.6 | 11.7 |
| | 13-Sep-87 | 00:00 | 59.0 | 856 | 15 | 2.0 | 974.8 | 1949.5 | 40.1 | 80.2 | 7.0 | 43.5 | 1.8 |
| | 13-Sep-87 | 01:00 | 60.0 | 685 | -1 | 1.0 | 770.7 | 770.7 | 7.1 | 7.1 | 7.0 | 17.2 | 0.2 |
| PO | 13-Sep-87 | 02:05 | 61.1 | 244 | -4 | 1.1 | 464.8 | 503.5 | -2.5 | -2.7 | 7.0 | 11.2 | -0.1 |
| | 13-Sep-87 | 04:00 | 63.0 | 455 | -2 | 1.9 | 349.6 | 670.0 | -3.0 | -5.7 | 7.0 | 15.0 | -0.1 |
| | 13-Sep-87 | 06:00 | 65.0 | 294 | -1 | 2.0 | 374.7 | 749.3 | -1.5 | -3.0 | 7.0 | 16.7 | -0.1 |
| | 13-Sep-87 | 14:55 | 73.9 | 382 | 36 | 8.9 | 338.1 | 3014.7 | 17.4 | 155.3 | 7.0 | 67.3 | 3.5 |
| | 13-Sep-87 | 19:40 | 78.7 | 649 | 28 | 4.7 | 515.2 | 2447.4 | 32.1 | 152.4 | 7.0 | 54.6 | 3.4 |
| PO | 13-Sep-87 | 20:10 | 79.2 | 233 | 22 | 0.5 | 441.0 | 220.5 | 25.0 | 12.5 | 7.3 | 5.1 | 0.3 |
| | 14-Sep-87 | 09:25 | 92.4 | 331 | 2 | 13.3 | 282.3 | 3740.8 | 11.7 | 154.6 | 7.0 | 83.5 | 3.5 |

TOTAL GRAMS ETOH: 2238.0 70.3
OVERALL EFFICIENCY: 96.9%

RED WINE II - EMISSION DATA FOR CARBON ADSORPTION UNIT

| TANK | DATE | TIME | HOURS | ETOH IN (PPM) | ETOH OUT (PPM) | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 10-Sep-87 | 11:42 | 0.0 | | | | | | | | | | |
| | 11-Sep-87 | 10:10 | 22.5 | 342 | 10 | 22.5 | 171.0 | 3842.7 | 5.2 | 115.8 | 7.3 | 88.9 | 2.7 |
| | 11-Sep-87 | 16:30 | 28.8 | 1144 | 17 | 6.3 | 743.2 | 4707.1 | 13.6 | 86.2 | 7.0 | 105.1 | 1.9 |
| | 11-Sep-87 | 20:50 | 33.1 | 2184 | 10 | 4.3 | 1664.3 | 7212.0 | 13.4 | 58.0 | 7.0 | 161.0 | 1.3 |
| B1 | 12-Sep-87 | 08:55 | 45.2 | 1992 | 29 | 12.1 | 2088.1 | 25231.2 | 19.4 | 233.9 | 7.5 | 603.7 | 5.6 |
| B2 | 12-Sep-87 | 09:30 | 45.8 | 1970 | 17 | 0.6 | 1980.9 | 1155.5 | 22.9 | 13.4 | 7.5 | 27.6 | 0.3 |
| | 12-Sep-87 | 13:55 | 50.2 | 1780 | 23 | 4.4 | 1874.7 | 8279.8 | 19.9 | 87.9 | 7.3 | 191.5 | 2.0 |
| | 13-Sep-87 | 10:00 | 70.3 | 749 | 278 | 20.1 | 1264.1 | 25387.9 | 150.2 | 3016.7 | 7.0 | 566.9 | 67.4 |
| | 13-Sep-87 | 17:15 | 77.6 | 1075 | 57 | 7.3 | 911.8 | 6610.7 | 167.1 | 1211.8 | 6.8 | 142.3 | 26.1 |
| | 13-Sep-87 | 20:45 | 81.1 | 562 | 47 | 3.5 | 818.7 | 2865.3 | 52.0 | 182.1 | 6.8 | 61.7 | 3.9 |
| PO | 13-Sep-87 | 21:45 | 82.1 | 265 | 29 | 1.0 | 413.7 | 413.7 | 38.4 | 38.4 | 6.8 | 8.9 | 0.8 |
| | 14-Sep-87 | 00:00 | 84.3 | 574 | 32 | 2.3 | 419.5 | 943.8 | 30.5 | 68.6 | 6.8 | 20.3 | 1.5 |
| | 14-Sep-87 | 02:00 | 86.3 | 689 | 32 | 2.0 | 631.4 | 1262.8 | 31.7 | 63.5 | 6.8 | 27.2 | 1.4 |
| | 14-Sep-87 | 03:25 | 87.7 | 896 | 33 | 1.4 | 792.6 | 1122.8 | 32.4 | 45.9 | 6.8 | 24.2 | 1.0 |
| PO | 14-Sep-87 | 05:15 | 89.6 | 489 | 29 | 1.8 | 692.5 | 1269.5 | 31.0 | 56.8 | 6.8 | 27.3 | 1.2 |
| | 14-Sep-87 | 06:30 | 90.8 | 374 | 28 | 1.2 | 431.1 | 538.9 | 28.7 | 35.9 | 6.8 | 11.6 | 0.8 |
| | 14-Sep-87 | 11:15 | 95.6 | 413 | 34 | 4.8 | 393.1 | 1867.3 | 31.4 | 149.0 | 6.8 | 40.2 | 3.2 |

TOTAL GRAMS ETOH: 2108.5 121.1
OVERALL EFFICIENCY: 94.3%

PO - Pumpover occurred during this sampling period.

TABLE 5.7

RED WINE II - EMISSION DATA FOR WATER SCRUBBER

| TANK | DATE | TIME | HOURS | ETOH IN (PPM) | ETOH OUT (PPM) | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 10-Sep-87 | 10:10 | 0.0 | | | | | | | | | | |
| | 11-Sep-87 | 12:15 | 26.1 | 471 | 8 | 26.1 | 235.3 | 6136.4 | 3.8 | 98.0 | 7.3 | 141.9 | 2.3 |
| | 11-Sep-87 | 17:25 | 31.3 | 368 | 4 | 5.2 | 419.3 | 2166.6 | 5.6 | 29.1 | 5.5 | 38.0 | 0.5 |
| | 11-Sep-87 | 23:50 | 37.7 | 434 | 7 | 6.4 | 401.0 | 2573.0 | 5.3 | 34.1 | 5.0 | 41.0 | 0.5 |
| | 12-Sep-87 | 02:00 | 39.8 | 1379 | 6 | 2.2 | 906.2 | 1963.3 | 6.6 | 14.3 | 5.0 | 31.3 | 0.2 |
| | 12-Sep-87 | 04:00 | 41.8 | 1657 | 6 | 2.0 | 1517.7 | 3035.5 | 6.3 | 12.6 | 5.0 | 48.4 | 0.2 |
| | 12-Sep-87 | 06:00 | 43.8 | 1486 | 6 | 2.0 | 1571.5 | 3143.0 | 6.2 | 12.5 | 5.0 | 50.1 | 0.2 |
| | 12-Sep-87 | 07:00 | 44.8 | 1269 | 7 | 1.0 | 1377.8 | 1377.8 | 6.4 | 6.4 | 6.5 | 28.6 | 0.1 |
| | 12-Sep-87 | 10:15 | 48.1 | 1808 | 5 | 3.2 | 1538.9 | 5001.6 | 6.0 | 19.4 | 7.0 | 111.7 | 0.4 |
| | 12-Sep-87 | 15:30 | 53.3 | 1584 | 5 | 5.3 | 1696.1 | 8904.7 | 5.3 | 27.7 | 6.8 | 191.7 | 0.6 |
| | 13-Sep-87 | 09:00 | 70.8 | 1155 | 6 | 17.5 | 1369.3 | 23962.8 | 5.7 | 100.3 | 7.5 | 573.3 | 2.4 |
| | 13-Sep-87 | 18:20 | 80.2 | 897 | 26 | 9.3 | 1025.8 | 9574.1 | 16.1 | 150.4 | 7.3 | 221.4 | 3.5 |
| | 14-Sep-87 | 08:10 | 94.0 | 364 | 4 | 13.8 | 630.5 | 8722.1 | 15.0 | 207.4 | 6.8 | 187.8 | 4.5 |
| | 14-Sep-87 | 12:00 | 97.8 | 597 | 24 | 3.8 | 480.4 | 1841.4 | 14.0 | 53.7 | 7.3 | 42.6 | 1.2 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 1708.0 | 16.7 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 99.0% |

RED WINE II - NO CONTROLS

| TANK | DATE | TIME | HOURS | ETOH (PPM) | TIME INTERVAL (HOURS) | ETOH PPM AVG | ETOH PPM-HOUR | FLOW (SCFM) | MASS ETOH (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 10-Sep-87 | 09:30 | 0.0 | | | | | | |
| | 10-Sep-87 | 15:55 | 6.4 | 7 | 6.4 | 3.6 | 23.2 | 0.0 | 0.0 |
| | 10-Sep-87 | 17:00 | 7.5 | 4 | 1.1 | 5.8 | 6.3 | 0.0 | 0.0 |
| | 10-Sep-87 | 18:00 | 8.5 | 3 | 1.0 | 3.9 | 3.9 | 0.0 | 0.0 |
| | 10-Sep-87 | 20:00 | 10.5 | 6 | 2.0 | 4.8 | 9.6 | 0.0 | 0.0 |
| | 10-Sep-87 | 22:00 | 12.5 | 4 | 2.0 | 5.4 | 10.8 | 0.0 | 0.0 |
| | 11-Sep-87 | 00:00 | 14.5 | 4 | 2.0 | 4.4 | 8.8 | 0.0 | 0.0 |
| | 11-Sep-87 | 02:00 | 16.5 | 30 | 2.0 | 17.0 | 34.1 | 0.0 | 0.0 |
| | 11-Sep-87 | 04:00 | 18.5 | 58 | 2.0 | 43.8 | 87.6 | 0.0 | 0.0 |
| | 11-Sep-87 | 06:00 | 20.5 | 74 | 2.0 | 65.7 | 131.4 | 0.0 | 0.0 |
| | 11-Sep-87 | 07:00 | 21.5 | 82 | 1.0 | 77.8 | 77.8 | 0.0 | 0.0 |
| | 11-Sep-87 | 12:45 | 27.3 | 44 | 5.8 | 63.2 | 363.5 | 0.0 | 0.0 |
| | 12-Sep-87 | 11:15 | 49.8 | 4214 | 22.5 | 2129.1 | 47905.9 | 2.0 | 305.6 |
| PO | 12-Sep-87 | 17:00 | 55.5 | 2978 | 5.7 | 3596.1 | 20677.8 | 2.9 | 191.3 |
| | 12-Sep-87 | 18:30 | 57.0 | 6171 | 1.5 | 4574.8 | 6862.2 | 2.9 | 63.5 |
| | 13-Sep-87 | 12:30 | 75.0 | 8789 | 18.0 | 7479.9 | 134638.8 | 1.4 | 601.3 |
| | | | | | | | | TOTAL GRAMS ETOH: | 1161.7 |

PO - Pumpover occurred during this sampling period.
* - Extrapolated value (off the calibrated scale of 0-25%)

TABLE

WHITE WINE II - EMISSION DATA FOR CATALYTIC HEATER

| TANK | DATE | TIME | HOURS | ETOH IN (PPM) | ETOH OUT (PPM) | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15-Sep-87 | 11:00 | 0.0 | | | | | | | | | | |
| | 16-Sep-87 | 16:45 | 29.8 | 13.0 | 7.4 | 29.8 | 6.5 | 192.8 | 3.7 | 110.7 | 6.8 | 4.2 | 2.4 |
| | 17-Sep-87 | 08:15 | 45.3 | 0.9 | 5.7 | 15.5 | 6.9 | 107.2 | 6.6 | 101.9 | 7.0 | 2.4 | 2.3 |
| | 17-Sep-87 | 11:55 | 48.9 | 2.2 | 0.0 | 3.7 | 1.5 | 5.6 | 2.9 | 10.5 | 7.0 | 0.1 | 0.2 |
| | 17-Sep-87 | 16:35 | 53.6 | 3.9 | 4.8 | 4.7 | 3.1 | 14.3 | 2.4 | 11.3 | 7.0 | 0.3 | 0.3 |
| | 18-Sep-87 | 08:35 | 69.6 | 2.3 | 3.1 | 16.0 | 3.1 | 50.3 | 3.9 | 63.2 | 7.0 | 1.1 | 1.4 |
| | 18-Sep-87 | 13:30 | 74.5 | 18.7 | 4.5 | 4.9 | 10.5 | 51.8 | 3.8 | 18.7 | 7.0 | 1.2 | 0.4 |
| | 19-Sep-87 | 02:00 | 87.0 | 48.4 | 1.1 | 12.5 | 33.6 | 419.5 | 2.8 | 35.5 | 7.0 | 9.4 | 0.8 |
| | 19-Sep-87 | 04:00 | 89.0 | 57.5 | 0.7 | 2.0 | 53.0 | 105.9 | 0.9 | 1.9 | 7.0 | 2.4 | 0.0 |
| | 19-Sep-87 | 06:00 | 91.0 | 70.4 | 0.7 | 2.0 | 64.0 | 128.0 | 0.7 | 1.4 | 7.0 | 2.9 | 0.0 |
| | 19-Sep-87 | 08:15 | 93.3 | 76.6 | 0.4 | 2.3 | 73.5 | 165.4 | 0.5 | 1.1 | 6.8 | 3.6 | 0.0 |
| | 20-Sep-87 | 13:40 | 122.7 | 1782.9 | 5.6 | 29.4 | 929.7 | 27349.8 | 3.0 | 86.9 | 6.8 | 593.3 | 1.9 |
| | 20-Sep-87 | 22:00 | 131.0 | 1079.7 | 6.8 | 8.3 | 1431.3 | 11927.4 | 6.2 | 51.4 | 6.8 | 258.7 | 1.1 |
| | 21-Sep-87 | 00:00 | 133.0 | 806.4 | 2.5 | 2.0 | 943.1 | 1886.1 | 4.7 | 9.3 | 6.8 | 40.9 | 0.2 |
| | 21-Sep-87 | 02:00 | 135.0 | 748.3 | 1.2 | 2.0 | 777.3 | 1554.7 | 1.9 | 3.7 | 7.0 | 34.7 | 0.1 |
| | 21-Sep-87 | 04:00 | 137.0 | 661.8 | 0.2 | 2.0 | 705.1 | 1410.1 | 0.7 | 1.4 | 7.0 | 31.5 | 0.0 |
| | 21-Sep-87 | 07:00 | 140.0 | 524.1 | 5.8 | 3.0 | 593.0 | 1779.0 | 3.0 | 9.0 | 7.0 | 39.7 | 0.2 |
| | 21-Sep-87 | 11:05 | 144.1 | 869.9 | 6.0 | 4.1 | 697.0 | 2846.2 | 5.9 | 24.2 | 7.0 | 63.6 | 0.5 |
| | 21-Sep-87 | 19:30 | 152.5 | 615.9 | 0.0 | 8.4 | 742.9 | 6252.7 | 3.0 | 25.4 | 7.0 | 139.6 | 0.6 |
| | 22-Sep-87 | 12:00 | 169.0 | 473.2 | 7.5 | 16.5 | 544.5 | 8984.4 | 3.7 | 61.8 | 7.0 | 200.6 | 1.4 |
| | 22-Sep-87 | 15:00 | 172.0 | 383.7 | 7.9 | 3.0 | 428.4 | 1285.2 | 7.7 | 23.1 | 7.0 | 28.7 | 0.5 |
| | 23-Sep-87 | 09:35 | 190.6 | 284.9 | 2.2 | 18.6 | 334.3 | 6212.4 | 5.1 | 93.9 | 7.0 | 138.7 | 2.1 |
| | 23-Sep-87 | 13:30 | 194.5 | 269.2 | 1.3 | 3.9 | 277.0 | 1085.1 | 1.7 | 6.8 | 7.0 | 24.2 | 0.2 |
| | 24-Sep-87 | 08:15 | 213.3 | 47.2 | 0.6 | 18.8 | 158.2 | 2965.8 | 1.0 | 17.8 | 7.0 | 66.2 | 0.4 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 1688.0 | 17.0 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 99.0% |

WHITE WINE II - EMISSION DATA FOR CARBON ABSORPTION UNIT

| TANK | DATE | TIME | HOURS | ETOH IN (PPM) | ETOH OUT (PPM) | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 15-Sep-87 | 11:00 | 0.0 | | | | | | | | | | |
| | 17-Sep-87 | 18:30 | 55.5 | 0.8 | 0.9 | 55.5 | 0.4 | 22.7 | 0.4 | 24.9 | 7.0 | 0.5 | 0.6 |
| | 18-Sep-87 | 09:30 | 70.5 | 9.8 | 2.9 | 15.0 | 5.3 | 79.8 | 1.9 | 28.6 | 7.0 | 1.8 | 0.6 |
| | 18-Sep-87 | 17:45 | 78.8 | 21.4 | 10.8 | 8.3 | 15.6 | 129.0 | 6.9 | 56.6 | 7.0 | 2.9 | 1.3 |
| | 19-Sep-87 | 12:25 | 97.4 | 141.8 | 5.5 | 18.7 | 81.6 | 1523.7 | 8.2 | 152.2 | 6.8 | 33.1 | 3.3 |
| | 20-Sep-87 | 14:25 | 123.4 | 2037.3 | 20.8 | 26.0 | 1089.5 | 28328.2 | 13.2 | 342.2 | 7.0 | 632.6 | 7.6 |
| | 21-Sep-87 | 10:00 | 143.0 | 896.2 | 5.3 | 19.6 | 1466.8 | 28723.9 | 13.1 | 255.6 | 7.0 | 641.4 | 5.7 |
| | 21-Sep-87 | 12:20 | 145.3 | 948.6 | 6.8 | 2.3 | 922.4 | 2152.3 | 6.1 | 14.1 | 7.0 | 48.1 | 0.3 |
| | 21-Sep-87 | 17:10 | 150.2 | 901.8 | 113.1 | 4.8 | 925.2 | 4471.9 | 60.0 | 289.8 | 7.0 | 99.9 | 6.5 |
| | 21-Sep-87 | 22:00 | 155.0 | 426.2 | 1.9 | 4.8 | 664.0 | 3209.4 | 57.5 | 278.0 | 7.0 | 71.7 | 6.2 |
| | 22-Sep-87 | 00:00 | 157.0 | 365.8 | 0.6 | 2.0 | 396.0 | 792.0 | 1.3 | 2.5 | 7.0 | 17.7 | 0.1 |
| | 22-Sep-87 | 02:00 | 159.0 | 363.6 | 1.1 | 2.0 | 364.7 | 729.4 | 0.8 | 1.7 | 7.0 | 16.3 | 0.0 |
| | 22-Sep-87 | 04:00 | 161.0 | 366.5 | 0.6 | 2.0 | 365.1 | 730.1 | 0.9 | 1.7 | 7.0 | 16.3 | 0.0 |
| | 22-Sep-87 | 06:30 | 163.5 | 364.2 | 0.5 | 2.5 | 365.4 | 913.4 | 0.6 | 1.4 | 7.0 | 20.4 | 0.0 |
| | 22-Sep-87 | 13:45 | 170.8 | 520.3 | 6.4 | 7.3 | 442.2 | 3206.1 | 3.4 | 25.0 | 7.0 | 71.6 | 0.6 |
| | 22-Sep-87 | 16:50 | 173.8 | 401.9 | 12.6 | 3.1 | 461.1 | 1421.6 | 9.5 | 29.3 | 7.0 | 31.7 | 0.7 |
| | 23-Sep-87 | 11:05 | 192.1 | 272.6 | 6.4 | 18.3 | 337.3 | 6154.8 | 9.5 | 173.8 | 7.0 | 137.4 | 3.9 |
| | 23-Sep-87 | 15:10 | 196.2 | 239.8 | 14.7 | 4.1 | 256.2 | 1046.1 | 10.5 | 43.0 | 7.0 | 23.4 | 1.0 |
| | 24-Sep-87 | 00:00 | 205.0 | 136.7 | 27.7 | 8.8 | 188.3 | 1663.0 | 21.2 | 187.3 | 7.0 | 37.1 | 4.2 |
| | 24-Sep-87 | 02:00 | 207.0 | 162.1 | 20.9 | 2.0 | 149.4 | 298.8 | 24.3 | 48.6 | 7.0 | 6.7 | 1.1 |
| | 24-Sep-87 | 04:00 | 209.0 | 147.9 | 16.6 | 2.0 | 155.0 | 310.0 | 18.7 | 37.4 | 7.0 | 6.9 | 0.8 |
| | 24-Sep-87 | 06:40 | 211.7 | 126.9 | 13.6 | 2.7 | 137.4 | 366.5 | 15.1 | 40.2 | 7.0 | 8.2 | 0.9 |
| | | | | | | | | | | TOTAL GRAMS ETOH: | | 1925.5 | 45.3 |
| | | | | | | | | | | OVERALL EFFICIENCY: | | | 97.6% |

TABLE

WHITE WINE II - EMISSION DATA FOR WATER SCRUBBER

| TANK | DATE | TIME | HOURS | ETOH IN (PPM) | ETOH OUT (PPM) | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | ETOH OUT PPM AVG | ETOH OUT PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) | MASS ETOH OUT (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 15-Sep-87 | 11:00 | 0.0 | | | | | | | | | | |
| | 17-Sep-87 | 09:45 | 46.8 | 1.3 | 0.0 | 46.8 | 0.6 | 30.2 | 0.0 | 0.0 | 7.3 | 0.7 | 0.0 |
| | 17-Sep-87 | 15:10 | 52.2 | 2.8 | 3.1 | 5.4 | 2.0 | 11.1 | 1.5 | 8.4 | 7.0 | 0.2 | 0.2 |
| | 17-Sep-87 | 19:45 | 56.8 | 0.0 | 0.8 | 4.6 | 1.4 | 6.4 | 1.9 | 8.9 | 7.0 | 0.1 | 0.2 |
| | 18-Sep-87 | 10:30 | 71.5 | 15.0 | 2.8 | 14.8 | 7.5 | 110.7 | 1.8 | 26.9 | 7.0 | 2.5 | 0.6 |
| | 18-Sep-87 | 22:00 | 83.0 | 64.9 | 1.3 | 11.5 | 40.0 | 459.4 | 2.1 | 23.8 | 7.0 | 10.3 | 0.5 |
| | 18-Sep-87 | 23:00 | 84.0 | 79.7 | 0.0 | 1.0 | 72.3 | 72.3 | 0.6 | 0.6 | 7.0 | 1.6 | 0.0 |
| | 19-Sep-87 | 16:15 | 101.3 | 448.0 | 3.5 | 17.3 | 263.9 | 4551.8 | 1.7 | 30.1 | 6.8 | 98.7 | 0.7 |
| | 20-Sep-87 | 16:20 | 125.3 | 2139.8 | 7.9 | 24.1 | 1293.9 | 31161.1 | 5.7 | 137.7 | 6.3 | 621.3 | 2.7 |
| | 21-Sep-87 | 08:30 | 141.5 | 437.9 | 5.2 | 16.2 | 1288.8 | 20835.8 | 6.6 | 106.4 | 7.5 | 498.5 | 2.5 |
| | 22-Sep-87 | 16:00 | 173.0 | 361.1 | 23.8 | 31.5 | 399.5 | 12583.7 | 14.5 | 457.8 | 7.0 | 281.0 | 10.2 |
| | 23-Sep-87 | 11:45 | 192.8 | 311.8 | 22.5 | 19.7 | 336.5 | 6645.0 | 23.2 | 457.6 | 7.0 | 148.4 | 10.2 |
| | 23-Sep-87 | 16:15 | 197.3 | 174.7 | 5.4 | 4.5 | 243.3 | 1094.7 | 14.0 | 62.8 | 7.0 | 24.4 | 1.4 |
| | | | | | | | | | TOTAL GRAMS ETOH: | | | 1687.8 | 29.3 |
| | | | | | | | | | OVERALL EFFICIENCY: | | | | 98.3% |

WHITE WINE II - NO CONTROLS

| TANK | DATE | TIME | HOURS | ETOH IN (PPM) | ETOH OUT (PPM) | TIME INTERVAL (HOURS) | ETOH IN PPM AVG | ETOH IN PPM-HOUR | FLOW (SCFM) | MASS ETOH IN (GRAMS) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 15-Sep-87 | 11:00 | 0.0 | | | | | | | |
| | 16-Sep-87 | 15:30 | 28.5 | 24.1 | 22.5 | 28.5 | 12.1 | 344.0 | 0.0 | 0.0 |
| | 16-Sep-87 | 19:45 | 32.8 | 0.7 | -0.4 | 4.3 | 12.4 | 52.7 | 0.0 | 0.0 |
| | 16-Sep-87 | 22:00 | 35.0 | 0.7 | 2.3 | 2.3 | 0.7 | 1.6 | 0.0 | 0.0 |
| | 17-Sep-87 | 00:00 | 37.0 | 0.5 | 2.0 | 2.0 | 0.6 | 1.2 | 0.0 | 0.0 |
| | 17-Sep-87 | 02:00 | 39.0 | 4.5 | 3.8 | 2.0 | 2.5 | 5.0 | 0.0 | 0.0 |
| | 17-Sep-87 | 04:00 | 41.0 | 4.5 | 3.2 | 2.0 | 4.5 | 9.0 | 0.0 | 0.0 |
| | 17-Sep-87 | 06:30 | 43.5 | 3.8 | 3.0 | 2.5 | 4.2 | 10.4 | 0.0 | 0.0 |
| | 17-Sep-87 | 11:00 | 48.0 | 4.1 | 3.4 | 4.5 | 3.9 | 17.7 | 0.0 | 0.0 |
| | 17-Sep-87 | 16:00 | 53.0 | 8.5 | 9.4 | 5.0 | 6.3 | 31.5 | 0.0 | 0.0 |
| | 17-Sep-87 | 22:00 | 59.0 | 11.5 | 11.5 | 6.0 | 10.0 | 60.2 | 0.0 | 0.0 |
| | 18-Sep-87 | 00:00 | 61.0 | 18.2 | 18.1 | 2.0 | 14.9 | 29.7 | 0.0 | 0.0 |
| | 18-Sep-87 | 02:00 | 63.0 | 27.2 | 27.2 | 2.0 | 22.7 | 45.4 | 0.0 | 0.0 |
| | 18-Sep-87 | 04:00 | 65.0 | 34.2 | 31.1 | 2.0 | 30.7 | 61.4 | 0.0 | 0.0 |
| | 18-Sep-87 | 06:45 | 67.8 | 35.0 | 30.6 | 2.8 | 34.6 | 95.1 | 0.0 | 0.0 |
| | 18-Sep-87 | 11:45 | 72.8 | 123.7 | 117.7 | 5.0 | 79.4 | 396.8 | 0.0 | 0.0 |
| | 20-Sep-87 | 18:40 | 127.7 | 5568.0 | 5564.5 | 54.9 | 2845.9 | 156285.7 | 1.4 | 678.0 |
| | 21-Sep-87 | 14:30 | 147.5 | 5126.0 | --- | 19.8 | 5347.0 | 106049.1 | 0.8 | 270.6 |
| | 22-Sep-87 | 08:30 | 165.5 | 4298.7 | 4573.3 | 18.0 | 4712.3 | 84822.0 | 0.8 | 216.5 |
| | 22-Sep-87 | 09:30 | 166.5 | 4934.4 | 5114.0 | 1.0 | 4616.5 | 4616.5 | 0.8 | 11.8 |
| | 22-Sep-87 | 18:30 | 175.5 | 5122.9 | 5123.3 | 9.0 | 5028.7 | 45258.0 | 0.8 | 115.5 |
| | 22-Sep-87 | 20:05 | 177.1 | 4626.0 | 4742.4 | 1.6 | 4874.5 | 7717.9 | 0.8 | 19.7 |
| | 22-Sep-87 | 22:00 | 179.0 | 4190.9 | 4025.6 | 1.9 | 4408.4 | 8449.5 | 0.8 | 21.6 |
| | 23-Sep-87 | 00:00 | 181.0 | 3958.7 | 4121.8 | 2.0 | 4074.8 | 8149.6 | 0.8 | 20.8 |
| | 23-Sep-87 | 02:00 | 183.0 | 4297.5 | 4560.5 | 2.0 | 4128.1 | 8256.3 | 0.8 | 21.1 |
| | 23-Sep-87 | 04:00 | 185.0 | 4260.1 | 4548.5 | 2.0 | 4278.8 | 8557.6 | 0.8 | 21.8 |
| | 23-Sep-87 | 06:45 | 187.8 | 4218.9 | 4501.1 | 2.8 | 4239.5 | 11658.5 | 0.8 | 29.8 |
| | 23-Sep-87 | 18:45 | 199.8 | 5020.3 | 5668.7 | 12.0 | 4619.6 | 55435.1 | 0.8 | 141.5 |
| | 24-Sep-87 | 09:15 | 214.3 | 1425.4 | --- | 14.5 | 3222.8 | 46731.2 | 0.8 | 119.3 |
| | | | | | | | | | TOTAL GRAMS ETOH: | 1687.9 |

C-87-041

APPENDIX D.

# Ethanol Emissions Control from Wine Fermentation Tanks Using Charcoal Adsorption

## *A Pilot Study*

**March 5, 1990**

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# SECTION II. EQUIPMENT

## *Fermentation*

The pilot plant installation where this work was performed is located at the CSU, Fresno enology facility. This fermentation line is provided with a bin dumper, a Demoisy Model D-8 crusher stemmer, and ancillary 3-inch diameter stainless steel must lines. Pomace pressing was performed on a Bucher RPL 18 press.

The fermentation line itself consists of four 1,412 gallon (shell volume) (1,467 nominal volume) jacketed, stainless steel fermentors (8 feet high x 5.5 feet diameter). The tanks are provided with manholes on the side at the bottom of the tank and on the conical top. In addition, each tank has a 6-inch diameter lidded hand hole on top. A 2-inch diameter vent is located at the center of the conical top. The tank shells are insulated with 3-inch thick polyurethane - aliphatic coating. Only tanks 1 and 2 were used for this experiment. Both tanks are provided with 2-inch diameter pumpover lines which extend to about 1-inch below the uppermost height of the tank shell. At this point, the pipe enters semi-tangentially into the tank to allow for as even a spray as possible. In addition, the pumpover lines are provided with a sight glass to allow for visual determination of pumpover rate and, when pumpover is not being conducted, with a means to indicate if a foamover occurs. This device permits must pumpover in what is essentially a "closed" system without the need to open either the manhole or hand hole.

Each tank is also provided with an anti-foam injector which consists of a silastic gland fitting located midway between the upper manhole and the tank vent. Each tank also has a sampling tap located 4 inches above the bottom manhole. Tank 1 was termed "reference" and tank 2 was termed "controlled." The vent of tank 1 was affixed to measuring devices to determine gas characteristics and flow. The vent of tank 2 was provided with a stainless steel capture hood which was piped to the emissions control device through 1-inch diameter piping as described below.

Cooling water (44 degrees Fahrenheit) for the tank jackets and condenser unit was provided by a 25-ton, chilled water refrigeration unit. Tank temperatures were thermostatically controlled by UE800 controllers in conjunction with Red Hat solenoid valves.

## *Emission Control*

Fermentation emissions were collected from fermentation tank 2 which is fitted with a cylindrical stainless steel capture hood provided with a slitted plastic skirt that extends to the top of the tank. The purpose of this skirt is to allow some air to be drawn into the control piping. Also, this slitted skirt acts as protection should a foamover occur.

The capture hood (See Fig. 1) is connected with 1-inch stainless steel square tubing to a foamover pot. A rotameter and valve are located at the exit of this vessel . From there the line goes into a tube-in-tube chiller cooled by 44 degrees Fahrenheit water. At the exit of this chiller there is a condensate collection vessel (300 mL volume). The purpose of this chiller and condensate trap is to remove as much water as possible before passing the gas stream through a charcoal adsorption bed. The gas stream is then pumped through appropriate piping and valving into either one of two charcoal adsorption beds enclosed in insulated 6-inch diameter x 3-foot stainless steel cylinders. After passage through the charcoal bed the stream is ducted into the atmosphere (See Fig. 2).

Each charcoal adsorption bed is also connected to a source of dry, filtered steam for purposes of regeneration. In normal operation, one bed is adsorbing volatiles while the other bed is either in the process of being regenerated or is idle.

Adsorbed volatiles freed from the charcoal upon steam regeneration are condensed into a stainless steel reservoir cooled by chilled water at 44 degrees Fahrenheit. The vent from this system is provided with an additional condenser in order to prevent the escape of volatiles into the atmosphere.

**Capture Hood**

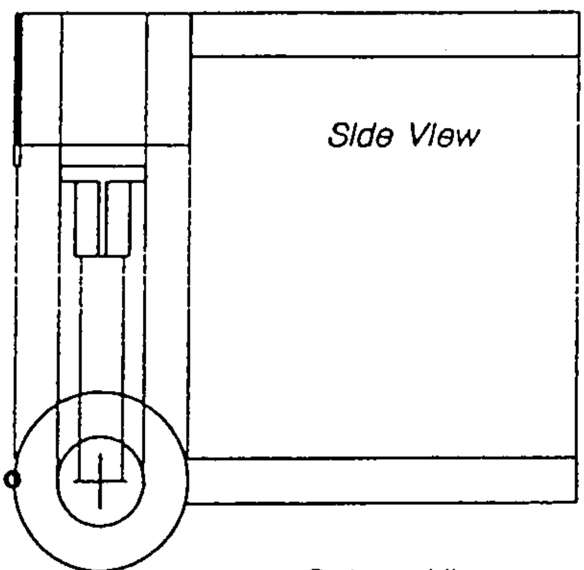


**Figure 1**

## *Instrumentation*

The instruments for determining ethanol concentrations and gas flows out of the fermentation tanks and through the charcoal adsorption unit are listed in Table 1. The specifics of the instrumentation are noted below.

**Table 1. Summary of Sampling and Analytical Methods**

| Control to be Analyzed | Sampling Method | Analytical Method or Detection Principle |
|---|---|---|
| Ethanol | Continuous Analyzer | FID |
| Gas Flows | Rotameter | Balanced Forces |
| Gas Volume | Positive Displacement | Positive Displacement |
| Gas Volume | Gas Test Meter | Expansion of Diaphragms |

1. Ethanol Concentrations

Ethanol concentrations were measured with Beckman 400 flame ionization detectors (FID). The sensor is a burner. A regulated flow of sample gas passes through a flame sustained by regulated flows of zero air and hydrogen (fuel gas). Hydrocarbon compounds, such as ethanol, contained in the sample gas undergo a complex ionization producing electrons and positive ions. Polarized electrodes collect these ions, causing current to flow through electronic measuring circuitry. Current flow is proportional to the rate at which carbon atoms enter the burner.

An FID does not respond to carbon dioxide ($C0_2$) or water vapor which is present in the fermentation gas stream with the ethanol. An FID will respond to other hydrocarbons in the gas stream, but previous studies indicated that the concentrations of other hydrocarbons in the gas stream are insignificant relative to the concentration of ethanol.

2. Gas Flow and Volume Measurement

a. Rotameters
Rotameters measure fluid flow. They are variable-area, constant-head, rate-of-flow meters. As fluid flows upward through a tapered tube, a shaped weight within the tapered tube is lifted upward until the upward fluid force balances its weight.

b. Positive Displacement Meter
Positive displacement meters measure total gas volume. Two figure-8 shaped (two-lobed) impellers counter-rotate within a rigid casing. Gas enters and exhausts on opposite sides of the casing. The impellers are accurately produced so that a continuous seal without contact is formed at all positions during rotation. As a result the impellers rotate with very little pressure and the gas on the inlet side is effec-

tively isolated from the outlet. In rotating, an impeller traps a known specific volume of gas between its lobes and the adjacent semi-circular portion of the meter casing. Rotation of the impellers is measured by a magnetically coupled counter.

c. Test Meter
The test meter measures total volume. Gas enters one half of a double-diaphragm contained in a molded port and pan. Expansion of the diaphragm causes the metering unit to move. When one diaphragm is fully expanded, then it begins to deflate and the other diaphragm begins to expand. Expansion of the second diaphragm causes the metering unit to continue to move.

# SECTION III. METHODS

## *Fermentations*

Four fermentations were carried out in this study as follows:

(1) Red I - Carignane grapes from CSU, Fresno vineyard, 918 gallons per tank (65 percent fill); 80 degrees Fahrenheit nominal fermentation temperature. Started 12:00 noon September 2, 1988. (Results for Red I are not presented in this report due to problems in measuring the volume of gas vented from the reference tank and collecting the ethanol captured by the charcoal adsorption unit.)

(2) Red II - Carignane grapes from CSU, Fresno vineyards, 918 gallons per tank (65 percent fill); 80 degrees Fahrenheit nominal fermentation temperature. Started 12:00 noon September 7, 1988.

(3) White I - Clarified French Colombard juice (provided by Gallo Winery) (2 percent solids), 918 gallons per tank (65 percent fill); 80 degrees Fahrenheit nominal fermentation temperature. This wine was fermented as a red. Started 12:00 noon September 14, 1988.

(4) White II - Clarified juice as above, 1130 gallons per tank (80 percent fill); 55 degrees Fahrenheit nominal fermentation temperature. Started 12:00 noon September 19, 1988.

Saccharomyces cereviseae var. Montrachet yeast was used. Zero time for each experiment (fermentation) was inoculation time. Both "reference" and "controlled" tanks were filled simultaneously. Fermentation progress was followed by measuring Balling and alcohol content (v/v by GC) at 8-hour intervals. For purposes of this study, the fermentations were considered complete when the Balling reached 2 degrees. Fermentation progress in each case may be seen in Figures 3, 4, and 5.

a. Gaseous Emissions

Sampling for ethanol in the fermentation tanks exhausts was performed in accordance with California Air Resources Board stationary source sampling method, "Method 100 - Procedures for Continuous Emission Stack Sampling." This test method is used for determining gaseous emissions from stationary sources.

For this particular study three gaseous hydrocarbon sampling instruments were available to sample the inlet and outlet of the charcoal control unit and the vent of the reference tank simultaneously. Total hydrocarbon concentration (mostly ethanol) was measured by an analyzer equipped with a flame ionization detector (FID). The gas samples were drawn through separate Teflon sampling lines by three sampling pumps and exhausted into the analyzers. Data from the three instruments were recorded on strip charts and a computer data acquisition system. The analyzers were calibrated at the ARB Sacramento facilities before the emissions test, and in the field before, during, and after each fermentation.

b. Flows

Flow rates into the control unit and analyzers were measured with rotameters. The analyzers and the control device required specific constant flows for optimum performance. The rotameters, at a glance, were able to indicate if the flows were correct. Any flow adjustment could be made quickly with the rotameters. The fermentation period was timed so total flows could be calculated.

A test gas meter and positive displacement meter measured total volume at a variety of flow rates. The test gas meter measured the gas from the reference tank to the analyzers. The positive displacement meter measured the amount of gas from the reference tank in excess of that needed by the sampling instruments. At the beginning and end of each fermentation, gas production from the reference tank was less than that required for the instruments. At those times the positive displacement meter was reversed to measure the dilution air going to the instruments.

Flow volumes out of the reference tank and flow rates through the control unit were periodically recorded during each fermentation.

## SECTION IV. RESULTS

### *Fermentations*

As mentioned above, all fermentations were considered complete for the purposes of this experiment when the Balling decreased to or below 2 degrees. Figures 3, 4, and 5 show progress for each fermentation. All fermentations were typical as shown by the decrease in Balling and the concomitant increase in alcohol content.

Since White Wine I was fermented as a red (80 degrees Fahrenheit), its fermentation curve is accelerated as compared to that of White Wine II which was fermented at 55 degrees Fahrenheit in the traditional manner.

## *Emissions*

For each fermentation, ethanol emissions from both tanks and the charcoal adsorption unit are shown graphically in Figures 7 through 12. The figures for the reference tank (tank 1) show the ethanol concentrations in parts per million (ppm) for the different periods of time plus the cumulative ethanol emission in pounds. The figures for the controlled tank (tank 2) show ethanol concentrations in ppm into and out of the control unit and the cumulative ethanol emission in pounds into and out of the control unit. The controlled tank shows lower ethanol concentrations than the reference tank because dilution air is being drawn into the charcoal adsorption unit in order to maintain 7 cubic feet per minute flow through the unit.

The total mass emissions, in pounds of ethanol from both fermentation tanks for each fermentation are shown on Table 2 below. The range is between 1.60 and 4.14 pounds of ethanol.

Table 2. Ethanol Emissions (Uncontrolled)

| Fermentation | 1<br>Reference Tank, lbs. of Ethanol | 2<br>Controlled Tank, 1/ lbs. of Ethanol |
|---|---|---|
| 1. Red II | 3.93 | 4.14 |
| 2. White I | 3.56 | 3.04 |
| 3. White II | 1.75 | 1.60 |

1/ Emissions from controlled tank to charcoal adsorption unit.

Table 3 below shows the total ethanol emissions into and out of the charcoal adsorption unit during each fermentation. This table also shows the control adsorption unit during each fermentation. As indicated, the control efficiency of the charcoal unit was better than 98 percent for the three fermentations.

**Table 3. Control Efficiency of Ethanol Control Unit (Charcoal Adsorption)**

| Fermentation | Ethanol In, lbs. | Ethanol Out, lbs. | Control Efficiency, 1/ % | Ethanol Collected 2/ from Control Unit lbs. | |
|---|---|---|---|---|---|
| 1. Red II | 4.14 | 0.0653 | 98.4 | 4.76 | 918 gal |
| 2. White I | 3.04 | 0.00421 | 99.9 | 2.96 | 713 gal |
| 3. White II | 1.60 | 0.0311 | 98.1 | 1.89 | 1130 gal |

1/ Efficiency = [(In-Out)/In] • 100
2/ Ethanol collected is ethanol recovered from the charcoal adsorption unit.

APPENDIX E.

Rb 9

# 1990 DEMONSTRATION PROGRAM
# ETHANOL EMISSIONS CONTROL
# FROM
# WINE FERMENTATION TANKS
# UTILIZING CARBON ADSORPTION TECHNOLOGY

Issued: June 24, 1991

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UNIFIED A.P.C.D.
NO. REGION

By: Akton Associates
737 Arnold Drive
Martinez, California

200 pounds per hour at initial steam pressures of 10 to 14 psig measured at the boiler. Outlet bed temperatures of greater than 230°F were obtained during "normal" regeneration cycles.

Condensed regeneration steam (condensate), including recovered ethanol, was collected, measured and analyzed for ethanol content prior to disposal.

Operation of the system was continuously monitored and all pertinent operations were logged at least once per hour. Logged data for all eight fermentation cycles are shown in the "Field Data" section. The duties of the emission test operators are attached as Appendix 2.

Both inlet and outlet ethanol concentrations were monitored by CARB personnel during runs 6, 7 & 8. Chart data for these tests are attached as Appendix 4.

## FERMENTATION CYCLES

A total of eight fermentation cycles were conducted between August 29 and September 28, 1990. Fermentation cycles 1, 2 and 8 were conducted with clarified juice at fermentation temperature of approximately 58°F. Initial Ballings (% sugar w/w) were approximately 20° and final alcohol contents were approximately 12 %. Tank fill was a nominal 170,000 gallons.

The remaining fermentation cycles 3 through 7, were red fermentations at nominal fermentation temperatures of 73°F. Initial Ballings were approximately 23°, and final alcohol contents varied from 8.6 to 10.2 % before transfer to other tanks.

All fermentation practices utilized were normal E. & J. Gallo Winery operating procedures. Exhibits 1 through 8 show relationships between time, sugar content, alcohol content and fermentation temperature for each cycle.

All sampling procedures, analysis and record keeping were conducted by E. & J. Gallo Winery personnel in accordance with normal winery operation, and as required by appropriate governmental agencies.

RESULTS OF FERMENTATIONS

Combined average results of fermentation conditions and quantities and composition of carbon regeneration condensate are shown in Tables 1 and 2.

A carbon activity analysis was conducted on a composite sample of carbon removed from the carbon beds after the final regeneration of the carbon at the conclusion of the tests. The reported "slight loss of activity" was judged by the equipment manufacturer to be typical for carbon which has been in service. A report of these tests is included as Appendix 3.

Results of "wipe tests" on inside surfaces of ducting to judge sanitation conditions were negative. Minimal carryover of foam or juice from the tank was noted. Significant discoloring of the hood was noted. No significant foam-over was detected during the program. It was reported that on one occasion, carryover required more extensive cleaning than simply wiping the duct interior. This was not thought to be significant enough to require recording, and the cleaning was completed by operating personnel.

Pressure drop through the carbon beds, (fan discharge to carbon bed outlet), remained constant at approximately 12.0 inches water column at low $CO_2$ concentrations. Internal fermentation tank pressures of 0.025 inches water column were measured at maximum red fermentation rates and with the adsorption system in normal operation.

The calculated amount of fuel required for the boiler during a normal red wine fermentation cycle requiring an average of 14 regenerations was 6.4 million BTU. Cooling water volume was not measured, but cooling must be supplied at a rate of 25,000 BTU per hour to condense regeneration steam and alcohol.

1990 DEMONSTRATION PROGRAM
FERMENTATION CONDITIONS
TABLE 1

| No. | Fermentation Type | Fermentation Date | Volume Fermented (Gallons) | Total Hours | Avg. Temp. (°F) | Initial Balling | Final Balling | Final Alcohol (% v/v) |
|---|---|---|---|---|---|---|---|---|
| 1 | White | 8/29-9/3 | 172,000 | 164 | 59 | 20.0 | ≤0.2* | 12.0 |
| 2 | White | 9/5-9/11 | 170,000 | 148 | 56 | 20.0 | ≤0.1* | 12.0 |
| 3 | Red | 9/12-9/13 | 164,000 | 32 | 72 | 23.2 | 6.5 | 9.5 |
| 4 | Red | 9/14-9/15 | 164,000 | 28 | 74 | 23.0 | 6.2 | 9.3 |
| 5 | Red | 9/16-9/17 | 164,000 | 32 | 73 | 23.0 | 5.0 | 9.6 |
| 6 | Red | 9/18-9/19 | 160,000 | 36 | 73 | 22.8 | 7.0 | 8.9 |
| 7 | Red | 9/20-9/22 | 160,000 | 48 | 74 | 22.6 | 4.6 | 10.2 |
| 8 | White | 9/23-9/28 | 170,000 | 128 | 57 | 21.6 | ≤0.7* | 11.7 |

* Residual Sugar
Note: Fermentation Tank 30'-0" ϕ X 207,000 gallons

1990 DEMONSTRATION PROGRAM
CONDENSATE QUANTITIES AND ANALYSIS
TABLE 2

| Fermentation Number | Condensate Collected (Gallons) | Alcohol Content (% v/v) | Alcohol (Pounds) | Pounds Alcohol Per 1000 Gals. Fermented |
|---|---|---|---|---|
| 1 | 383 | 9.45 | 238.3 | 1.39(a) |
| 2 | 775 | 7.75 | 395.5 | 2.33 |
| 3 | 275 | 25.45 | 460.8 | 2.80 |
| 4 | 220 | 24.55 | 355.6 | 2.16(b) |
| 5 | 325 | 21.85 | 467.6 | 2.85(b) |
| 6 | 352 | 21.85 | 506.4 | 3.17 |
| 7 | 454 | 21.30 | 636.7 | 3.98 |
| 8 | 339 | 12.50 | 279.0 | 1.64 |

(a) Programming and fan problems resulted in significant unit down-time
(b) Wet carbon beds noted

DISCUSSION OF OPERATIONS

Several major operational problems were encountered during the program. While all were corrected without disturbing the normal fermentation cycle, significant down-time was experienced and, therefore, the overall capture of emitted alcohol was reduced. Since only one fermentation tank was connected to the system, the quantity of ethanol not captured would be variable with the type of wine fermenting and the point in the fermentation cycle. Operational problems included:

1) Excessive fan vibration resulting from failed bearing and distorted shaft. Unit was shut-down and parts replaced.

2) Shut-down of analyzer system on several occasions due to:

   a) loss of fuel

   b) loss of ignition

c) moisture in inlet line

d) sample pump failure

Adsorption unit was bypassed in all cases and analyzer system problems corrected. Time loss was variable from 30 minutes to three hours on each occasion.

3) Initial programming problems of regeneration cycle controller resulted in delayed start-up of unit during initial fermentation cycle.

4) Plugging of condensate withdrawal lines resulting in incomplete regeneration cycles during fermentation cycles 4 and 5. Carbon fines migrated through support screens and plugged drain piping, resulting in an inability to achieve desired regeneration cycles. The unit was shut down and lines cleared. This problem, which was assumed to be a result of new carbon, resulted in both lost unit availability during repair and inefficient operation during period before repair.

Minor operational difficulties were also encountered, but resulted in minimal disruption of unit availability. These include:

Failure of pressure gauges

Adjustment of rental boiler steam pressure controls

Carbon Efficiency - Calculations based on average carbon adsorber outlet gas ethanol concentrations and total amounts of alcohol condensed indicate that alcohol removal efficiencies of greater than 98% were achieved for red wine fermentation cycles 6 and 7 and greater than 97% for white wine fermentation 8. Comparison of inlet versus outlet VOC concentrations as measured by CARB staff confirms that these results were achieved on an overall basis. Analyzer data for three fermentation runs, included herein as Appendix 4, confirms the overall efficiencies noted above. It should be noted that these efficiencies are for the carbon adsorber units only, and do not reflect overall system capture and abatement efficiency. As addressed above, total capture may have been less than 90% during short periods of red wine fermentation.

Overall Efficiency - Overall efficiency is also effected by pumpover and sampling practice. The fermentation tank utilized had facilities which allowed both sampling and pumpover without requiring the removal of tank top opening covers. Capture of gases evolved from the tank during fermentation was, therefore, primarily limited by hood capture efficiency and system flow rate capacity.

Ethanol to Carbon Ratios - The amount of ethanol adsorbed per pound of carbon for each regeneration cycle was within the normally expected range of alcohol concentrations and bed temperatures experienced. Calculated averages were 0.052 pounds ethanol per pound of carbon for red wines and 0.025 pounds per pound of carbon for white wine.

Ethanol Content of Condensate - Condensate ethanol concentrations of 21 to 25% (v/v) for red wine fermentations and 8 to 12% for white wine were observed. These values are

WINE III, FERMENTATION 6

| Date | Time | THC, ppm C3 In | Out | Recovery, percent |
|---|---|---|---|---|
| | 1030 | 1300 | 22 | 98.3 |
| | 1100 | 1350 | 23 | 98.3 |
| | 1130 | 1300 | 12 | 99.1 |
| | 1200 | 1800 | 14 | 99.2 |
| | 1230 | 1950 | 20 | 99.0 |
| | 1300 | 1850 | 22 | 98.8 |
| | 1330 | 1800 | 15 | 99.2 |
| | 1400 | 1900 | 16 | 99.2 |
| | 1430 | 2050 | 21 | 99.0 |
| | 1500 | 2100 | 14 | 99.3 |
| | 1530 | 1750 | 13 | 99.3 |
| | 1600 | 1800 | 15 | 99.2 |
| | 1630 | 1650 | 14 | 99.2 |
| | 1700 | 1550 | 11 | 99.3 |
| | 1730 | 1500 | 12 | 99.2 |
| | 1800 | 1500 | 14.5 | 99.0 |
| | 1830 | 1450 | 11 | 99.2 |
| | 1900 | 1400 | 11 | 99.2 |
| | 1930 | 1450 | 12 | 99.2 |
| | 2000 | 1450 | 15 | 99.0 |
| | 2030 | 1500 | 13 | 99.1 |
| | 2100 | 1500 | 11 | 99.3 |
| | 2130 | 1500 | 11 | 99.3 |
| | 2200 | 1550 | 13 | 99.2 |
| | 2230 | 1550 | 10 | 99.4 |
| | 2300 | 1600 | 11 | 99.3 |
| | 2330 | 1650 | 9 | 99.5 |
| 9/20/90 | 2400 | 1700 | 9 | 99.5 |
| | 0030 | 1800 | 9 | 99.5 |
| | 0100 | 1800 | 8 | 99.6 |
| | 0130 | 1800 | 7 | 99.6 |
| | 0200 | 1800 | 7 | 99.6 |
| | 0230 | 750 | 7.5 | 99.0 |
| | 0300 | 1800 | 8 | 99.6 |
| | 0330 | 1800 | 7 | 99.6 |
| END | 0400 | 1650 | 6.5 | 99.6 |
| AVERAGES | | 1093 | 12 | 97.0 |
| (Ferm. only) | | Overall | Eff. => | 98.9 |
| Emptying Tank | 0430 | 1150 | 6.5 | 99.4 |
| | 0500 | 800 | 6 | 99.3 |
| | 0530 | 700 | 6 | 99.1 |
| | 0600 | 600 | 5.5 | 99.1 |

WINE III, FERMENTATION 7

| Date | Time | THC, ppm C3 In | THC, ppm C3 Out | Recovery, percent |
|---|---|---|---|---|
| | 1200 | 1400 | 14 | 99.0 |
| | 1230 | 1350 | 18 | 98.7 |
| | 1300 | 1300 | 12 | 99.1 |
| | 1330 | 1250 | 8 | 99.4 |
| | 1400 | 1200 | 11 | 99.1 |
| | 1430 | 1250 | 13 | 99.0 |
| | 1500 | 1350 | 10 | 99.3 |
| | 1530 | 1400 | 9 | 99.4 |
| | 1600 | 1450 | 12 | 99.2 |
| | 1630 | 1450 | 14 | 99.0 |
| | 1700 | 1450 | 10 | 99.3 |
| | 1730 | 1425 | 13 | 99.1 |
| | 1800 | 1500 | 18 | 98.8 |
| | 1830 | 1500 | 11 | 99.3 |
| | 1900 | 1500 | 11 | 99.3 |
| | 1930 | 1550 | 18 | 98.8 |
| | 2000 | 1500 | 14 | 99.1 |
| | 2030 | 1350 | 6 | 99.6 |
| | 2100 | 1300 | 14 | 98.9 |
| | 2130 | 1350 | 19 | 98.6 |
| | 2200 | 1350 | 8 | 99.4 |
| | 2230 | 1325 | 8 | 99.4 |
| | 2300 | 1400 | 13 | 99.1 |
| | 2330 | 1500 | 22 | 98.5 |
| 9/22/90 | 2400 | 1550 | 11 | 99.3 |
| | 0030 | 1450 | 10 | 99.3 |
| | 0100 | 1450 | 19 | 98.7 |
| | 0130 | 1450 | 22 | 98.5 |
| | 0200 | 1450 | 8 | 99.4 |
| | 0230 | 1450 | 10 | 99.3 |
| | 0300 | 1525 | 14 | 99.1 |
| | 0330 | 1550 | 23 | 98.5 |
| | 0400 | 1550 | 11 | 99.3 |
| | 0430 | 1475 | 13 | 99.1 |
| | 0500 | 1350 | 27 | 98.0 |
| | 0530 | 1425 | 20 | 98.6 |
| | 0600 | 1500 | 9 | 99.4 |
| | 0630 | 1450 | 14 | 99.0 |
| | 0700 | 1500 | 19 | 98.7 |
| | 0730 | 1500 | 23 | 98.5 |
| | 0800 | 1575 | 23 | 98.5 |
| | 0830 | 1000 | 18 | 98.2 |
| | 0900 | 850 | 29 | 96.6 |
| | 0930 | 800 | 22 | 97.3 |
| | 1000 | 550 | 8 | 98.5 |
| | 1030 | 400 | 10 | 97.5 |
| | 1100 | 350 | 10 | 97.1 |
| End | 1130 | 250 | 13 | 94.8 |
| AVERAGES | | 960 | 13 | 97.2 |
| | | Overall | Eff. => | 98.6 |

WINE III, FERMENTATION 8

| Date | Time | THC, ppm C3 In | Out | Recovery, percent |
|---|---|---|---|---|
| | 0700 | 310 | 11 | 96.5 |
| | 0800 | 280 | 19 | 93.2 |
| | 0900 | 290 | 6 | 97.9 |
| | 1000 | 290 | 4 | 98.6 |
| | 1100 | 300 | 5 | 98.3 |
| | 1200 | 330 | 13 | 96.1 |
| | 1300 | 320 | 20 | 93.8 |
| | 1400 | 300 | 34 | 88.7 |
| | 1500 | 280 | 4 | 98.6 |
| | 1600 | 270 | 6 | 97.8 |
| | 1700 | 260 | 27 | 89.6 |
| | 1800 | 270 | 3 | 98.9 |
| | 1900 | 260 | 4 | 98.5 |
| | 2000 | 270 | 9 | 96.7 |
| | 2100 | | 19 | |
| | 2200 | | 29 | |
| | 2300 | | 42 | |
| 9/28/90 | 2400 | | 59 | |
| | 0100 | | 1 | |
| | 0200 | | 2 | |
| | 0300 | | 5 | |
| | 0400 | | 8 | |
| | 0500 | | 14 | |
| | 0600 | | | |
| | 0700 | | | |
| | 0800 | 280 | 65 | 76.8 |
| | 0900 | 290 | 2 | 99.3 |
| | 1000 | 290 | 4 | 98.6 |
| | 1100 | 340 | 5 | 98.5 |
| | 1200 | 350 | | 100.0 |
| | 1300 | 360 | 37 | 89.7 |
| | 1400 | 320 | 27 | 91.6 |
| AVERAGES | | 213 | 16 | 88.0 |
| | | Overall Eff. => | | 92.5 |

# APPENDIX F.

E. & J. GALLO WINERY

*Modesto, California*

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San Joaquin Valley Unified
Air Pollution Control District

December 14, 1992

Maria Lima
S.J.U.V.A.P.C.D.
1999 Tuolumne Street
Fresno, CA 93721

Dear Ms. Lima:

Enclosed is the protocol for, and results of, the full scale fermentation emission tests conducted at E. & J. Gallo's Fresno Winery. As the attached documentation shows, these tests were devised in conjunction with the staff of the California Air Resources Board, and monitored by members of the staff. The primary purpose was to develop emission factors for ethanol during fermentation. This could be done very accurately since all of the emissions during each of eight fermentations were trapped on granular activated carbon, then steamed off and condensed. The volume of the condensate was measured in each case, and a comprehensive chemical analysis performed by gas chromatography. Although the chief objective was to obtain an accurate measurement of ethanol content, other constituents, including acetaldehyde, were also quantitated. This provided the basis for our estimate of total acetaldehyde emissions. The average acetaldehyde emitted during the red and white fermentations was calculated in pounds per thousand gallons and then applied to the total amount of wine fermented that year in each category.

Copies of the analytical data sheets, the volume of condensate for each test fermentation, the calculations of the average acetaldehyde content for the red and white fermentations, and (as confidential information) the total gallons of red and white wine fermented that year are included.

These should give the background on the whole ethanol emission measurement history, and the information taken from those experiments which were used to quantitate the acetaldehyde emissions and to give a rough estimate of the $H_2S$ levels based on frequent sampling using Dräger tubes. (We realize that Dräger

- continued -

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December 14, 1992

tubes are not sanctioned for official measurement, but we were able to take measurements throughout a fermentation cycle to get an idea of the amounts emitted and if those emissions varied within the duration of the fermentation. As the results showed, $H_2S$ quantities varied tremendously; some fermentations had none, and those which tested positive did not show a consistent pattern of emission.

Sincerely,

Arthur Caputo, Jr.

Arthur Caputi Jr.

ACJ:el

In accordance with our proposed inventory plan for the Emission Inventory Criteria and Guidelines Regulation for the Administration of the Air Toxics "Hot Spots" Information and Assessment Act of 1987, Gallo formulated a source test to determine the amount of acetaldehyde emitted from our fermenters. During the fermentation, condensate was collected and the acetaldehyde concentration was determined by gas chromatography. The following calculations were used to determine the total amount of acetaldehyde emitted from the fermentations during our 1990 crushing season.

## <u>Acetaldehyde Calculations</u>

(Modesto Lab Results)

**Fermentation #1**
(White)
(170,016 gals)

383 gal. condensate x 3.78 L = 1,447.7 L
22 mg/L x 1,447.7 = 31,849.4 mg = 31.8 g
31.8g ÷ 453.5 g/lb = 0.07 lb
0.07 lb ÷ 170.0 = <u>0.00041 lb/1000 gals.</u>

**Fermentation #2**
(White)
(172,322 gals)

484 gal. condensate (fraction #1) x 3.78 L = 1,829.5 L
20 mg/L x 1,829.5 = 36,590 mg = 36.6 g
36.6 g ÷ 453.5 g/lb = 0.08 lb

291 gal. condensate (fraction #2) x 3.78 L = 1,100 L
23 mg/L x 1,100 = 25300 mg = 25.3 g
25.3 g ÷ 453.5 g/lb = 0.06 lb

0.08 lb + 0.06 lb = 0.14 lb
0.14 lb ÷ 172.3 = <u>0.00081 lb/1000 gals.</u>

**Fermentation #3**
(Red)
(157,120 gals)

275 gal. condensate x 3.78 L = 1,039.5 L
84 mg/L x 1,039.5 = 87,318 mg = 87.3 g
87.3 g ÷ 453.5 g/lb = 0.19 lb
0.19 lb ÷ 157.1 = <u>0.0012 lb/1000 gals.</u>

**Fermentation #4**
(Red)
(152,740 gals)

220 gal. condensate x 3.78 = 831.6 L
87 mg/L x 831.6 L = 72,349 mg = 72.3 g
72.3 g ÷ 453.5 g/lb = 0.16 lb
0.16 lb ÷ 152.7 = <u>0.001 lb/1000 gals.</u>

**Fermentation #5**
(Red)
(145,280 gals)

325 gal. condensate x 3.78 = 1,228.5 L
114 mg/L x 1,228.5 L = 140,009 mg = 140.0g
140.0 g + 453.5 g/lb = 0.31 lb
0.31 lb + 145.3 = <u>0.0021 lb/1000 gals.</u>

**Fermentation #6**
(Red)
(146,145 gals)

352 gal. condensate x 3.78 = 1,330.6 L
169 mg/L x 1,330.6 = 224,871.4 mg = 224.9g
224.9 g + 453.5 g/lb = 0.50 lb
0.50 lb + 146.1 = <u>0.0034 lb/1000 gals.</u>

**Fermentation #7**
(Red)
(144,475 gals)

454 gal. condensate x 3.78 = 1,716 L
226 mg/L x 1,716.1 = 387,838.6 mg = 387.8g
387.8 g + 453.5 g/lb = 0.86 lb
0.86 lb + 144.5 = <u>0.0060 lb/1000 gals.</u>

**Fermentation #8**
(White)
(169,028 gals)

339 gal. condensate x 3.78 = 1,281.4 L
58 mg/L x 1,281.4 = 74,321.2 mg = 74.3 g
74.3 g + 453.5 g/lb = 0.16 lb
0.16 lb + 169.0 = <u>0.0009 lb/1000 gals.</u>

<u>Average lb acetaldehyde (white)</u> = 0.00041 + 0.00081 + 0.0009 + 3
= 0.00071 lb/1000 gals

<u>Average lb acetaldehyde (red)</u> = 0.0012 + 0.001 + 0.0021 + 0.0034 + 0.0060 + 5
= 0.00274 lb/1000 gals

A. CAPUTI-RES

ID: RES TANK: ART 5100=60=0358 EXP. RUN #1

173 REQ 07Sep90 1120 DRAW 04Sep90 0000 C B

Fermentation #1

| | | | | |
|---|---|---|---|---|
| [redacted] | 22 [redacted] | MG/L | acetal | |
| ALC | 11.75 | VOL % | | |
| ALD | 40. | MG/L | | |
| FO | 281. | MG/L | | |
| FS02 | 5. | MG/L | free $SO_2$ | |
| ISOA | 149. | MG/L | isoamyl alc. | |
| ISO3 | 23. | MG/L | isobutyl " | |
| MEOH | 47. | MG/L | | |
| NBUT | UND | MG/L | n-butanol | UNDETECTABLE |
| NPRO | 87. | MG/L | n-propyl alc. | |
| PH | 3.56 | | | |
| RSLC | 0.04 | GM/100ML | reducing sugar, by liq. chrom. | |
| SECB | UND | MG/L | sec-butanol | UNDETECTABLE |
| TA | 0.64 | G/100ML | total acids | |
| TS02 | 65. | MG/L | total $SO_2$ | |
| VA | 0.023 | G/100ML | volatile acid | |

10-10-90 07:17 AM RESEARCH SUMMARY

ID: RES TANK: AC 0000=00=0000

9798 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #7

| | | | |
|---|---|---|---|
| ACTA | 226. | MG/L | acetal |
| ALC | 21.35 | VOL % | EtOH |
| ALD | 170. | MG/L | aldehyde |
| FO | 1558. | MG/L | fusel oil |
| ISOA | 1010. | MG/L | |
| ISOB | 217. | MG/L | |
| MEOH | 88. | MG/L | |
| NBUT | 2. | MG/L | |
| NPRO | 100. | MG/L | |
| SECB | 2. | MG/L | |
| VA | 0.019 | G/100ML | |

9799 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #5

| | | | |
|---|---|---|---|
| ACTA | 114. | MG/L | |
| ALC | 21.95 | VOL % | |
| ALD | 260. | MG/L | |
| FO | 1082. | MG/L | |
| ISOA | 631. | MG/L | |
| ISOB | 193. | MG/L | |
| MEOH | 119. | MG/L | |
| NBUT | 2. | MG/L | |
| NPRO | 140. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.009 | G/100ML | |

ACC 9800 REQ 09Oct90 1527 DRAW 09Oct90 0000 C B RUN #6

| | | | |
|---|---|---|---|
| ACTA | 169. | MG/L | |
| ALC | 21.80 | VOL % | |
| ALD | 180. | MG/L | |
| FO | 1298. | MG/L | |
| ISOA | 793. | MG/L | |
| ISOB | 217. | MG/L | |
| MEOH | 109. | MG/L | |
| NBUT | 2. | MG/L | |
| NPRO | 114. | MG/L | |
| SECB | 3. | MG/L | |
| VA | 0.011 | G/100ML | |

ACC 9801 REQ 09Oct90 1527 DRAW 09Oct90 0000 C B [redacted]

fermentation #2A

| | | | |
|---|---|---|---|
| [redacted] | 20 [redacted] | MG/L | |
| ALC | 7.10 | VOL % | |
| ALD | 105. | MG/L | |
| FO | 259. | MG/L | |
| ISOA | 143. | MG/L | |
| ISOB | 22. | MG/L | |
| MEOH | 22. | MG/L | |
| NBUT | UND | MG/L | UNDETECTABLE |
| NPRO | 74. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.013 | G/100ML | |

10-10-90 07:17 AM RESEARCH SUMMARY

CC: A CAPUTI-RES CC: A. CAPUTI-RES

L ID: RES TANK: AC 0000=00=0000

ACC 9795 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 [redacted]

fermentation #2 B

| | | |
|---|---|---|
| [redacted] | 23 [redacted] | MG/L |
| ALC | 9.15 | VOL % |
| ALD | 55. | MG/L |
| FO | 324. | MG/L |
| ISOA | 189. | MG/L |
| ISOB | 23. | MG/L |
| MEOH | 19. | MG/L |
| NBUT | UND | MG/L UNDETECTABLE |
| NPRO | 89. | MG/L |
| SECB | UND | MG/L UNDETECTABLE |
| VA | 0.006 | G/100ML |

ACC 9796 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 RUN #3

| | | |
|---|---|---|
| ACTA | 84. | MG/L |
| ALC | 25.05 | VOL % |
| ALD | 745. | MG/L |
| FO | 1212. | MG/L |
| ISOA | 632. | MG/L |
| ISOB | 152. | MG/L |
| MEOH | 230. | MG/L |
| NBUT | 5. | MG/L |
| NPRO | 338. | MG/L |
| SECB | UND | MG/L UNDETECTABLE |
| VA | 0.010 | G/100ML |

ACC 9797 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 RUN #4

| | | |
|---|---|---|
| ACTA | 87. | MG/L |
| ALC | 24.60 | VOL % |
| ALD | 550. | MG/L |
| FO | 1299. | MG/L |
| ISOA | 671. | MG/L |
| ISOB | 165. | MG/L |
| MEOH | 199. | MG/L |
| NBUT | 6. | MG/L |
| NPRO | 369. | MG/L |
| SECB | 2. | MG/L |
| VA | 0.011 | G/100ML |

10-10-90 07:17 AM RESEARCH SUMMARY

A. CAPUTI-RES CC: A. CAPUTI-RES

ID: RES TANK: AC 0000=00=0000

9795 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 RUN #28

| | | | |
|---|---|---|---|
| ACTA | 23. | MG/L | |
| ALC | 9.15 | VOL % | |
| ALD | 55. | MG/L | |
| FO | 324. | MG/L | |
| ISOA | 189. | MG/L | |
| ISOB | 23. | MG/L | |
| MEOH | 19. | MG/L | |
| NBUT | UND | MG/L | UNDETECTABLE |
| NPRO | 89. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.006 | G/100ML | |

ACC 9796 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 [redacted]

94

Fermentation #3

| | | | |
|---|---|---|---|
| [redacted] | [redacted] | MG/L | |
| ALC | 25.05 | VOL % | |
| ALD | 745. | MG/L | |
| FO | 1212. | MG/L | |
| ISOA | 632. | MG/L | |
| ISOB | 152. | MG/L | |
| MEOH | 230. | MG/L | |
| NBUT | 5. | MG/L | |
| NPRO | 338. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.010 | G/100ML | |

ACC 9797 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 RUN #4

| | | |
|---|---|---|
| ACTA | 87. | MG/L |
| ALC | 24.60 | VOL % |
| ALD | 550. | MG/L |
| FO | 1299. | MG/L |
| ISOA | 671. | MG/L |
| ISOB | 165. | MG/L |
| MEOH | 199. | MG/L |
| NBUT | 6. | MG/L |
| NPRO | 369. | MG/L |
| SECB | 2. | MG/L |
| VA | 0.011 | G/100ML |

CC: A. CAPUTI-RES        CC: A. CAPUTI-RES

L ID: RES        TANK: AC        0000=00=0000

ACC 9795 REQ 090ct90 1526 DRAW 090ct90 0000 C 8    RUN #2B

| | | | |
|---|---|---|---|
| ACTA | 23. | MG/L | |
| ALC | 9.15 | VOL % | |
| ALD | 55. | MG/L | |
| FO | 324. | MG/L | |
| ISOA | 189. | MG/L | |
| ISOB | 23. | MG/L | |
| MEOH | 19. | MG/L | |
| NBUT | UND | MG/L | UNDETECTABLE |
| NPRO | 89. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.006 | G/100ML | |

ACC 9796 REQ 090ct90 1526 DRAW 090ct90 0000 C 8    RUN #3

| | | | |
|---|---|---|---|
| ACTA | 84. | MG/L | |
| ALC | 25.05 | VOL % | |
| ALD | 745. | MG/L | |
| FO | 1212. | MG/L | |
| ISOA | 632. | MG/L | |
| ISOB | 152. | MG/L | |
| MEOH | 230. | MG/L | |
| NBUT | 5. | MG/L | |
| NPRO | 338. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.010 | G/100ML | |

ACC 9797 REQ 090ct90 1526 DRAW 090ct90 0000 C 8 [redacted]

.87

| | | |
|---|---|---|
| [redacted] | | MG/L |
| ALC | 24.60 | VOL % |
| ALD | 550. | MG/L |
| FO | 1299. | MG/L |
| ISOA | 671. | MG/L |
| ISOB | 165. | MG/L |
| MEOH | 199. | MG/L |
| NBUT | 6. | MG/L |
| NPRO | 369. | MG/L |
| SECB | 2. | MG/L |
| VA | 0.011 | G/100ML |

fermentation #4

10-10-90 07:17 AM RESEARCH SUMMARY

L ID: RES TANK: AC 0000=00=0000

ACC 9798 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #7

| | | |
|---|---|---|
| ACTA | 226. | MG/L |
| ALC | 21.35 | VOL % |
| ALD | 170. | MG/L |
| FO | 1558. | MG/L |
| ISOA | 1010. | MG/L |
| ISOB | 217. | MG/L |
| MEOH | 88. | MG/L |
| NBUT | 2. | MG/L |
| NPRO | 100. | MG/L |
| SECB | 2. | MG/L |
| VA | 0.019 | G/100ML |

ACC 9799 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B [redacted]

114

| | | | |
|---|---|---|---|
| [redacted] | [redacted] | MG/L | |
| ALC | 21.95 | VOL % | |
| ALD | 260. | MG/L | Fermentation |
| FO | 1082. | MG/L | #5 |
| ISOA | 631. | MG/L | |
| ISOB | 193. | MG/L | |
| MEOH | 119. | MG/L | |
| NBUT | 2. | MG/L | |
| NPRO | 140. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.009 | G/100ML | |

ACC 9800 REQ 09Oct90 1527 DRAW 09Oct90 0000 C B RUN #6

| | | |
|---|---|---|
| ACTA | 169. | MG/L |
| ALC | 21.80 | VOL % |
| ALD | 180. | MG/L |
| FO | 1298. | MG/L |
| ISOA | 793. | MG/L |
| ISOB | 217. | MG/L |
| MEOH | 109. | MG/L |
| NBUT | 2. | MG/L |
| NPRO | 114. | MG/L |
| SECB | 3. | MG/L |
| VA | 0.011 | G/100ML |

ACC 9801 REQ 09Oct90 1527 DRAW 09Oct90 0000 C B RUN #2A

| | | | |
|---|---|---|---|
| ACTA | 20. | MG/L | |
| ALC | 7.10 | VOL % | |
| ALD | 105. | MG/L | |
| FO | 259. | MG/L | |
| ISOA | 143. | MG/L | |
| ISOB | 22. | MG/L | |
| MEOH | 22. | MG/L | |
| NBUT | UND | MG/L | UNDETECTABLE |
| NPRO | 74. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.013 | G/100ML | |

L ID: RES TANK: AC 0000=00=0000

ACC 9798 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 RUN #7

| | | |
|---|---|---|
| ACTA | 226. | MG/L |
| ALC | 21.35 | VOL % |
| ALD | 170. | MG/L |
| FO | 1558. | MG/L |
| ISOA | 1010. | MG/L |
| ISOB | 217. | MG/L |
| MEOH | 88. | MG/L |
| NBUT | 2. | MG/L |
| NPRO | 100. | MG/L |
| SECB | 2. | MG/L |
| VA | 0.019 | G/100ML |

ACC 9799 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 RUN #5

| | | | |
|---|---|---|---|
| ACTA | 114. | MG/L | |
| ALC | 21.95 | VOL % | |
| ALD | 260. | MG/L | |
| FO | 1082. | MG/L | |
| ISOA | 631. | MG/L | |
| ISOB | 193. | MG/L | |
| MEOH | 119. | MG/L | |
| NBUT | 2. | MG/L | |
| NPRO | 140. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.009 | G/100ML | |

ACC 9800 REQ 09Oct90 1527 DRAW 09Oct90 0000 C 8 [redacted]

169

Fermentation #6

| | | |
|---|---|---|
| [redacted] | | MG/L |
| ALC | 21.80 | VOL % |
| ALD | 180. | MG/L |
| FO | 1298. | MG/L |
| ISOA | 793. | MG/L |
| ISOB | 217. | MG/L |
| MEOH | 109. | MG/L |
| NBUT | 2. | MG/L |
| NPRO | 114. | MG/L |
| SECB | 3. | MG/L |
| VA | 0.011 | G/100ML |

ACC 9801 REQ 09Oct90 1527 DRAW 09Oct90 0000 C 8 RUN #2A

| | | | |
|---|---|---|---|
| ACTA | 20. | MG/L | |
| ALC | 7.10 | VOL % | |
| ALD | 105. | MG/L | |
| FO | 259. | MG/L | |
| ISOA | 143. | MG/L | |
| ISOB | 22. | MG/L | |
| MEOH | 22. | MG/L | |
| NBUT | UND | MG/L | UNDETECTABLE |
| NPRO | 74. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.013 | G/100ML | |

10-10-90 07:17 AM RESEARCH SUMMARY

L ID: RES TANK: AC 0000=00=0000

ACC 9798 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 [redacted]

226

Fermentation #7

| | | |
|---|---|---|
| [redacted] | | MG/L |
| ALC | 21.35 | VOL % |
| ALD | 170. | MG/L |
| FO | 1558. | MG/L |
| ISOA | 1010. | MG/L |
| ISOB | 217. | MG/L |
| MEOH | 88. | MG/L |
| NBUT | 2. | MG/L |
| NPRO | 100. | MG/L |
| SECB | 2. | MG/L |
| VA | 0.019 | G/100ML |

ACC 9799 REQ 09Oct90 1526 DRAW 09Oct90 0000 C 8 RUN #5

| | | | |
|---|---|---|---|
| ACTA | 114. | MG/L | |
| ALC | 21.95 | VOL % | |
| ALD | 260. | MG/L | |
| FO | 1082. | MG/L | |
| ISOA | 631. | MG/L | |
| ISOB | 193. | MG/L | |
| MEOH | 119. | MG/L | |
| NBUT | 2. | MG/L | |
| NPRO | 140. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.009 | G/100ML | |

ACC 9800 REQ 09Oct90 1527 DRAW 09Oct90 0000 C 8 RUN #6

| | | |
|---|---|---|
| ACTA | 169. | MG/L |
| ALC | 21.80 | VOL % |
| ALD | 180. | MG/L |
| FO | 1298. | MG/L |
| ISOA | 793. | MG/L |
| ISOB | 217. | MG/L |
| MEOH | 109. | MG/L |
| NBUT | 2. | MG/L |
| NPRO | 114. | MG/L |
| SECB | 3. | MG/L |
| VA | 0.011 | G/100ML |

ACC 9801 REQ 09Oct90 1527 DRAW 09Oct90 0000 C 8 RUN #2A

| | | | |
|---|---|---|---|
| ACTA | 20. | MG/L | |
| ALC | 7.10 | VOL % | |
| ALD | 105. | MG/L | |
| FO | 259. | MG/L | |
| ISOA | 143. | MG/L | |
| ISOB | 22. | MG/L | |
| MEOH | 22. | MG/L | |
| NBUT | UND | MG/L | UNDETECTABLE |
| NPRO | 74. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.013 | G/100ML | |

10-03-90 07:12 AM RESEARCH SUMMARY

CC: A. CAPUTI-RES

L ID: RES TANK: ART 0000=00=0000 EXP. RUN #8

ACC 7645 REQ 02Oct90 0858 DRAW 28Sep90 0000 C 4 TK: 2930 CONDENSATE

| | | | |
|---|---|---|---|
| ACTA | 58. | MG/L | |
| ALC | 12.35 | VOL % | |
| ALD | 105. | MG/L | |
| FO | 638. | MG/L | |
| ISOA | 388. | MG/L | |
| ISOB | 47. | MG/L | |
| MEOH | 16. | MG/L | |
| NBUT | UND. | MG/L | UNDETECTABLE |
| NPRO | 145. | MG/L | |
| SECB | UND | MG/L | UNDETECTABLE |
| VA | 0.020 | G/100ML | |

Fermentation #8

# Hydrogen Sulfide Emission Factors

Red Fermentations:

| | Fermentation No. | Lbs. $H_2S$ Produced | Gallons Fermented | lbs/1,000 gal |
|---|---|---|---|---|
| 77°F 23°C | 3 | 0 | 157,120 | 0 |
| [illegible] | 4 | 0 | 152,740 | 0 |
| [illegible] | 5 | 0.42 | 145,280 | 0.0029 |
| [illegible] | 6 | 0.33 | 146,145 | 0.0023 |
| [illegible] | 7 | 0.51 | 144,475 | 0.0035 |
| | Totals | 1.26 | 745,760 | |

Factor = 0.0017 lbs. $H_2S$/1,000 gallons (1.26/745,760)

White Fermentation:

| | Fermentation No. | Lbs. $H_2S$ Produced | Gallons Fermented | |
|---|---|---|---|---|
| 57°F 21.6°C | 8 | 0.24 | 169,028 | 0.0014 |

Factor = 0.0014 lbs. $H_2S$/1,000 gallons (0.24/169,028)

# Hydrogen Sulfide Calculations

## 1990 Fermentation - Fresno[1]

**Fermentation #3**
(Red)

0 Hydrogen Sulfide

**Fermentation #4**
(Red)

0 Hydrogen Sulfide

**Fermentation #5**
(Red)

Portion of ferm. with measurable $H_2S$ = 16 hours
Average $H_2S$ = 4 + 5 +2 = 4.5 ppm
(4.5 ppm + $10^6$) x (66,000 x 16 hrs) = 4.75 $ft^3$
4.75 $ft^3$ + 11.23 $ft^3$/lb = <u>0.42 lb $H_2S$</u>

**Fermentation #6**
(Red)

Portion of ferm. with measurable $H_2S$ = 8 hours
Average $H_2S$ = 7 ppm
(7 ppm + $10^6$) x (66,000 x 8 hrs) = 3.7 $ft^3$
3.7 $ft^3$ + 11.23 $ft^3$/lb = <u>0.33 lb $H_2S$</u>

**Fermentation #7**
(Red)

Portion of ferm. with measurable $H_2S$ = 17 hours
Average $H_2S$ = (6 + 4 + 6 + 5 + 4.5) + 5 = 5.1 ppm
(5.1 ppm + $10^6$) x (66,000 x 17) = 5.72 $ft^3$
5.72 $ft^3$ + 11.23 $ft^3$/lb = <u>0.51 lb $H_2S$</u>

---

1. <u>Factors Used in the Following Calculations:</u>
1,100 cfm x 60 = 66,000 cfh
To calculate the number of volumes of gas: ppm $H_2S$ is divided by 1,000,000
$H_2S$ = 11.23 $ft^3$/lb

**Fermentation #8**
(White)

Portion of ferm. with measurable $H_2S$ = 16 hours
Average $H_2S$ = (4 + 1.25) ÷ 2 = 2.6 ppm
(2.6 ppm ÷ $10^6$) x (66,000 x 16) = 2.75 $ft^3$
2.75 $ft^3$ ÷ 11.23 $ft^3$/lb = <u>0.24 lb $H_2S$</u>

# Hydrogen Sulphide Concentration - 1990 Fermentations

Hydrogen Sulphide Concentration - Fermentation #3 (Red)

| time/ date | 0710 | 1020 | 1100 | 1425 | 1500 | 1600 | 2300 |
|---|---|---|---|---|---|---|---|
| 9/12 | 0 | | 0 | | 0 | | 0 |
| 9/13 | | 0 | | 0 | | 0 | |

Hydrogen Sulphide Concentration - Fermentation #4 (Red)

| time/ date | 0710 | 1210 | 1315 | 1600 | 1700 |
|---|---|---|---|---|---|
| 9/14 | | | 0 | 0 | |
| 9/15 | 0 | 0 | | | 0 |

Hydrogen Sulphide Concentration - Fermentation #5 (Red)

| time/date | 1130 | 1855 | 2300 |
|---|---|---|---|
| 9/16 | | | 0 |
| 9/17 | 4 | 5 | 0 |

## Hydrogen Sulphide Concentration - Fermentation #6 (Red)

| time/date | 0640 | 1200 | 1530 | 2330 | 2355 |
|---|---|---|---|---|---|
| 9/18 | | | 0 | | 0 |
| 9/19 | 0 | 7 | | 0 | |

## Hydrogen Sulphide Concentration - Fermentation #7 (Red)

| time/date | 0640 | 0720 | 1220 | 1505 | 2345 |
|---|---|---|---|---|---|
| 9/20 | | | | 0 | 0 |
| 9/21 | 6 | 4 | 6 | 5 | 4.5 |

## Hydrogen Sulphide Concentration - Fermentation #8 (White)

| time/ date | 0630 | 0640 | 0645 | 0705 | 1205 | 1210 | 1230 | 1320 | 1530 | 2330 | 2345 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/23 | | | | | | | | | 0 | 4 | |
| 9/24 | | | | 0 | 0 | | | | | | 0 |
| 9/25 | | | 0 | | | 0 | | | | | 0 |
| 9/26 | 0 | | | | | | 0 | | | | |
| 9/27 | | 0 | | | | | | Trace | | 0 | |
| 9/28 | | | | 1.25 | | | | | | | |

Hydrogen Sulphide Concentration (ppm) - Fermentations #3 - #6 - 1990 (Fresno)

| date/tim | 9/12 | 9/13 | 9/14 | 9/15 | 9/16 | 9/17 | 9/18 | 9/19 | 9/20 | 9/21 | 9/23 | 9/24 | 9/25 | 9/26 | 9/27 | 9/28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0630 | | | | | | | | | | | | | | 0 | | |
| 0640 | | | | | | | | 0 | | 6 | | | 0 | | 0 | |
| 0650 | | | | | | | | | | | | | | | | |
| 0700 | | | | | | | | | | | | 0 | | | | |
| 0710 | 0 | | | 0 | | | | | | 4 | | | | | | 1.25 |
| 1020 | | 0 | | | | | | | | | | | | | | |
| 1100 | 0 | | | | | | | | | | | | | | | |
| 1130 | | | | | | 4 | | | | | | | | | | |
| 1200 | | | | | | | | 7 | | | | 0 | | | | |
| 1210 | | | | 0 | | | | | | | | | 0 | | | |
| 1220 | | | | | | | | | | 6 | | | | | | |
| 1230 | | | | | | | | | | | | | | 0 | | |
| 1315 | | | 0 | | | | | | | | | | | | | |
| 1320 | | | | | | | | | | | | | | | Tr. | |
| 1425 | | 0 | | | | | | | | | | | | | | |
| 1515 | 0 | | | | | | | | 0 | 5 | | | | | | |
| 1530 | | | | | | | 0 | | | | 0 | | | | | |
| 1600 | | 0 | 0 | | | | | | | | | | | | | |
| 1700 | | | | 0 | | | | | | | | | | | | |
| 1740 | | | | | | | | | | | | | | | | |
| 1855 | | | | | | 5 | | | | | | | | | | |
| 1920 | | | | | | | | | | | | | | | | |
| 2300 | 0 | | | | 0 | 0 | | | | | | | | | | |
| 2330 | | | | | | | | | | | | | | | 0 | |
| 2345 | | | | | | | 0 | 0 | 0 | 4.5 | 4 | 0 | 0 | | | |

# APPENDIX G.

NFC

STATE OF CALIFORNIA—CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

PETE WILSON, *Governor*

AIR RESOURCES BOARD
2020 L STREET
P.O. BOX 2815
SACRAMENTO, CA 95814-2815

November 1, 1994

Mark Boese
Deputy Air Pollution Control Officer
San Joaquin Valley Unified Air Pollution Control District
1990 Tuolumne Street, Suite 200
Fresno, California 93721

Dear Mr. Boese:

As discussed during our recent telephone conversation, I am writing to provide you with a summary of our analysis of the data collected during the pilot studies conducted at the California State University, Fresno, and the full scale demonstration study conducted at the Gallo Winery in Fresno. Based on our analysis, we intend to revise our emission inventory for wineries and revise our original estimate of cost effectiveness for controlling winery emissions.

Winery Emission Inventory

Based on the most recent source test data, the emission factors for white wine fermentation is about 1.9 pounds of ethanol emitted per 1,000 gallons of wine fermented. The emission factor for red wine is about 4.7 pounds of ethanol emitted per 1,000 gallons of wine fermented. These new emission factors are approximately 30 percent less than the emission factors that were presented in the technical support document for the Air Resources Board's suggested control measure for winery emissions. Therefore, we recommend that the new emission factors be used to revise the winery emission inventory.

Cost Effectiveness to Control Winery Emissions

Based on the new emission factors and our winery tank usage survey, we have recalculated the cost effectiveness to control winery emissions. The new cost effectiveness ranges from about $40,000 to $120,000 per ton of emissions reduced.

If you have any questions regarding the information that I have provided or need further assistance, please call me at (916) 322-6020, or have your staff call Mr. Gary Yee, Manager, Industrial Section, Criteria Pollutants Branch, Stationary Source Division, at (916) 327-5986.

Sincerely,

Dean C Simeroth

Dean C. Simeroth, Chief
Criteria Pollutants Branch

cc: Michael H. Scheible
Deputy Executive Officer
Air Resources Board

Arthur Caputi
E & J Gallo Winery
Post Office Box 1130
Modesto, California 95353