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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

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ETHANOL EMISSIONS AND CONTROL

FOR WINE FERMENTATION TANKS

This report presents an estimate of emissions from four 1400 gallon wine fermentation tanks and three ethanol control techniques. These emission estimates are based on tests performed by the Air Resources Board (ARB) staff using ARB test methods. The results have been reviewed by the staff and are believed to be accurate within the limits of the methods. However, data are usually affected by test methods and process variables which are sometimes not apparent during the tests. The data should not, therefore, be necessarily considered typical of a specific source or industry until the effects of such variables are known and taken into account.

ACKNOWLEDGMENTS

The project engineers were David Todd and Cindy Castronovo of the ARB. Instrument technicians were Jack LaBrue and Bud Thoma of the ARB. The chemists were Bob Okamoto and Don Fitzell, also of the ARB. Assistance was provided by Dr. Carlos Muller, the staff and students of the California State University, Fresno, Department of Enology and Bill Roddy, Bill House, and John Pheasant of the Fresno County APCD. Additional assistance was provided by Jerry Fox of Frederiksen Engineering, and Art Caputi of Gallo, Harold Dervishian of Cribari, and Tom Johnson and Mike Hardy of Mont La Salle Vineyards. Chemical analyses were performed by the Department of Health Services Air and Industrial Hygiene Laboratory.

STATE OF CALIFORNIA
AIR RESOURCES BOARD

Ethanol Emissions and Control
for Wine Fermentation Tanks

I. SUMMARY

Ambient air quality standards for oxidant are frequently violated in many of California's air basins. Emissions from wine fermentation tanks contribute to oxidant concentrations through the release of ethanol vapor through vents in the roof of the tank. The released ethanol vapors react in sunlight to form photochemical oxidant.

A proposed Suggested Control Measure (SCM) for Control of Ethanol Emissions from Winery Fermentation tanks has been considered by the Air Resources Board (ARB or Board). The Board has deferred action on the SCM pending outcome of a demonstration program to further evaluate the methods to reduce emissions from winery fermentation tanks.

Phase I of the demonstration program was conducted during the 1987 fermentation season. It consisted in part of a pilot program to evaluate scrubbing, carbon adsorption and catalytic incineration as technologies to reduce the ethanol content of fermentation tank exhaust gases.

The ARB Engineering Evaluation Branch (EEB) performed emission tests on four wine fermentation tanks and three ethanol control devices during four wine fermentations as part of the Phase I program. Two red wine and two white wine fermentations were conducted in four 1400 gallon capacity tanks at the California State University at Fresno. The white wine fermentations lasted about 10 days, while the red wines were fermented over a 4 to 5 day period.

The EEB conducted continuous analysis for oxygen, carbon dioxide and total hydrocarbons at the inlet and outlet of each control device. Samples were also taken for determination of moisture, selected volatile organics and hydrogen sulfide concentrations. Details on these analyses can be found in the test results section.

Table S-1 gives a summary of the calculated total amounts of ethanol entering and leaving each control device for each fermentation. The total amount of ethanol released by the Tank 4 (no control equipment) was difficult to measure due to low emission flow and the values reported are low compared to the other tanks. Though the total mass of ethanol emitted may seem low, it should be kept in mind that only about 1000 gallons per tank were fermented in this pilot program. Tanks of over 600,000 gallon capacity can be found at the larger wineries.

Figure S-1 shows the average control efficiences for each control device as calculated from the data in Table S-1. As can be seen, each of the control devices is capable of obtaining at least 90% efficiency.

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

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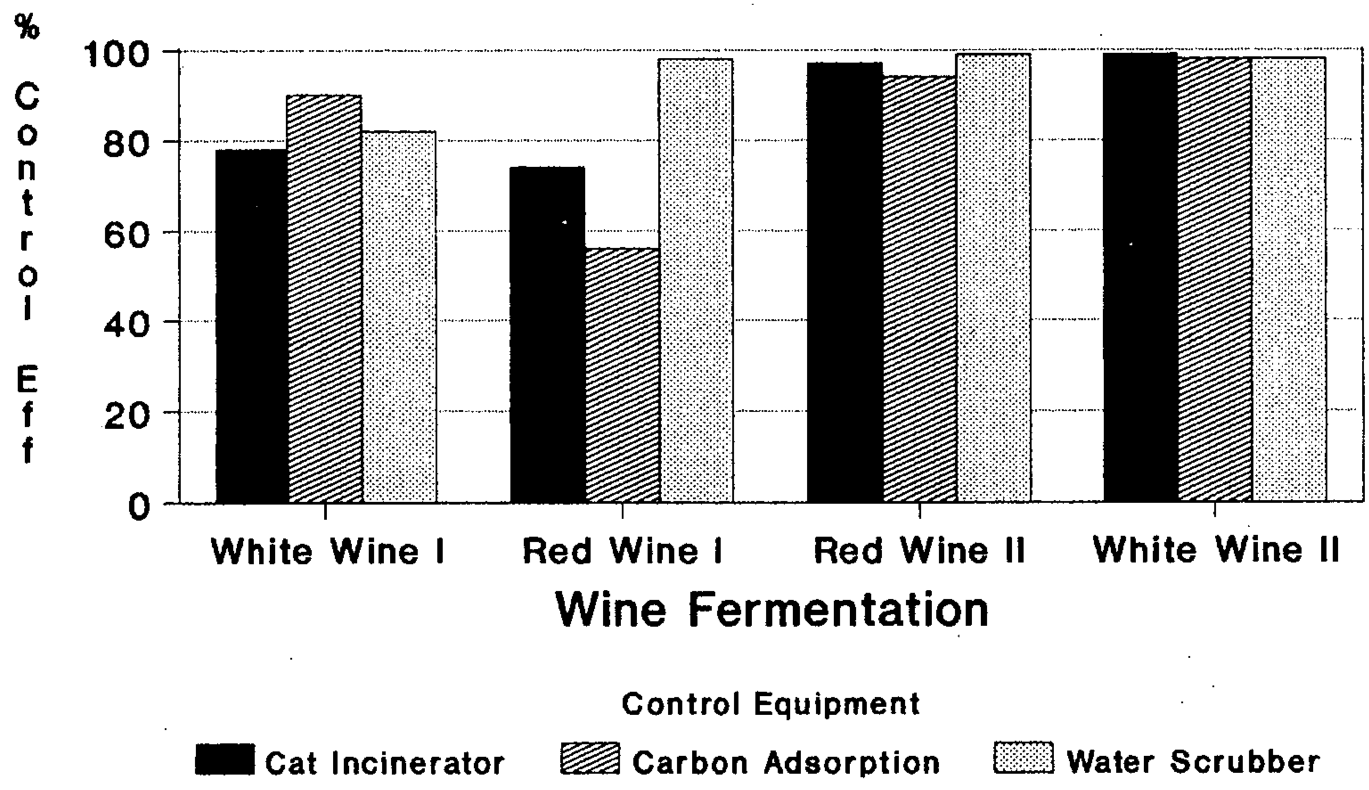
a/ Catalytic incinerator experienced start-up difficulties during White Wine I

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

Figure S-1

ETHANOL CONTROL EFFICIENCY SUMMARY



Red Wine I data limited due to foamover

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II. INTRODUCTION

At the request of the Air Resources Board (ARB) and under the supervision of the Ad Hoc Advisory Committee, the Engineering Evaluation Branch (EEB) performed emissions tests on four wine fermentation tanks and three ethanol control devices during four wine fermentations. Each of the control devices was connected to a fermentation tank. The fourth tank, which was not connected to a control device, was used as a reference tank.

The tested tanks and control devices were located at California State University at Fresno (CSUF) which operates pilot-scale wine fermentation facilities as part of its Viticulture and Enology programs. The four wines - 2 reds and 2 whites - were fermented by the Enology Department of CSUF under the direction of Dr. Carlos Muller.

The objectives of the emissions tests were:

A. Determine emissions of ethanol, carbon dioxide, and other compounds.

B. Determine flow rates and moisture contents of the various exhaust streams.

C. Determine control efficiencies for the three different types of control equipment for ethanol emissions.

During wine fermentation, ethanol emissions are usually vented to the atmosphere along with produced carbon dioxide. The released ethanol may react in sunlight to form photochemical oxidant.

This report includes additional information on wine fermentation, the control devices, description of the sampling methods and the test results.

III. PROCESS DESCRIPTION

For this study, four wines were fermented by the CSUF Department of Enology. Each fermentation used four nearly identical 1400 gallon general purpose wine fermentation tanks. The fermentations were done with techniques generally used throughout the wine industry. A general description of wine fermentation is included in this section.

The three ethanol control devices were a catalytic incinerator, a carbon adsorption unit, and a wet (water) scrubber. All were pilot scale units sized for the 1400 gallon fermentation tanks. A description of each of the units is described in this section. Figure 3.1 is a schematic of the setup.

A. WINE FERMENTATION

Fermentation is the process that makes wine from the juices of fruits such as grapes. Fermentation is the anaerobic (without free oxygen) breakdown of organic compounds by the action of microorganisms or their extracts, to products simpler than the starting substrate. With wine, this breakdown is caused by yeast. The yeast provides complicated enzymes that create alcohol, carbon dioxide gas, glycerin and other products from the sugar in the juice.

The concentration of alcohol in wine is based upon sugar content, extent of fermentation, and losses or additions of alcohol. Wine grapes generally contain 15-25 percent sugar. One percent sugar yields about 0.55 percent alcohol by volume. In general, the theoretical chemical reaction for converting sugar to alcohol is:

$$C_6H_{12}O_6 = 2\ C_2H_5OH + 2\ CO_2$$

According to the above equation, sugar should yield 51.1 percent alcohol by weight, but in reality sugar only yields about 47 percent retained alcohol by weight of the sugar fermented (glucose). The rest goes into other products such as glycerin, hydrogen sulfide, methyl and ethyl mercaptans, and lost alcohol.

The fermentation is initiated by adding the yeast innoculation to the grape juice. The juice is "pumped over" every 6 hours to promote uniform fermentation. The fermentation chemical reaction releases heat and the temperature is controlled by circulating chilled water through the tank "jackets". If the temperature is not kept under control, the rate of fermentation can escalate to the point where a foamover can occur. This "boiling over" of a fermentation tank occurred during Red Wine I of this study.

During the fermentation, alcohol is lost with escaping carbon dioxide (CO_2). The losses can range from less than 0.1 percent to over 10 percent. This alcohol loss is affected by the alcohol concentration within the wine, agitation of the fermenting liquid, the presence of a pomace cap, fermentation temperature, and the rate at which carbon dioxide is produced.

B. CATALYTIC INCINERATOR

The catalytic incinerator used a ceramic catalyst containing noble metals to incinerate ethanol emissions pumped from the fermentation tank. The carbon dioxide and ethanol emissions from the fermentation tank are pumped into the control device at a constant flow rate. Dilution air is added as needed at the vent of the fermentation tank to maintain constant flow. The flow of gases from a fermentation tank vary as the fermentation proceeds. The combined fermentation and dilution gases are heated to temperature by an electric heater and then enter the catalytic reactor where the ethanol is incinerated. Following the catalytic reactor, the gases are then vented to the atmosphere. Figure 3.2 is a diagram of the incinerator.

C. CARBON ADSORPTION

The carbon adsorption unit used carbon to adsorb and hold the ethanol emissions pumped from the fermentation tank. Like the incinerator unit, carbon dioxide and ethanol emissions are pumped into the control device at a constant flow with dilution air added as needed to make up for the flow variations in carbon dioxide and ethanol. Prior to entering the carbon bed, the gas stream is cooled and then heated to make it as "dry" as practical. Then the gases are routed through the carbon and vented to the atmosphere.

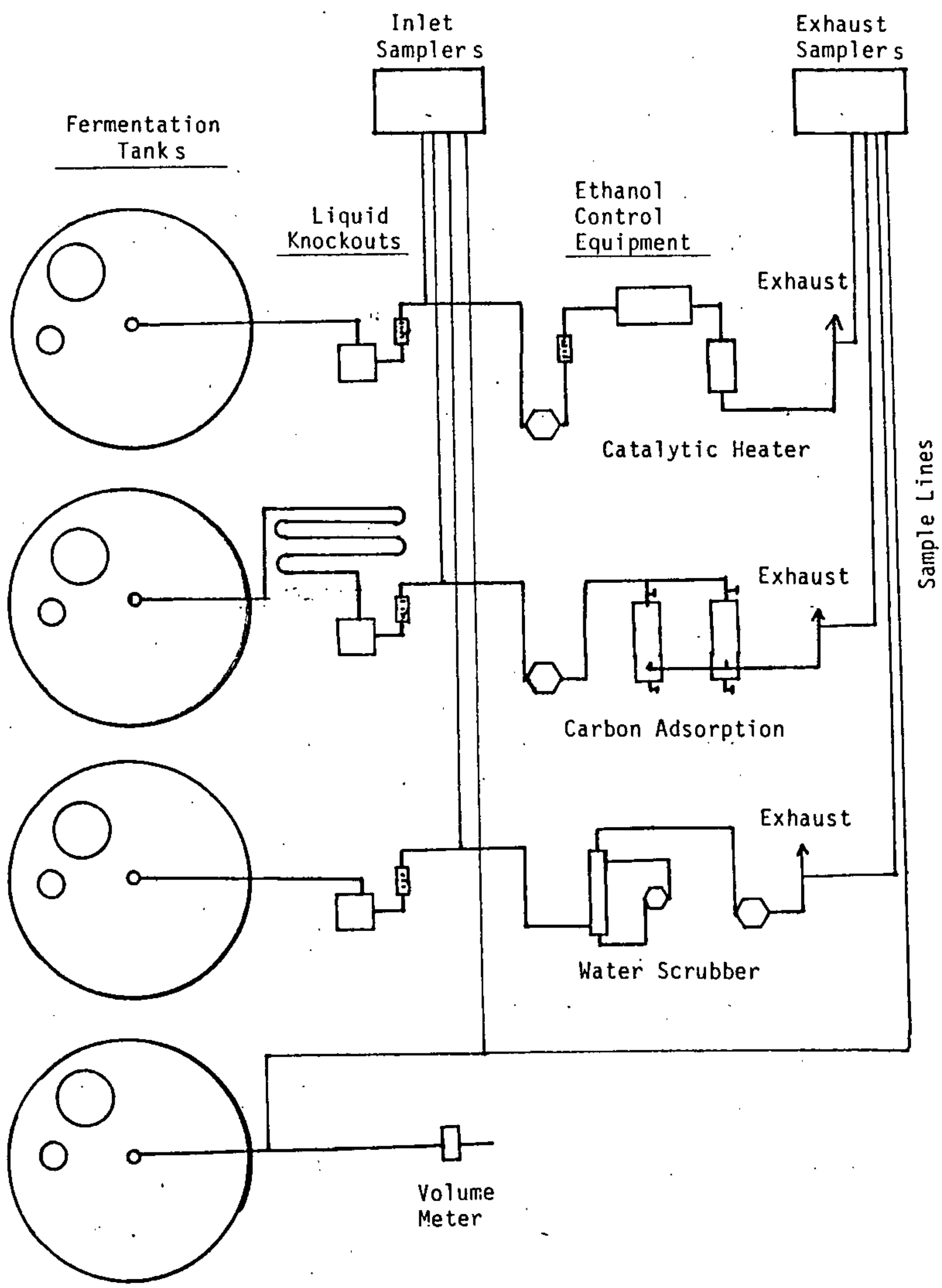
As the ethanol passes through the carbon bed, it is collected and stored on the surface of the carbon particles. Eventually the carbon bed cannot adsorb any more ethanol and breakthrough occurs. At that time, the gases are routed to the standby carbon bed. Then the used bed is purged with steam to desorb the ethanol and carry it out of the bed. Outside the bed, the steam and ethanol are allowed to cool and condense. The water and ethanol are then disposed, and the carbon bed is put on standby until the other carbon bed begins to show signs of breakthrough. Figure 3.3 is a diagram of the carbon adsorption unit.

D. WET SCRUBBER

The wet scrubber unit uses locally available tap water to remove ethanol from the gas stream. As with the other two control units, carbon dioxide, ethanol, and make-up air are all pulled into the unit at a constant flowrate. The gas stream enters a vertical column near the bottom and water enters near the top. As the water cascades down the column, the gases are drawn up through the column. Metal packing material in the column breaks-up the two flows to help the water absorb the ethanol. The water with the ethanol is collected at the bottom of the column and recycled back to the top of the column. During the process, some of the recycled water is bled off for disposal along with the collected ethanol. Fresh water is added at the top of the column to makeup for the water that is bled off. Figure 3.4 is a diagram of the wet scrubber.

Figure 3.1

Wine Test Set-Up



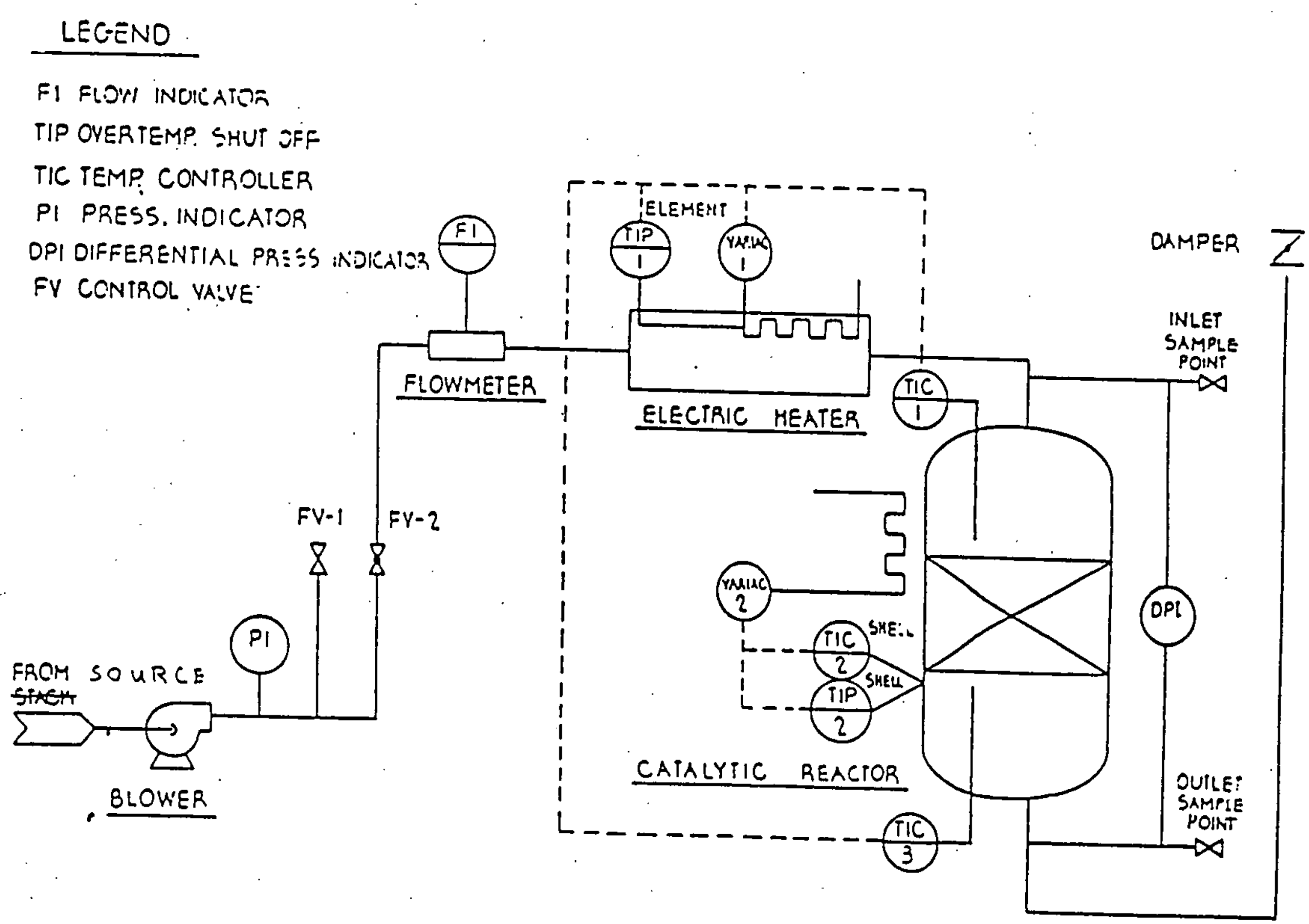


Figure 3.2 Flow Schematic Pilot Test Unit – Catalytic Incinerator - Engelhard Industries

Figure 3.3

Carbon Adsorption System

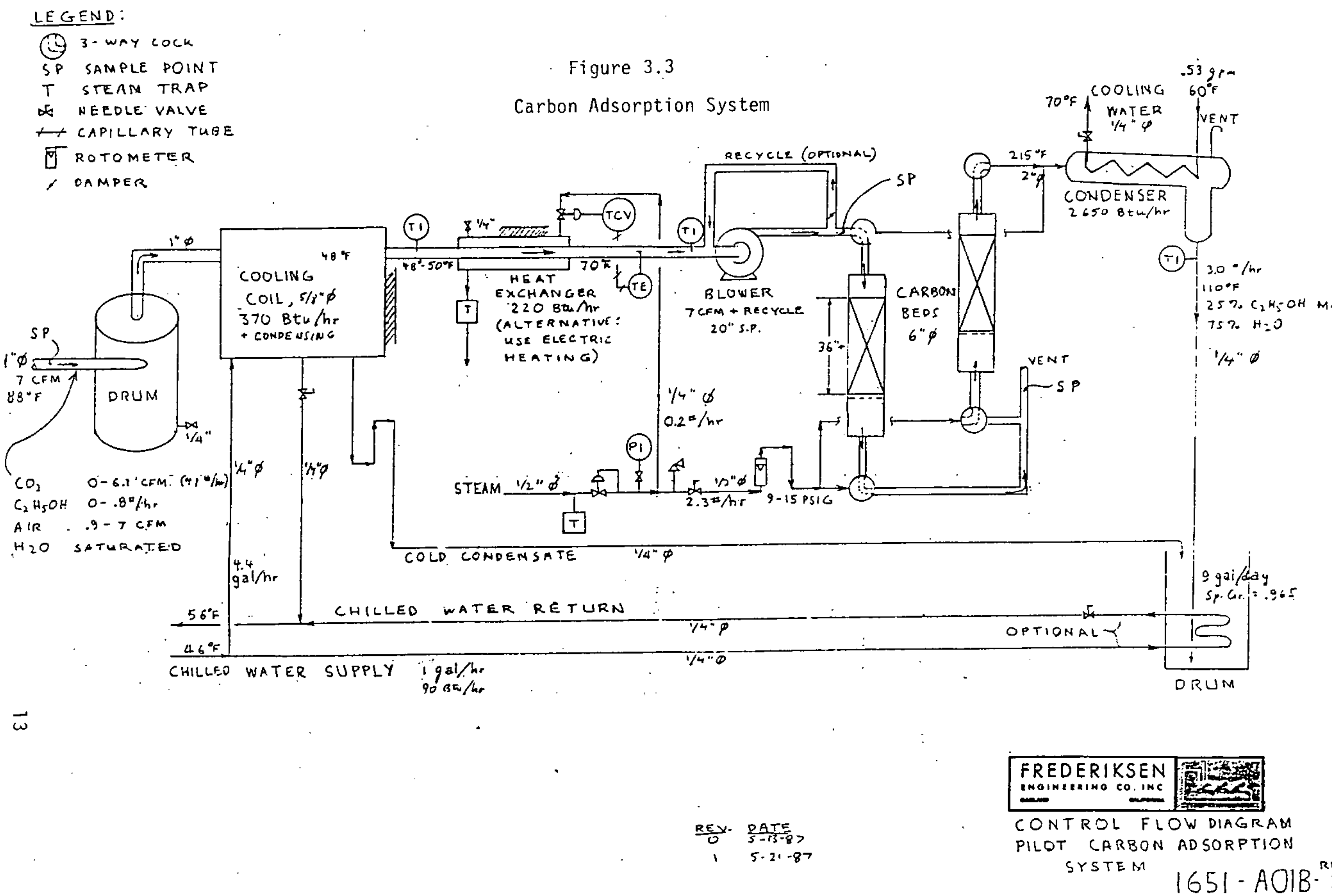
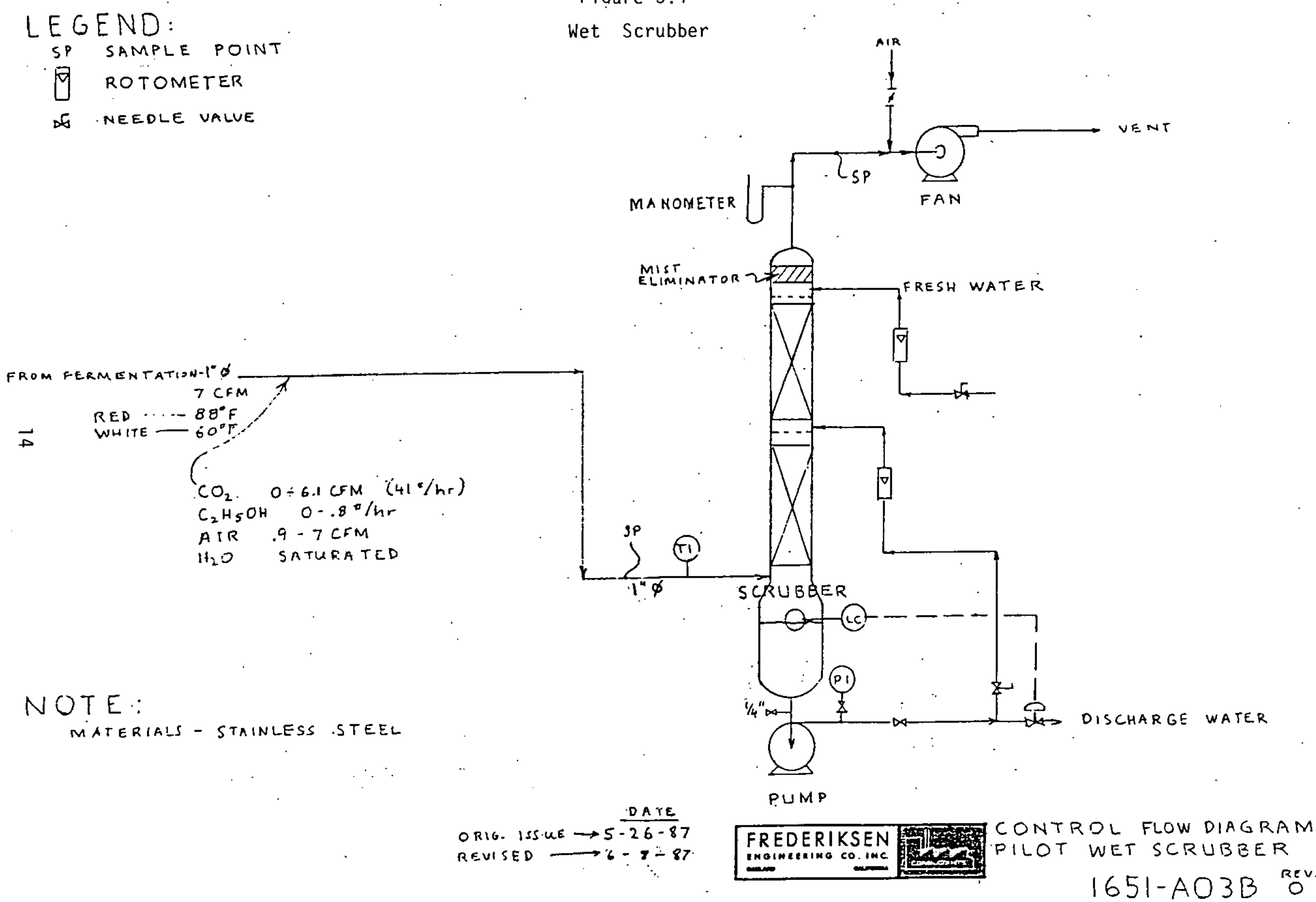


Figure 3.4
Wet Scrubber



IV. TEST PROCEDURES

Sampling was performed at the inlet and outlet of each of the three control units and the outlet of the reference tank. The components analyzed for this test as well as the sampling methods are shown in Table 4.1. Specific information is given below.

A. GASEOUS EMISSIONS

Sampling for the gaseous carbon dioxide, oxygen, and total hydrocarbons was performed in accordance with California Administrative Code Section 94114, which incorporated by reference "Method 100 - Procedures for Continuous Emission Stack Sampling." This test method is used for determining gaseous emissions from stationary sources. (See Figure 4.1.)

Two sets of gaseous sampling instruments were available so the inlet and outlet of a control unit were sampled simultaneously. However, the inlet and outlet of only one control unit could be sampled at a time. For the reference tank, both sets of gaseous sampling instruments simultaneously sampled the tank vent.

Carbon dioxide concentrations,were measured by non-dispersive infrared (NDIR) spectroscopy. Oxygen content was measured with a paramagnetic instrument. Total hydrocarbon concentrations (mostly ethanol) were measured by an analyzer equipped with a flame ionization detector (FID). Data from the instruments was recorded on strip charts and a computer data acquisition system. The analyzers were calibrated in the ARB Sacramento facilities before the emissions test and in the field before and after each tank or control device was sampled. Sampling periods for the control devices and reference tank varied in duration from one-half hour to overnight.

B. VOLATILE ORGANICS

Bag samples and charcoal tubes were used to measure volatile organic compounds. The bags were filled with clean nitrogen and prechecked for contamination before they were used for sampling. Bag samples were collected by placing a bag in a rigid container and evacuating the container until the bag was properly inflated (see Figure 4.2). Tube samples were collected in charcoal tubes by pulling a measured amount of gas through the tube.

After a sample gas was collected, both bags and tubes were stored in containers to avoid exposure to sunlight. The tubes were also kept in cold storage. Cold storage was not needed for the bag samples because they were analyzed in an ARB mobile laboratory parked nearby. The tubes were analyzed in Berkeley by the Department of Health Services Air and Industrial Hygiene Laboratory (AIHL).

C. MOISTURE CONTENT

Moisture content of the sampled gas streams was determined by ARB Test Method 4 for stationary sources. A measured volume of gas is pulled through a moisture trap consisting of iced impingers followed by a container of silica gel (see Figure 4.3).

After the moisture content was determined, a sample of the impinger liquid was iced and transported to AIHL to be analyzed for ethanol content.

D. FLOW RATE

Flow rates into the control devices and analyzers were measured with rotameters. All other flow rates, such as the flow out of the reference tank, were measured with positive displacement or dry gas volume meters.

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

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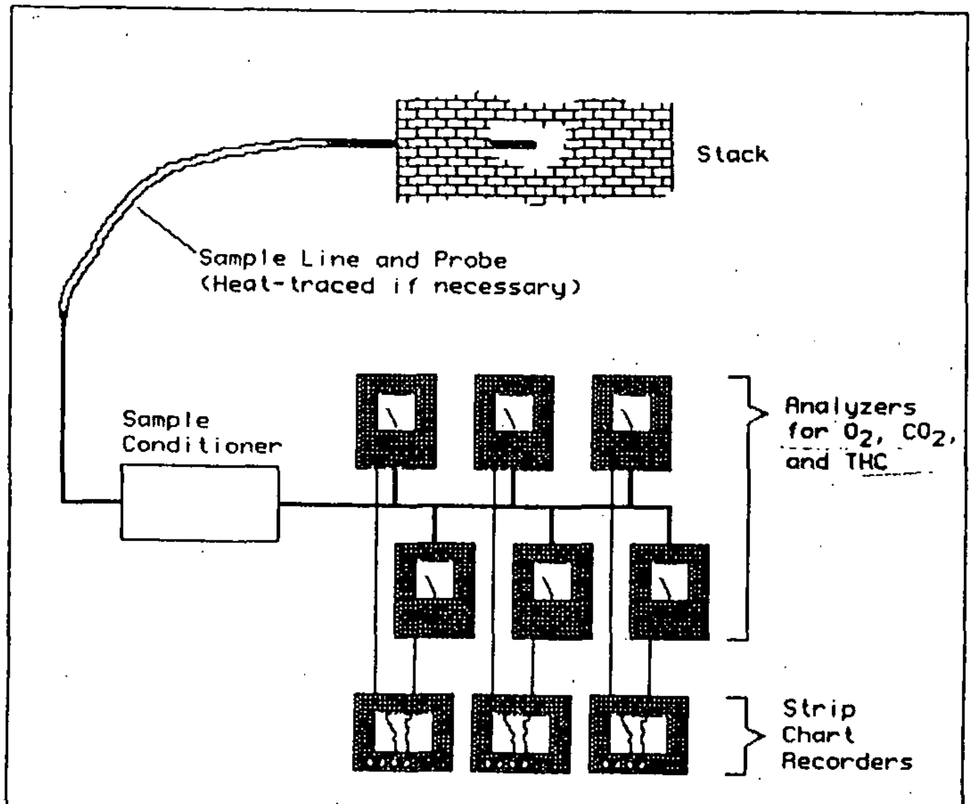


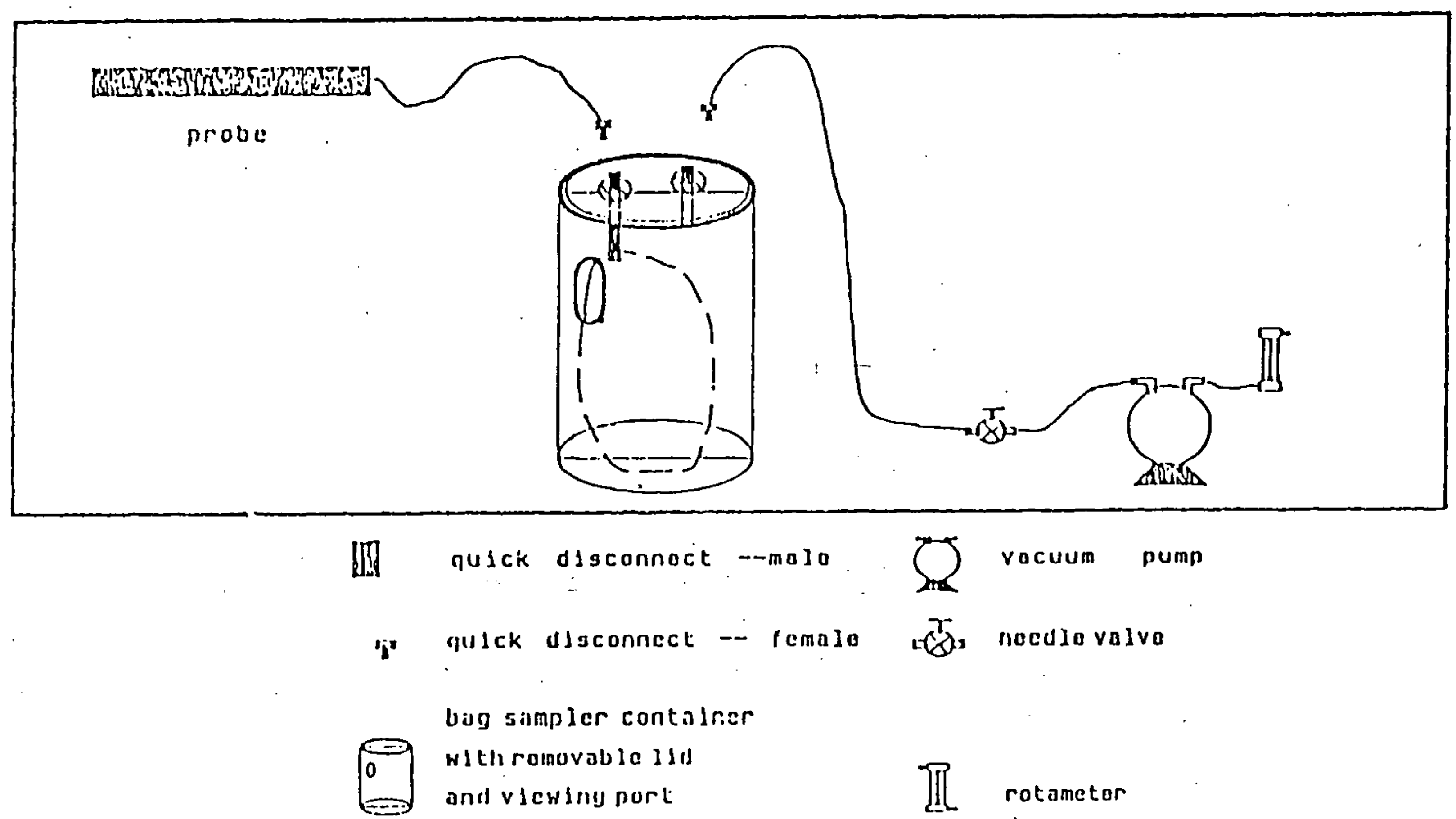
Simplified schematic of Method 100 apparatus. Details not shown include calibration gas plumbing, analyzer exhaust plumbing, optional pitot and thermocouple arrangements, etc.

Figure 4.1

Method 100 Apparatus

Figure 4.2

Bag Sampling Train



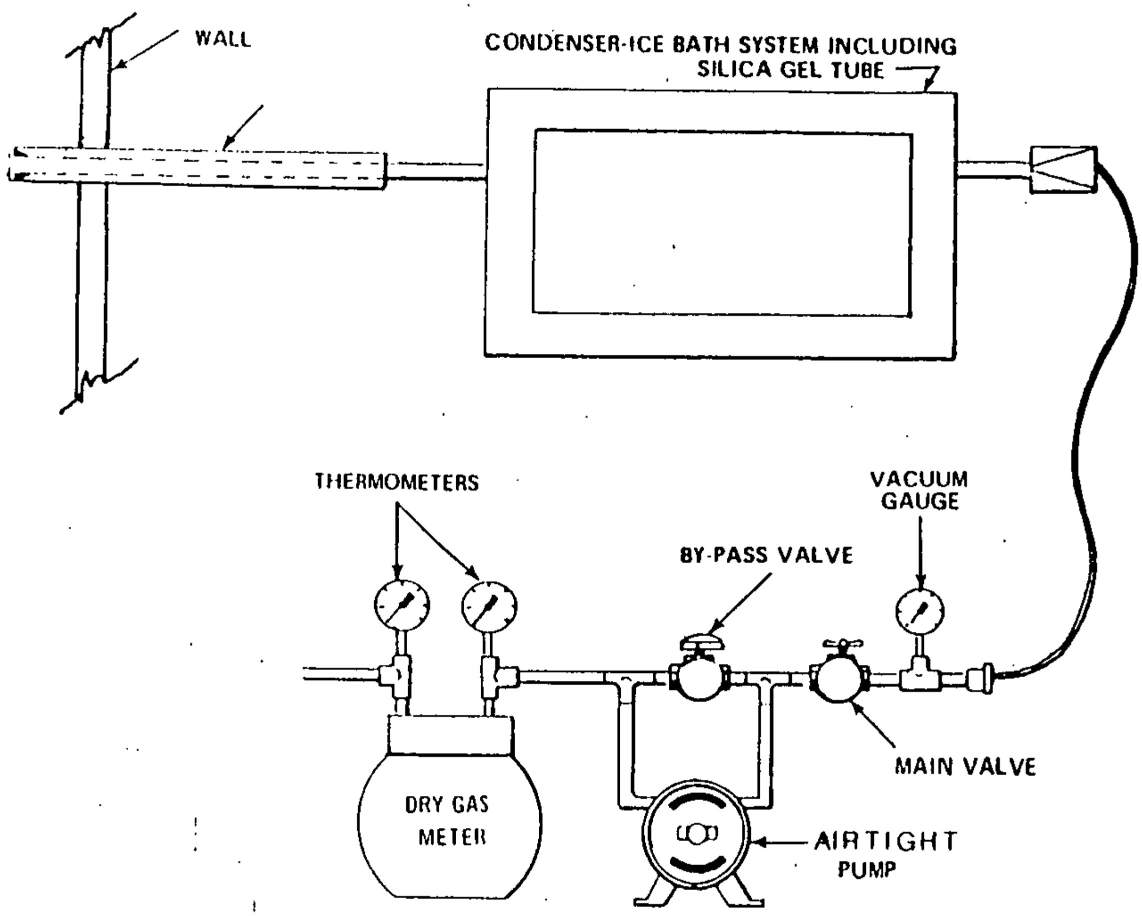


Figure 4.3 Moisture sampling train (Reference Method).

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.

WHITE WINE I

The continuous emission data for White Wine I is listed in Tables 5.1 through 5.4. Selected portions of this data are plotted in Figures 5.1 through 5.8. For each tank, the control efficiency over the course of the fermentation is plotted on the same page as the inlet and outlet ethanol emission data.

TANK 1

The catalytic incinerator outlet temperature was 250 deg F or less during the first five days of the fermentation. This may account for the generally low efficiency during this period. However, the efficiency of the catalytic incinerator was greater than 85% for the second half of the first fermentation. A graph was developed to show the relationship between the outlet temperature and the control efficiency. This graph is shown in Figure 5.8.

TANK 2

The second half of the fermentation shows two possible "breakthrough" conditions in the carbon bed. Otherwise, this control method was able to attain over 95% control efficiency.

TANK 3

After day 4 of the fermentation, this unit consistently showed better than 95% control efficiency. This is in spite of some operational problems with the scrubber. On Day 3, the water pump broke down and was replaced. Also, occasionally the water flow through the scrubber was too high, and would restrict the air flow from the tank.

TABLE 5.1

WHITE WINE 1 - EMISSION DATA FOR CATALYTIC INCINERATOR

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	CO2 IN (%)	CO2 OUT (%)	O2 IN (%)	O2 OUT (%)	OUTLET TEMP F
1	19-Aug-87	11:30	0.0								
	20-Aug-87	13:00	25.5	3.44	3.44	0.00	0.0	0	20.9	20.9	
	20-Aug-87	16:30	29.0	1.72	20.64	0	0.0	0	20.9	20.8	200
	21-Aug-87	07:00	43.5	86	1.72	98.00	0.1	0	20.8	20.9	280
	21-Aug-87	11:00	47.5	48.16	25.8	46.43	0.7	0.6	20.2	20.9	225
	21-Aug-87	14:30	51.0	34.4	20.64	40.00	1.3	1.0	20.0	20.5	220
	22-Aug-87	08:00	68.5	15.48	6.88	55.56	3.5	2.2			250
	22-Aug-87	10:00	70.5	25.8	15.48	40.00	5.3	5.0	20.0	20.2	225
	22-Aug-87	14:30	75.0	25.8	27.52	0	7.3	7.5	19.3	19.8	220
	23-Aug-87	10:30	95.0	189.2	149.64	20.91	12.0	11.0	18.5	19.0	210
	23-Aug-87	15:20	99.8	232.2	154.8	33.33	12.0	10.5	18.3	18.5	220
	24-Aug-87	10:00	118.5	258	0	100.00	9.0	7.0	19.5	20.0	350
	24-Aug-87	13:15	121.7	412.8	51.6	87.50	11.5	10.0	18.5	19.0	310
	24-Aug-87	17:10	125.7	430	43	90.00	11.5	9.0	19.0	19.0	325
	26-Aug-87	07:00	163.5	86	3.44	96.00	4.0	3.0	20.4	20.5	450
	26-Aug-87	17:00	173.5	146.2	1.72	98.82	4.0	7.5	19.6	19.8	460
	27-Aug-87	08:30	189.0	68.8	1.72	97.50	2.2	5	20.2	19.5	470
	27-Aug-87	17:00	197.5	120.4	8.6	92.86	2.3	5	20.3	20.1	390
	28-Aug-87	06:50	211.3	103.2	5.16	95.00	2	3	20.5	20.6	450

TABLE 5.2

WHITE WINE 1 - EMISSION DATA FOR CARBON ADSORPTION UNIT

TANK	DATE	TIME	HOURS	ETOH IN	ETOH OUT	% EFF	CO2 IN	CO2 OUT	O2 IN	O2 OUT
2	19-Aug-87	11:30	0.0							
	19-Aug-87	14:30	3.0	1.72	0	100.00	0.1	0	20.6	20.9
	20-Aug-87	14:00	26.5	3.44	1.72	50.00	0.0	0	20.9	20.9
	20-Aug-87	17:00	29.5	3.44	5.16	0.00	0.1	0.5	20.9	20.8
	21-Aug-87	08:00	44.5	86	1.72	98.00	0.4	0.25	20.8	20.9
	21-Aug-87	10:30	47.0	51.6	5.16	90.00	0.6	0.5	20.2	20.9
	21-Aug-87	11:30	48.0	60.2	12.04	80.00	0.5	0.4	20.2	20.9
	21-Aug-87	15:00	51.5	34.4	6.88	80.00	1.5	0.6	20.9	20.5
	21-Aug-87	17:00	53.5	13.76	8.6	37.50	1.2	0.5	20.6	20.5
	22-Aug-87	09:00	69.5	13.76	1.72	87.50	6.0	3.5	20.3	20.2
	22-Aug-87	10:45	71.2	24.08	0.86	96.43	7.0	5.3	19.8	20.0
	22-Aug-87	15:00	75.5	25.8	3.44	86.67	8.4	6.5	18.8	19.6
	23-Aug-87	07:30	92.0	103.2	0	100.00	12.5	8.5	18.0	19.0
	23-Aug-87	11:15	95.7	232.2	6.88	97.04	15.4	13.0	17.5	18.0
	23-Aug-87	16:55	101.4	283.8	1.72	99.39	14.2	12.8	16.8	17.7
	24-Aug-87	14:55	123.4	473	8.6	98.18	14.0	10.0	18.0	18.0
	25-Aug-87	06:50	139.3	261.44	154.8	40.79	11.5	7.0	18.8	20.0
	25-Aug-87	11:45	144.2	275.2	1.72	99.38	11.3	7.5	19.0	19.8
	26-Aug-87	08:00	164.5	154.8	2.58	98.33	2.2	2.0	20.5	20.6
	26-Aug-87	14:30	171.0	189.2	3.44	98.18	5.2	7.5	20.0	20.0
	27-Aug-87	11:00	191.5	120.4	72.24	40.00	3	6.5	20.3	20.3
	27-Aug-87	11:30	192.0	120.4	1.72	98.57	3	6.5	20.3	20.3
	27-Aug-87	17:50	198.3	129	5.16	96.00	2.4	3	20.5	20.0
	28-Aug-87	07:40	212.2	60.2	1.72	97.14	2	2.5	20.8	20.8

TABLE 5.3

WHITE WINE I - EMISSION DATA FOR WATER SCRUBBER

TANK	DATE	TIME	HOURS	ETOH IN	ETOH OUT	% EFF	CO2 IN	CO2 OUT	O2 IN	O2 OUT
3	19-Aug-87	11:30	0.0							
	19-Aug-87	15:00	3.5	2	0	100.00	0.1	0	20.6	20.9
	20-Aug-87	09:30	22.0	2	2	0.00	0.0	0	20.9	20.9
	20-Aug-87	14:30	27.0	5	3	33.33	0.0	0	20.9	20.9
	20-Aug-87	17:30	30.0	5	3	33.33	---	0	20.9	---
	21-Aug-87	08:30	45.0	258	3	98.67	0.6	0.25	20.8	20.9
	21-Aug-87	12:30	49.0	103	7	93.33	1.3	---	20.5	20.9
	21-Aug-87	15:30	52.0	38	7	81.82	1.2	0.3	20.9	20.5
	21-Aug-87	17:30	54.0	15	9	44.44	1.8	0.7	20.6	20.5
	22-Aug-87	09:30	70.0	15	2	88.89	5.8	1.5	20.3	20.8
	22-Aug-87	11:30	72.0	28	0	100.00	8.0	2.5	19.5	20.5
	22-Aug-87	15:30	76.0	38	3	90.91	11.2	2.5	18.5	20.4
	23-Aug-87	08:30	93.0	120	2	98.57	12.3	2.8	18.8	20.8
	23-Aug-87	11:48	96.3	258	7	97.33	16.5	4.3	17.0	20.3
	24-Aug-87	08:30	117.0	292	0	100.00	15.3	0.3	15.8	20.8
	24-Aug-87	11:15	119.7	378	5	98.64	16.0	5.3	17.7	20.2
	24-Aug-87	15:45	124.2	564	4	99.24	22.5	5.0	16.6	20.2
	25-Aug-87	08:00	140.5	550	10	98.13	21.0	3.0	17.0	20.0
	25-Aug-87	14:00	146.5	433	3	99.21	15.5	8.0	18.0	20.5
	26-Aug-87	09:00	165.5	52	2	96.67	2.3	0.5	20.3	20.8
	26-Aug-87	15:30	172.0	258	2	99.33	6.5	1.0	20.0	20.4
	27-Aug-87	06:30	187.0	172	3	98.00	6	3	20.0	19.8
	27-Aug-87	13:00	193.5	120	3	97.14	5	2.5	20	20.3

TABLE 5.4

WHITE WINE I - NO CONTROL EQUIPMENT

TANK	DATE	TIME	HOURS	ETOH	CO2 IN	CO2 OUT	O2 IN	O2 OUT
4	19-Aug-87	11:30	0					
	19-Aug-87	15:30	4.0	36	0.1	0	20.9	20.9
	20-Aug-87	16:00	28.5	636	0.6	0	20.9	20.8
	21-Aug-87	09:15	45.7	1462	3.0	---	20.0	20.9
	21-Aug-87	13:30	50.0	1720	1.8	0.6	20.5	21.0
	21-Aug-87	21:00	57.5	69	5.0	0.3	20.4	21.0
	22-Aug-87	13:45	74.2	146	27.0	---	11.0	---
	22-Aug-87	16:00	76.5	181	21.0	23.0	8.0	11.0
	24-Aug-87	12:00	120.5	860	31.0	---	12.5	---
	24-Aug-87	16:25	124.9	1032	28.0	25.0	14.0	14.0
	25-Aug-87	09:15	141.7	860	27.0	25.0	13.5	13.5
	25-Aug-87	15:45	148.2	1032	27.0	25.0	13.8	14.0
	26-Aug-87	10:45	167.2	3354	20+	25+	1.0	1.0
	27-Aug-87	14:15	194.7	1032	20+	25+	14	15.0

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Figure 5.1

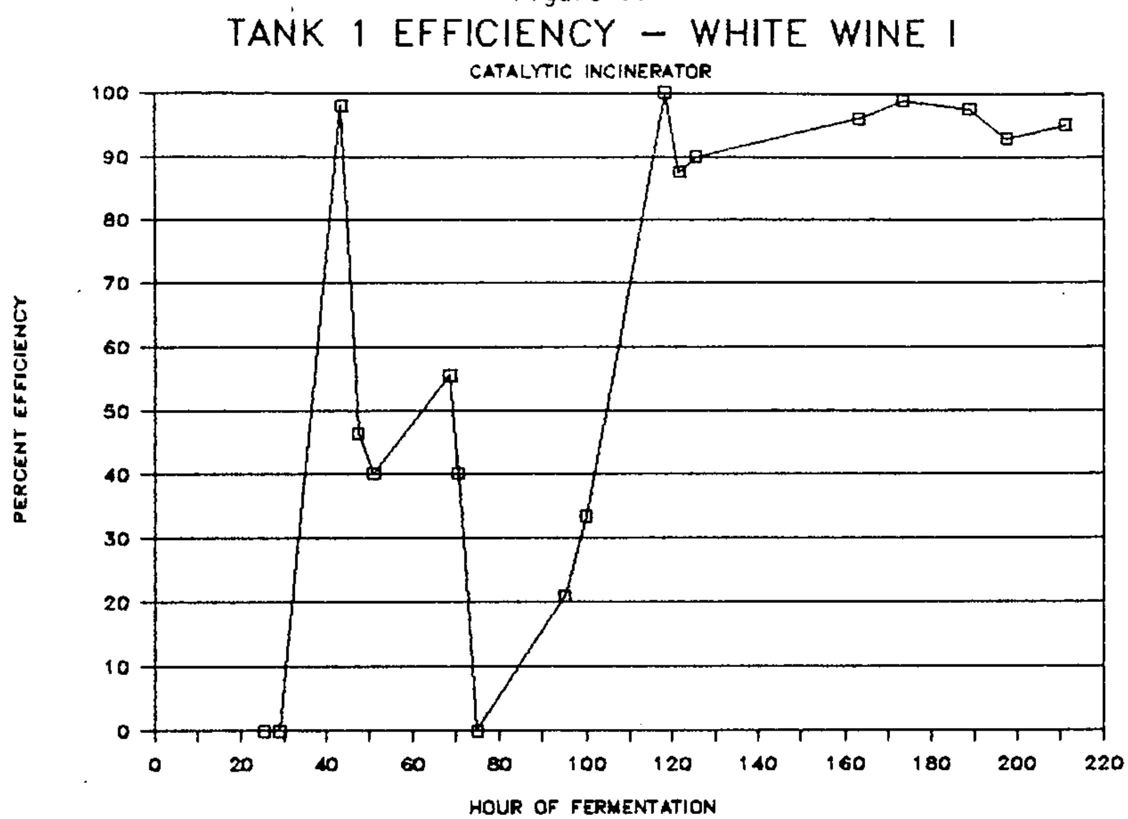


Figure 5.2

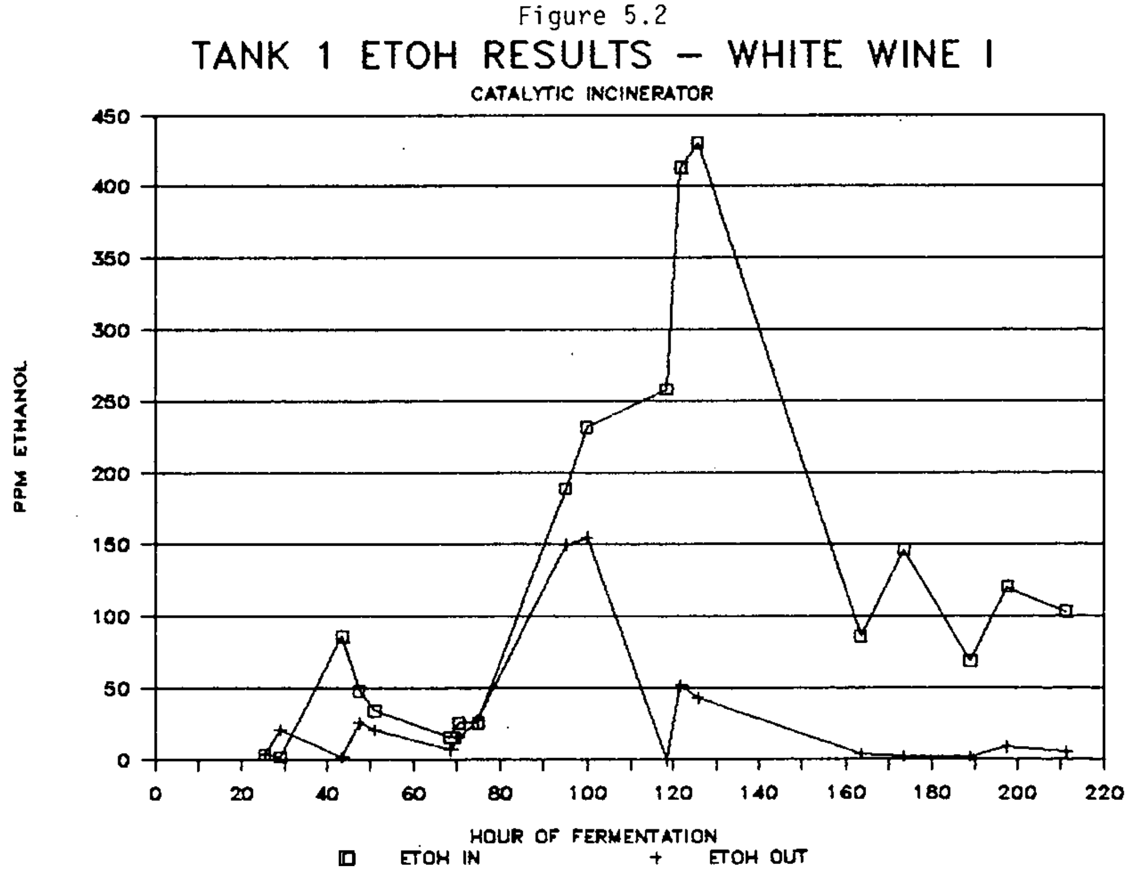


Figure 5.3

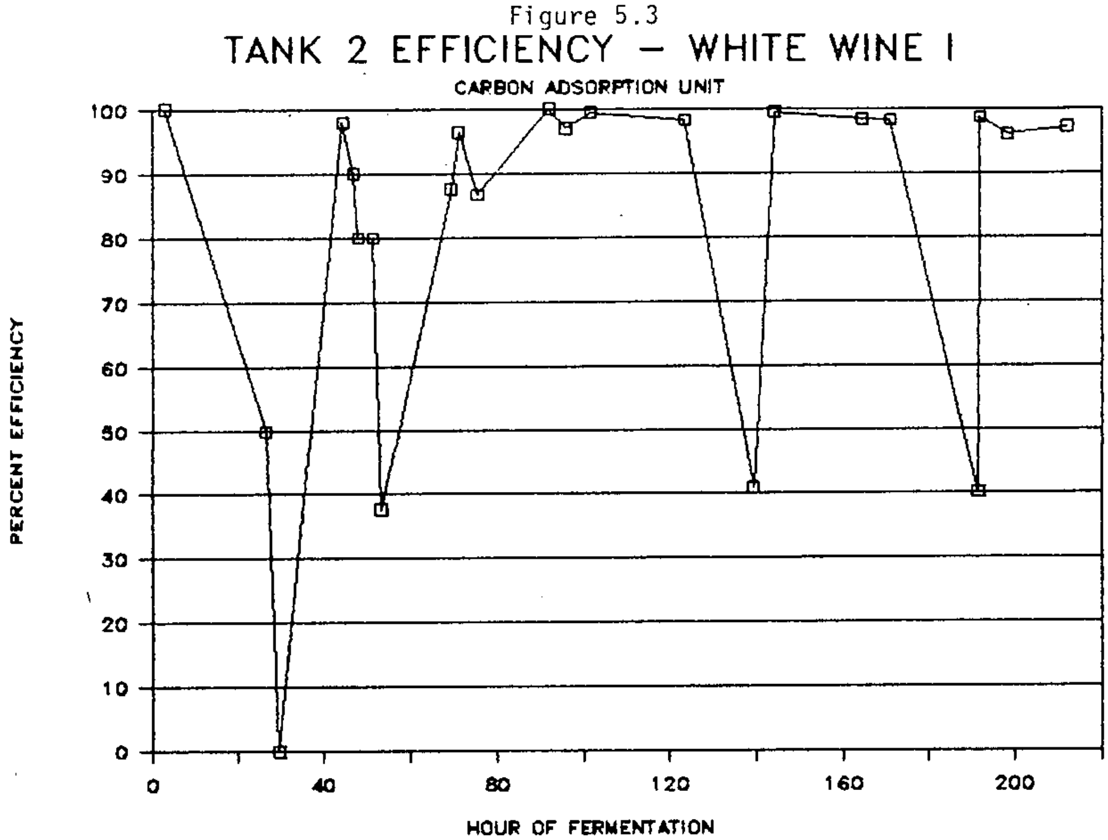


Figure 5.4

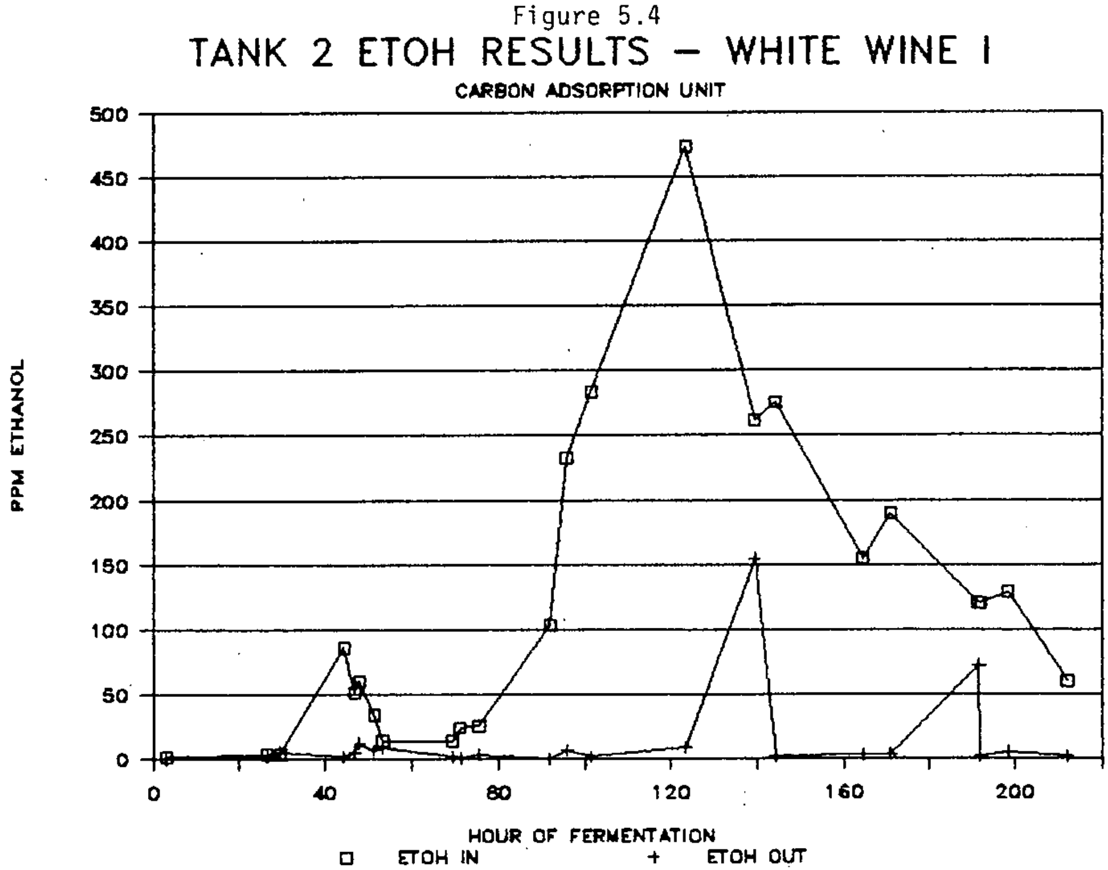


Figure 5.5

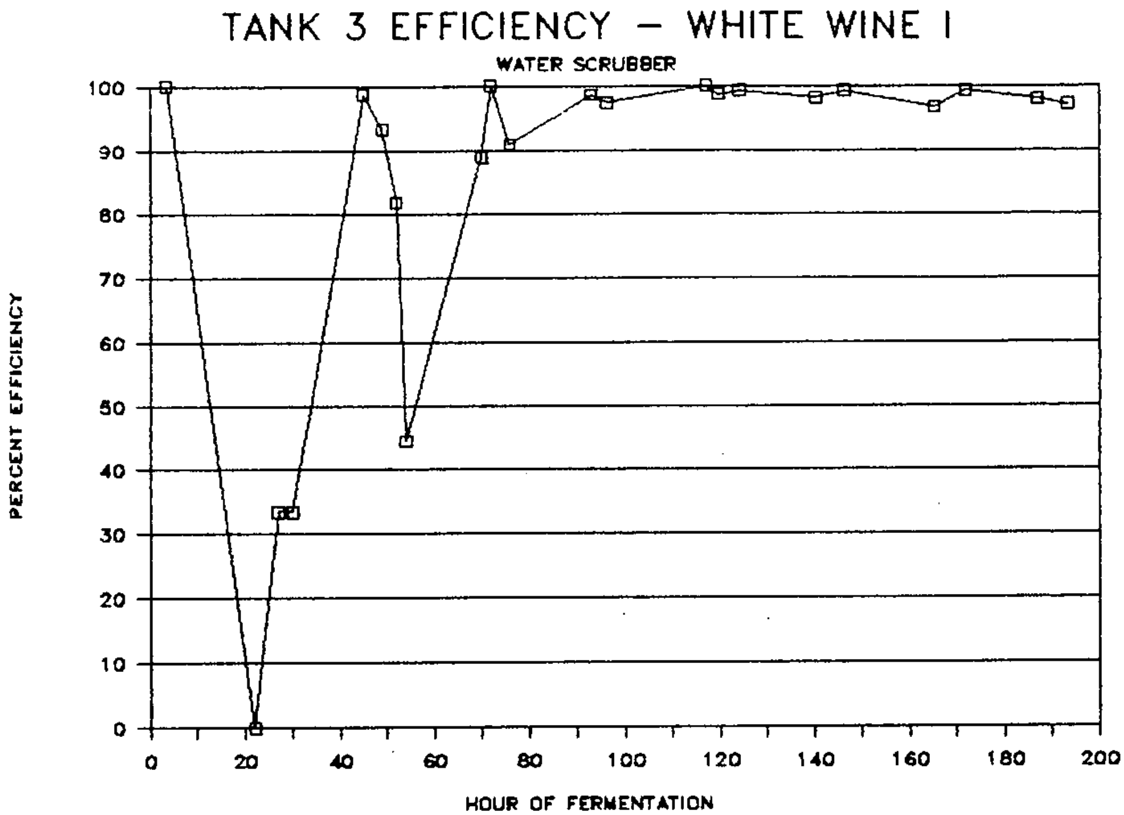


Figure 5.6

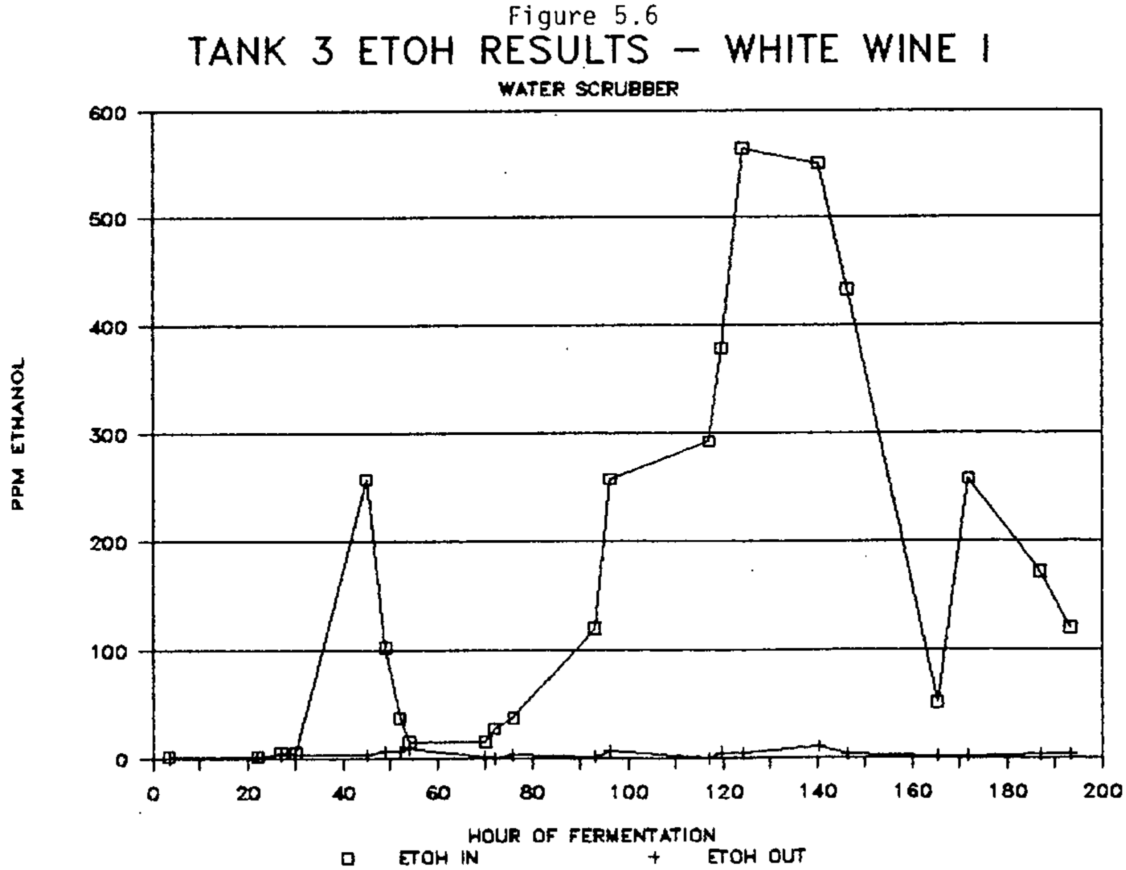


Figure 5.7

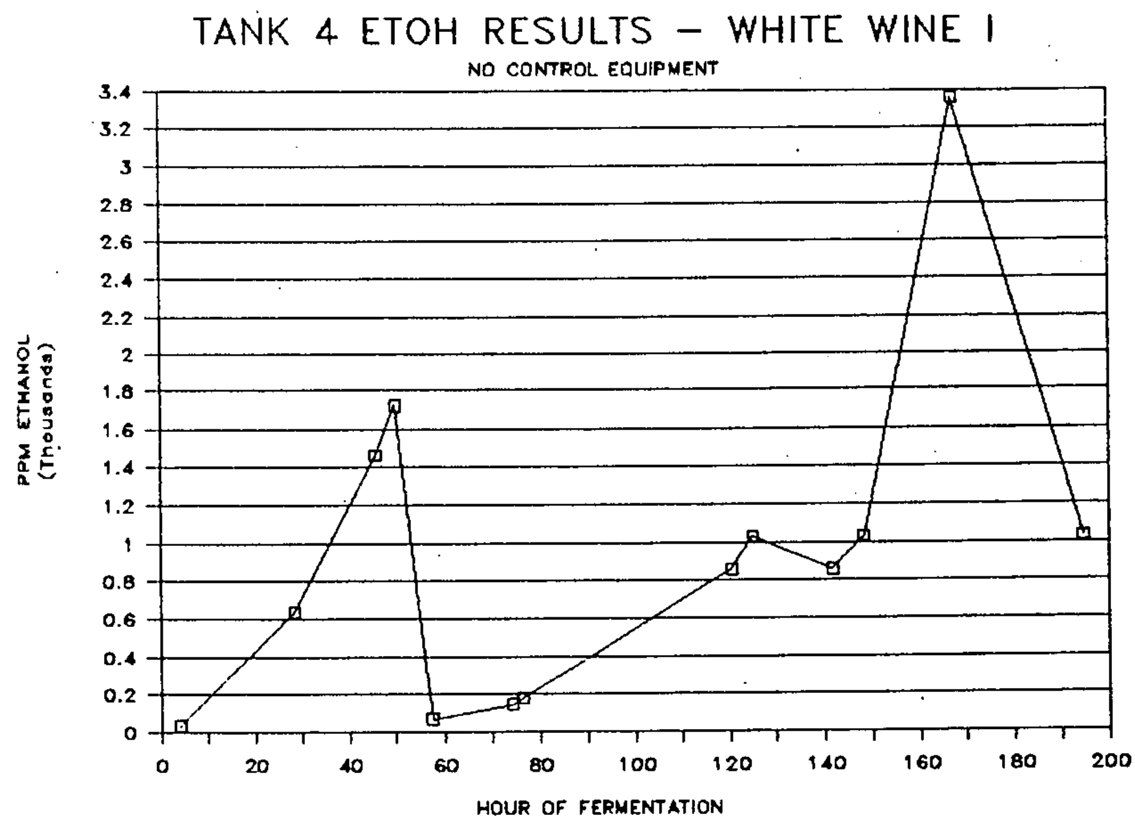
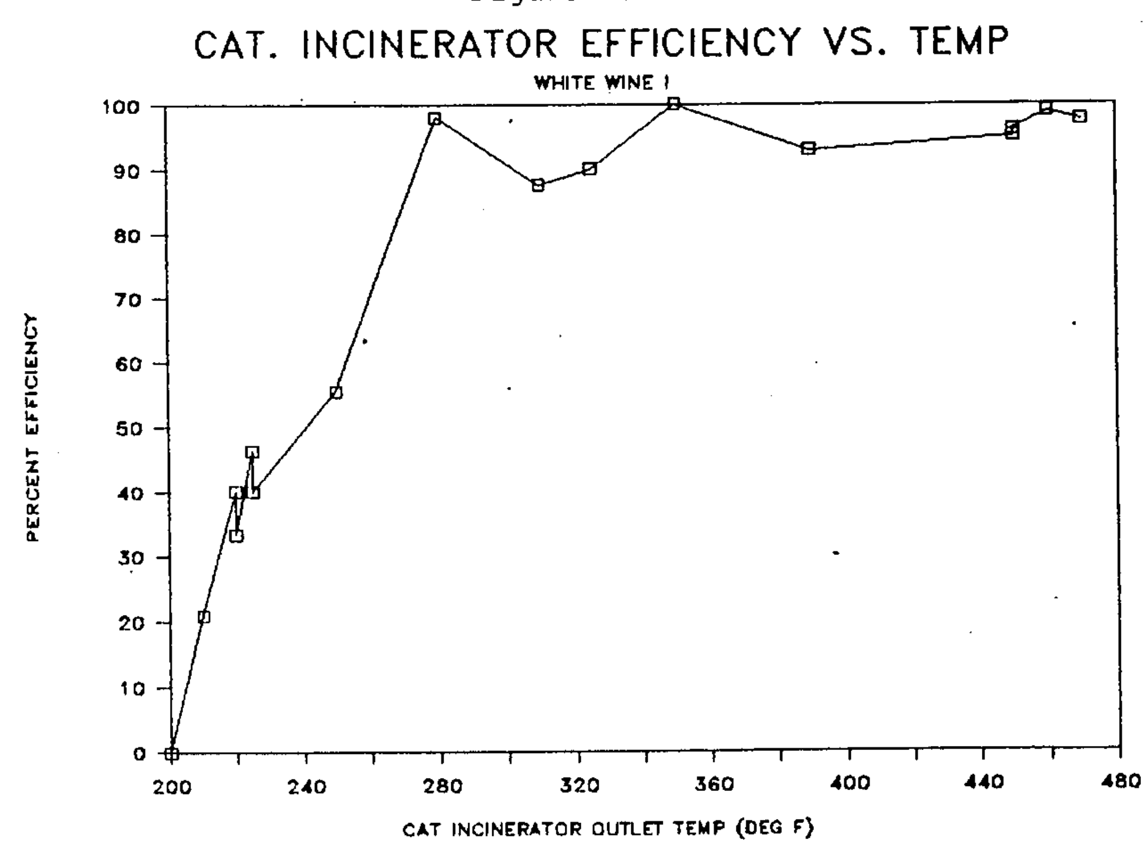


Figure 5.8



RED WINE I

Grape juice for this fermentation was obtained from the crush of red grapes from the Fresno State vineyards. The tanks were filled and fermentation initiated on the afternoon of August 31, 1987. Tanks 1, 2, and 3 experienced foamovers the morning of September 1. Consequently, the earliest data collected for the test was during the late afternoon of September 1. The tank hatches were not tightened until September 3 due to the foamover threat.

On September 2, there was a problem with condensation in the sample lines. To protect the analyzers and the sample pump, dry impingers were placed in ice water immediately upstream of the sample pump. This could reduce the amount of ethanol reaching the analyzers, as the ethanol could condense and be trapped in the impinger.

The fermentation was completed about noon on September 4. The data is listed in Table 5.5 and plotted in Figures 5.9 through 5.15.

TANK 1

Only one data point showed a control efficiency less than 90% and this was for an outlet temperature of 460 deg F. For all the other data points, the outlet temperature was in the range of 520 to 550 deg F.

TANK 2

The second data point which shows a control efficiency of 23% documents a "breakthrough" condition for carbon bed #2.

TANK 3

The scrubber unit continued to show good control efficiency in spite of some operational problems with the recirculation pump.

TANK 4

It should be noted that emissions from Tank 4 are not significantly diluted by ambient air as the inlet concentrations into the control devices. This is due to the hood collection systems on Tanks 1, 2 and 3 to provide the constant flow rates required by each of the control devices.

TABLE 5.5

RED WINE I - EMISSION DATA FOR CATALYTIC HEATER

TANK	DATE	TIME	HOURS	ETOH IN	ETOH OUT	% EFF	CO2 IN	CO2 OUT	O2 IN	O2 OUT	OUTLET TEMP
1	31-Aug-87	12:00	0.0								
	01-Sep-87	19:00	31.0	2881	1075	62.69	19.0	18	13	14.5	460
	02-Sep-87	18:40	54.7	860	43	95.00	11.0	10	18.5	18.7	550
	03-Sep-87	08:35	68.6	344	12	96.50	3.0	3.5	20.2	20.2	520
	03-Sep-87	14:50	74.8	1290	17	98.67	12.5	12.5	18	17.5	535
	04-Sep-87	06:45	90.8	292	10	96.47	5.0	5.5	20.2	20.2	520
	04-Sep-87	11:45	95.7	344	17	95.00	4.0	5.3	20.3	20.5	520

RED WINE I - EMISSION DATA FOR CARBON ADSORPTION UNIT

TANK	DATE	TIME	HOURS	ETOH IN	ETOH OUT	% EFF	CO2 IN	CO2 OUT	O2 IN	O2 OUT
2	31-Aug-87	15:00	0							
	01-Sep-87	16:30	25.5	3784	1075	71.59	>20	>20	14	15
	02-Sep-87	13:15	46.2	3354	2580	23.08	17.0	11	17.5	18
	03-Sep-87	09:10	66.2	722	163	77.38	12.5	7.5	19.2	19
	03-Sep-87	13:35	70.6	1247	5	99.59	13.2	8.5	18.5	18.8
	04-Sep-87	07:35	88.6	344	26	92.50	7.7	9.8	18.8	20

RED WINE I - EMISSION DATA FOR WATER SCRUBBER

TANK	DATE	TIME	HOURS	ETOH IN	ETOH OUT	%EFF	CO2 IN	CO2 OUT	O2 IN	O2 OUT
3	31-Aug-87	17:00	0							
	02-Sep-87	09:20	40.3	860	0	100.00	19.0	0	16	21
	02-Sep-87	16:05	47.1	1600	17	98.92	18.0	0.6	17	20.6
	03-Sep-87	12:00	67.0	826	52	93.75	10.8	0.2	19.5	21
	04-Sep-87	08:00	87.0	301	5	98.29	3.8	0.8	19.5	20.9

RED WINE I - NO CONTROLS

TANK	DATE	TIME	HOURS	ETOH IN	ETOH OUT	% EFF	CO2 IN	CO2 OUT	O2 IN	O2 OUT
4	31-Aug-87	19:15	0							
	02-Sep-87	12:00	40.8	6880	6880	0.00	>20	>20	16	16
	03-Sep-87	16:30	69.3	7740	7740	0.00	>20	>20	13	12.5
	04-Sep-87	10:00	86.8	4300	4300	0.00	>20	>25	9.3	10

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Figure 5.9

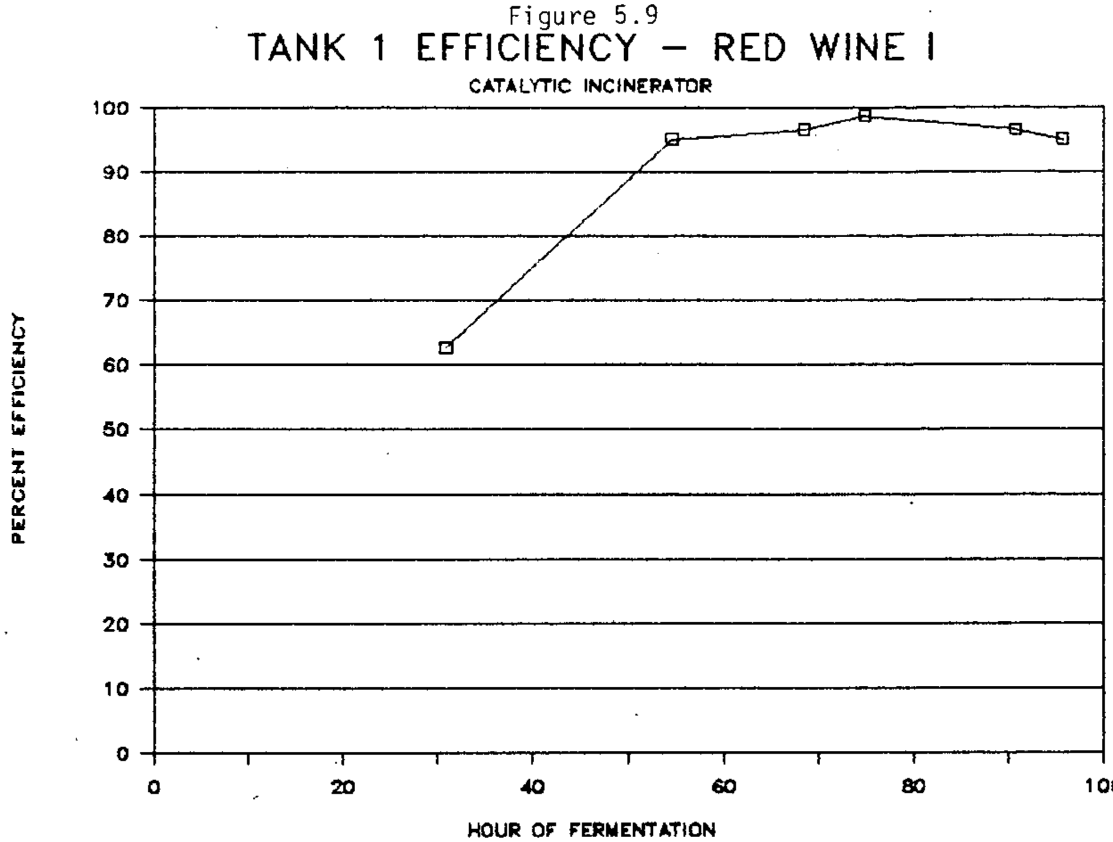


Figure 5.10

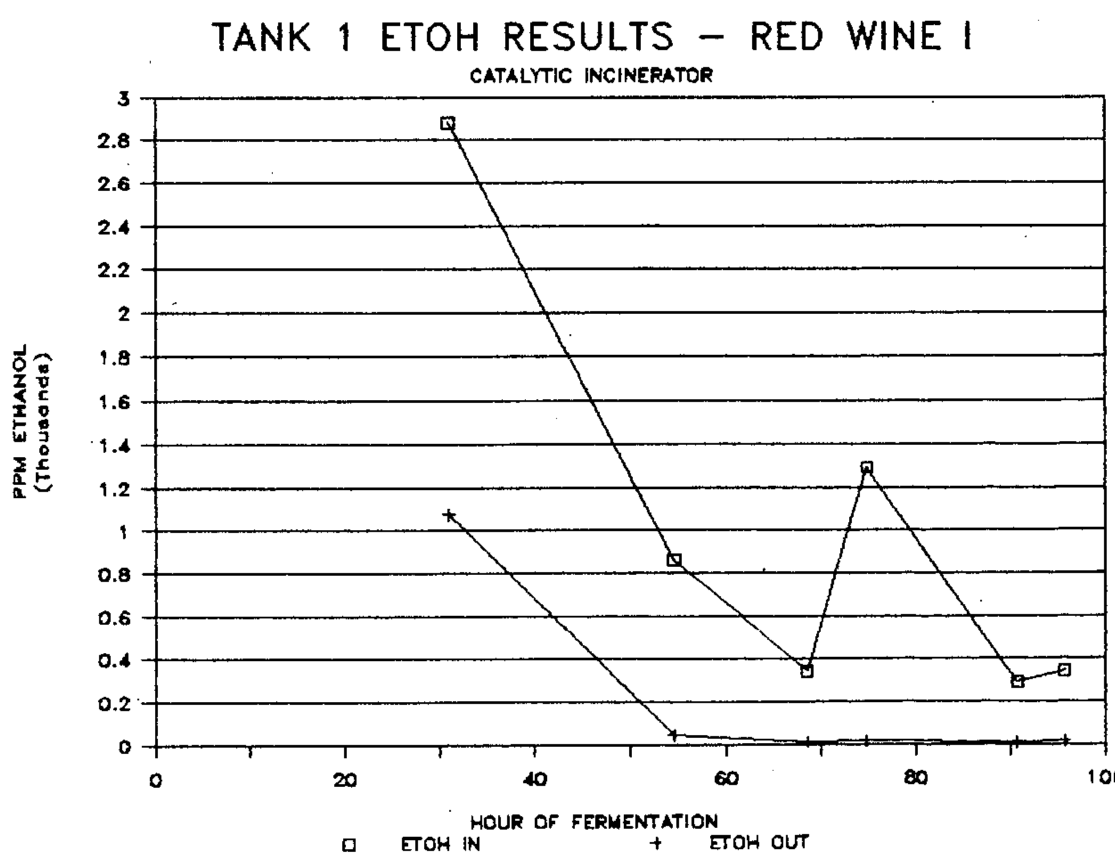


Figure 5.11

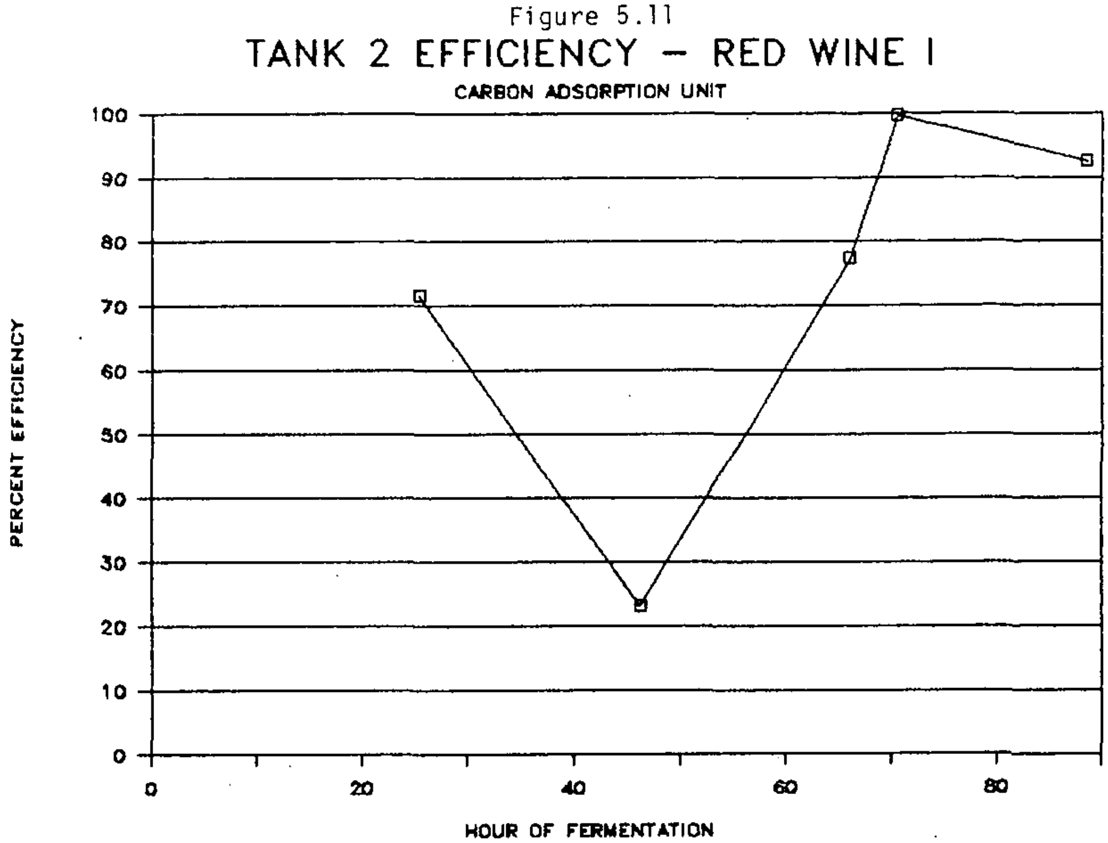


Figure 5.12

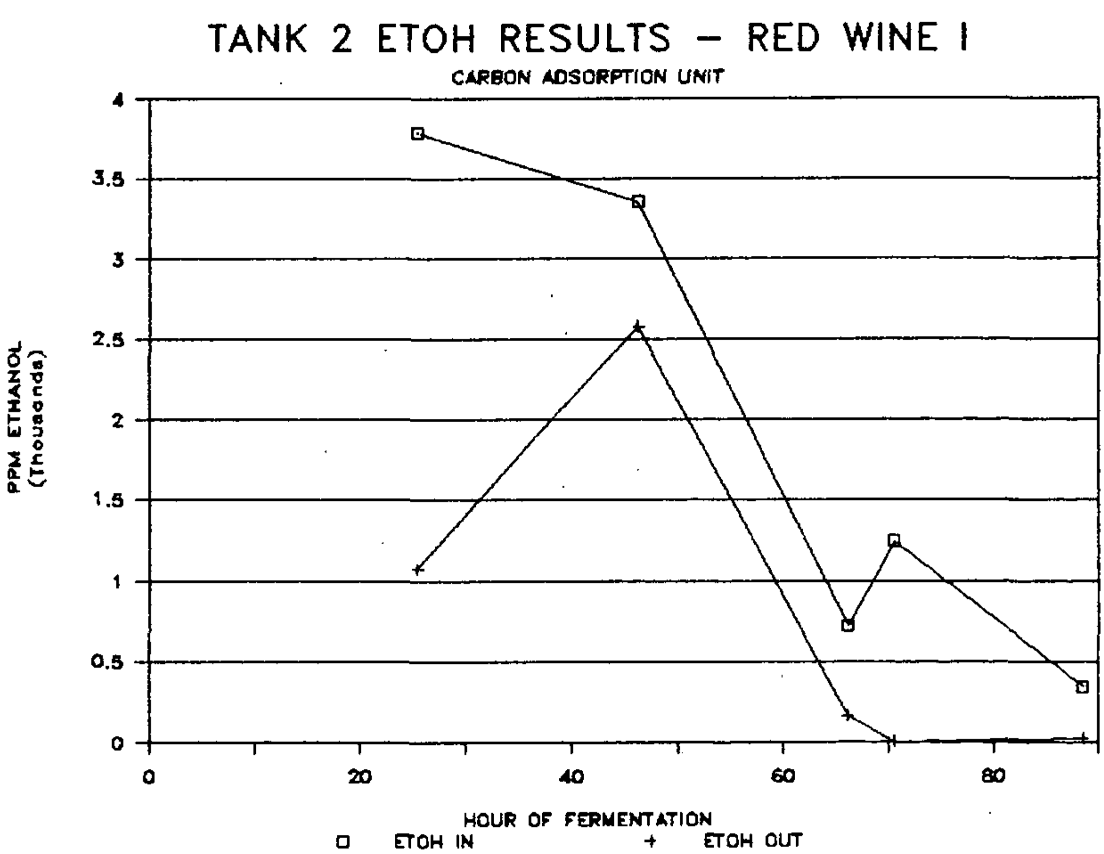


Figure 5.13

TANK 3 EFFICIENCY — RED WINE I

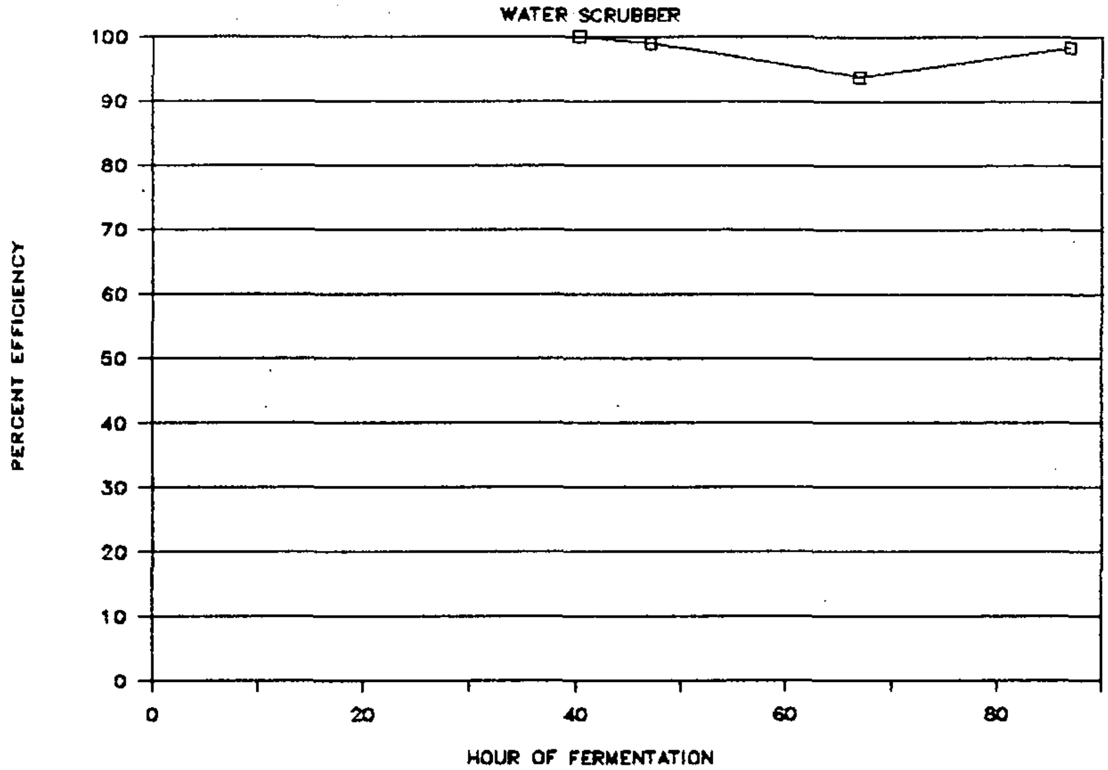


Figure 5.14

TANK 3 ETOH RESULTS — RED WINE I

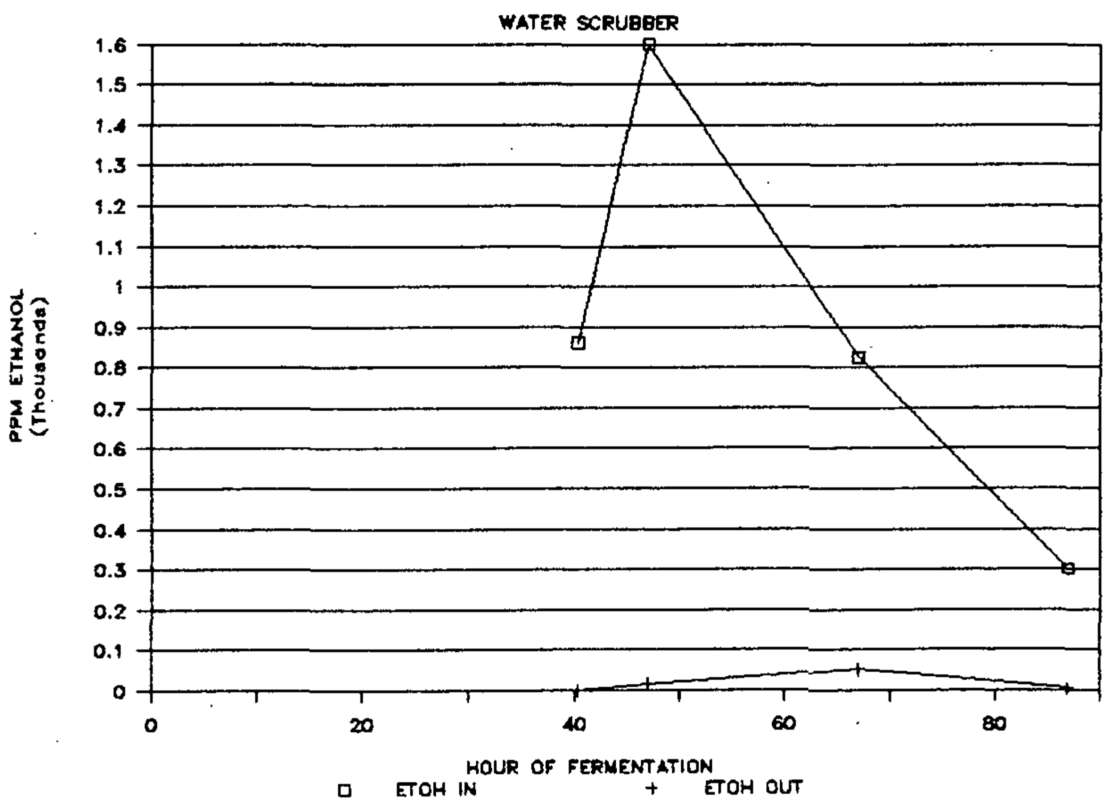
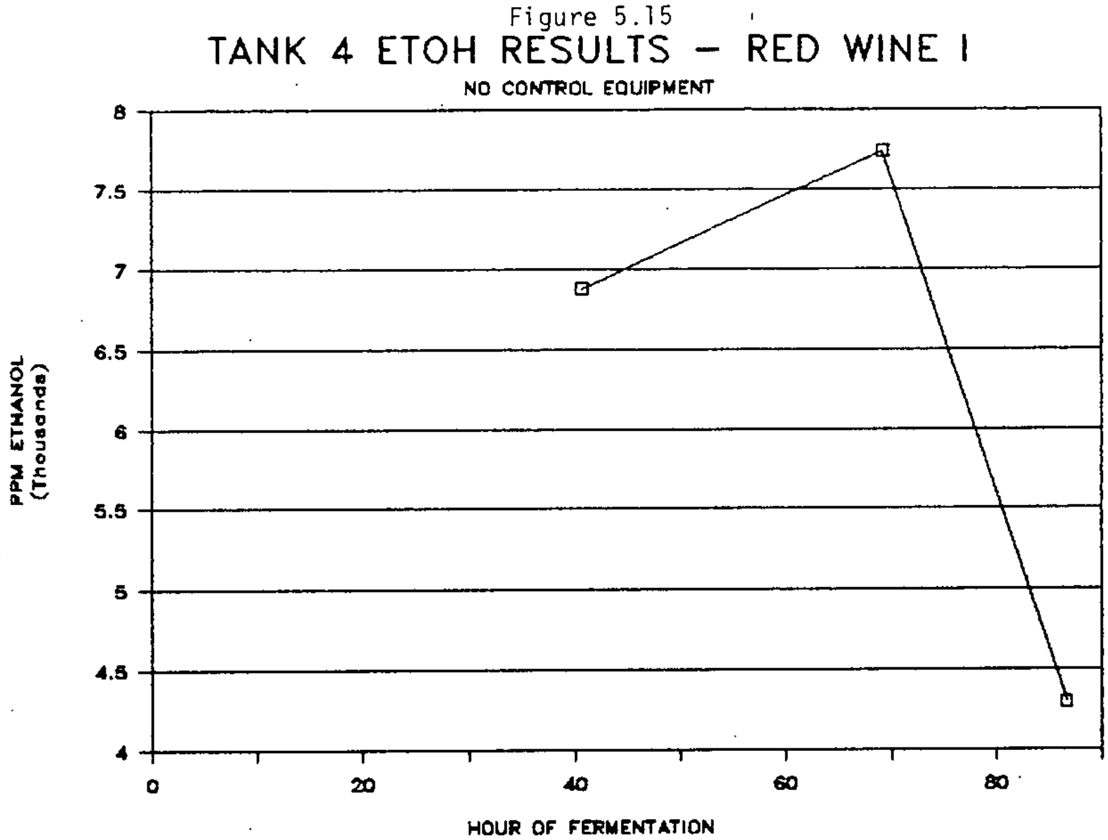


Figure 5.15



TANK 4 ETOH RESULTS — RED WINE I
NO CONTROL EQUIPMENT
PPM ETHANOL (Thousands)
8
7.5
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
HOUR OF FERMENTATION

RED WINE II

Grape juice for this fermentation was again furnished by the crush of red grapes from the Fresno State vineyards. The tank were filled and fermentation initiated on September 10, 1987.

The fermentations were completed about noon on September 14. The data for this fermentation was also recorded at 5 minute intervals by a datalogger. The data is summarized in Tables 5.6 and 5.7 and plotted in Figures 5.16 through 5.22.

TANK 1

All of the data for this fermentation show the catalytic incinerator operating at better than 90% efficiency. Temperatures of the incinerator exhaust ranged from 540 to 615 degrees F.

TANK 2

Steam was unavailable for regeneration of the carbon adsorption unit on September 12 and 13. In spite of this, only one data point was taken which showed an efficiency less than 90%.

TANK 3

On September 11, the scrubber was disassembled and the packing rearranged to try and reduce the pressure drop. Some water was still being observed dripping from the scrubber pump exhast pipe indicating water carryover. Further scrubber operation adjustments were made on September 12 and no water carryover was then observed.

The scrubber appeared to be operating at better than 95% efficiency.

TANK 4

Emission data was not taken near the end of the fermentation. Total emissions estimated by integrating the curve in Fig. 5.22 would be lower than the actual emissions.

TABLE 5.6

RED WINE II - EMISSION DATA FOR CATLYTIC INCINERATOR

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	O2 IN (%)	O2 OUT (%)	CO2 IN (%)	CO2 OUT (%)	OUTLET TEMP F
1	10-Sep-87	13:00	0.0								520
	11-Sep-87	11:20	22.3	1593	83	94.8	16.2	15.0	19.7	23.0	560
	11-Sep-87	15:10	26.2	1044	64	93.8	17.3	16.0	12.1	14.3	550
	11-Sep-87	19:50	30.8	3194	53	98.4	13.4	12.0	26.6 *	36.9 *	550
	12-Sep-87	08:30	43.5	1781	18	99.0	15.8	15.6	20.2	22.6	615
	12-Sep-87	12:50	47.8	1932	49	97.5	16.7	16.0	17.3	18.6	605
	12-Sep-87	22:00	57.0	1093	65	94.1	18.2	18.3	11.8	11.8	590
	13-Sep-87	00:00	59.0	856	15	98.2	18.7	18.9	9.7	9.4	580
	13-Sep-87	01:00	60.0	685	-1	100.0	18.9	19.1	9.2	8.9	555
PO	13-Sep-87	02:05	61.1	244	-4	100.0	20.1	20.6	1.2	1.1	540
	13-Sep-87	04:00	63.0	455	-2	100.0	19.0	19.2	7.8	7.1	550
	13-Sep-87	06:00	65.0	294	-1	100.0	19.2	19.8	4.6	4.3	545
	13-Sep-87	14:55	73.9	382	36	90.6	19.9	19.9	3.5	3.7	550
	13-Sep-87	19:40	78.7	649	28	95.6	19.2	20.2	6.5	6.1	570
PO	13-Sep-87	20:10	79.2	233	22	90.8	20.5	20.5	0.2	0.3	555
	14-Sep-87	09:25	92.4	331	2	99.5	19.1	19.6	5.8	4.2	---

RED WINE II - EMISSION DATA FOR CARBON ADSORPTION UNIT

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	O2 IN (%)	O2 OUT (%)	CO2 IN (%)	CO2 OUT (%)
2	10-Sep-87	11:42	0.0							
	11-Sep-87	10:10	22.5	342	10	97.0	18.8	18.8	10.3	8.0
	11-Sep-87	16:30	28.8	1144	17	98.5	16.8	17.7	15.4	14.5
	11-Sep-87	20:50	33.1	2184	10	99.5	13.9	15.1	26.8 *	30.1 *
B1	12-Sep-87	08:55	45.2	1992	29	98.6	15.9	17.2	20.2	18.2
B2	12-Sep-87	09:30	45.8	1970	17	99.1	16.3	17.5	19.2	16.8
	12-Sep-87	13:55	50.2	1780	23	98.7	17.8	17.1	15.5	17.4
	13-Sep-87	10:00	70.3	749	278	62.9	18.8	19.5	11.4	8.4
	13-Sep-87	17:15	77.6	1075	57	94.7	18.7	19.8	10.7	8.8
	13-Sep-87	20:45	81.1	562	47	91.6	19.2	17.1	9.1	7.9
PO	13-Sep-87	21:45	82.1	265	29	88.9	20.7	20.6	1.2	1.0
	14-Sep-87	00:00	84.3	574	32	94.5	19.7	19.6	7.4	5.8
	14-Sep-87	02:00	86.3	689	32	95.4	19.4	19.5	8.3	6.5
	14-Sep-87	03:25	87.7	896	33	96.3	19.1	19.6	7.4	5.9
PO	14-Sep-87	05:15	89.6	489	29	94.1	20.3	20.6	1.1	0.9
	14-Sep-87	06:30	90.8	374	28	92.4	20.0	20.4	2.6	2.1
	14-Sep-87	11:15	95.6	413	34	91.7	19.6	19.6	6.0	4.4

PO - Pumpover occurred during this sampling period. C-87-041

* - Extrapolated value (off the calibrated scale of 0-25%)

TABLE 5.7

RED WINE II - EMISSION DATA FOR WATER SCRUBBER

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	O2 IN (%)	O2 OUT (%)	CO2 IN (%)	CO2 OUT (%)
3	10-Sep-87	10:10	0.0							
	11-Sep-87	12:15	26.1	471	8	98.4	20.4	20.0	2.1	1.0
	11-Sep-87	17:25	31.3	368	4	99.0	17.7	20.7	13.3	1.2
	11-Sep-87	23:50	37.7	434	7	98.4	19.5	21.5	8.6	0.1
	12-Sep-87	02:00	39.8	1379	6	99.5	15.9	21.2	20.4	0.1
	12-Sep-87	04:00	41.8	1657	6	99.6	16.0	21.2	19.5	0.1
	12-Sep-87	06:00	43.8	1486	6	99.6	17.0	21.2	15.4	0.1
	12-Sep-87	07:00	44.8	1269	7	99.5	16.4	19.0	17.3	0.0
	12-Sep-87	10:15	48.1	1808	5	99.7	16.9	21.1	16.8	0.4
	12-Sep-87	15:30	53.3	1584	5	99.7	18.2	20.8	12.1	0.1
	13-Sep-87	09:00	70.8	1155	6	99.5	17.5	21.1	17.7	0.1
	13-Sep-87	18:20	80.2	897	26	97.1	19.2	21.6	6.0	0.1
	14-Sep-87	08:10	94.0	364	4	98.9	18.9	20.0	7.3	2.3
	14-Sep-87	12:00	97.8	597	24	96.0	19.5	16.5	9.2	4.1

RED WINE II - NO CONTROLS

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	O2 IN (%)	O2 OUT (%)	CO2 IN (%)	CO2 OUT (%)
4	10-Sep-87	09:30	0.0							
	10-Sep-87	15:55	6.4	7			20.9	21.1	0.2	0.1
	10-Sep-87	17:00	7.5	4			20.9	21.0	0.3	0.2
	10-Sep-87	18:00	8.5	3			20.7	21.1	0.4	0.3
	10-Sep-87	20:00	10.5	6			20.2	20.9	1.1	0.9
	10-Sep-87	22:00	12.5	4			20.1	20.9	1.2	1.0
	11-Sep-87	00:00	14.5	4			19.3	21.0	0.6	0.5
	11-Sep-87	02:00	16.5	30			18.2	20.7	0.7	0.5
	11-Sep-87	04:00	18.5	58			18.5	20.7	0.8	0.6
	11-Sep-87	06:00	20.5	74			18.5	20.6	1.3	1.0
	11-Sep-87	07:00	21.5	82			18.3	20.5	1.7	1.4
	11-Sep-87	12:45	27.3	44			20.5	19.9	1.2	0.9
	12-Sep-87	11:15	49.8	4214			4.3	4.3	29.5 *	44.9 *
PO	12-Sep-87	17:00	55.5	2978			14.5	13.9	21.2	26.8 *
	12-Sep-87	18:30	57.0	6171			3.7	3.0	29.2 *	44.6 *
	13-Sep-87	12:30		8789			2.9	3.2	31.9 *	50.7 *

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

C-87-041

Figure 5.16

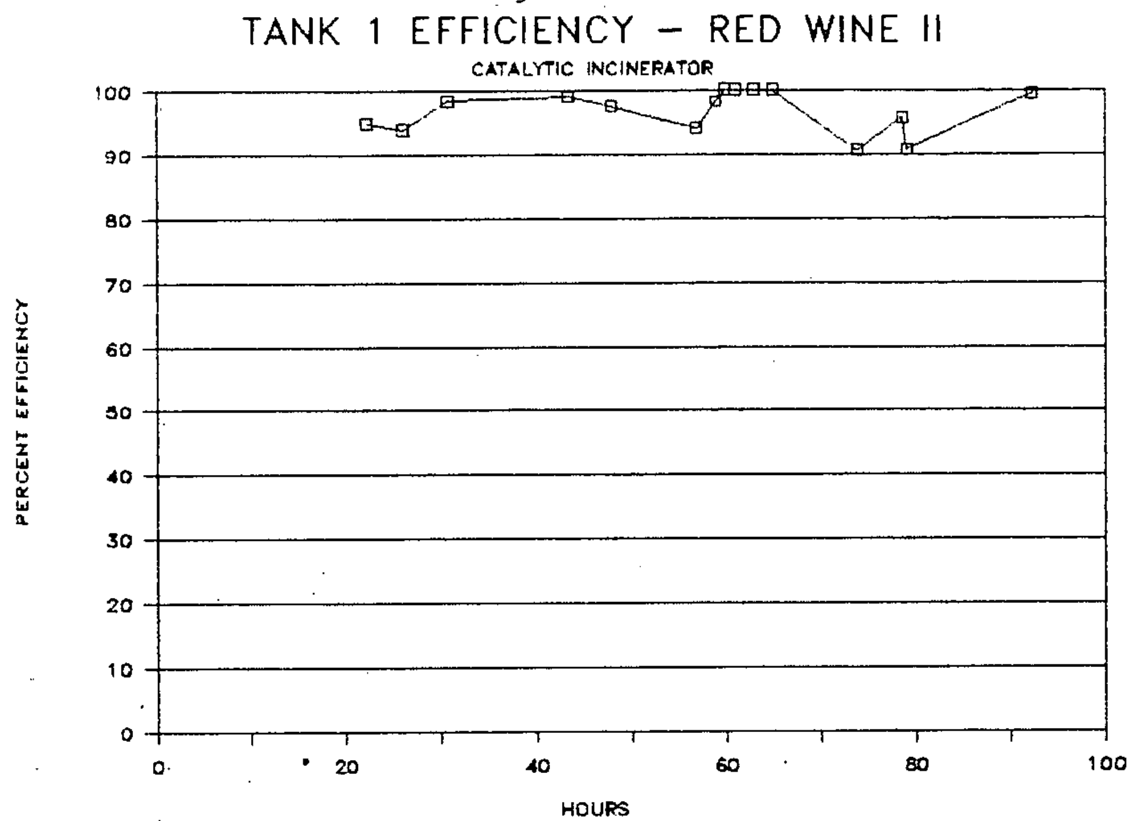


Figure 5.17

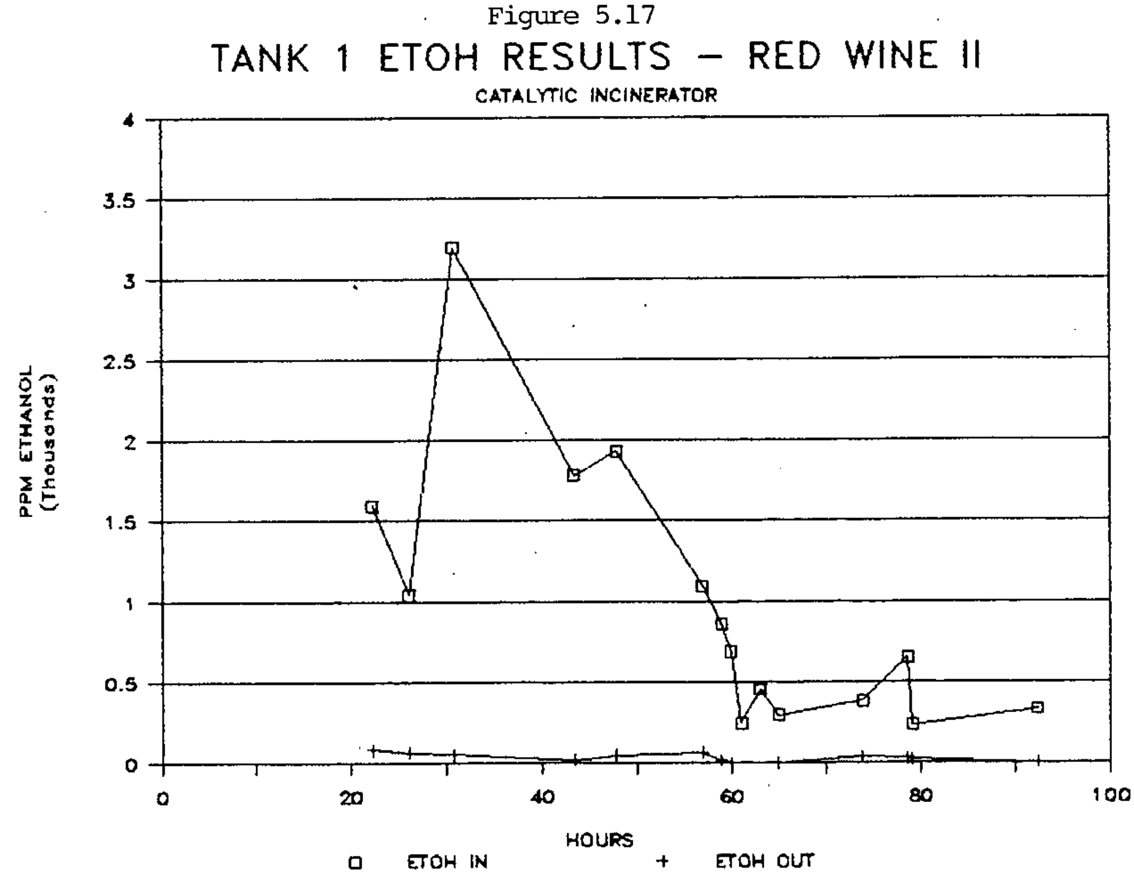


Figure 5.18

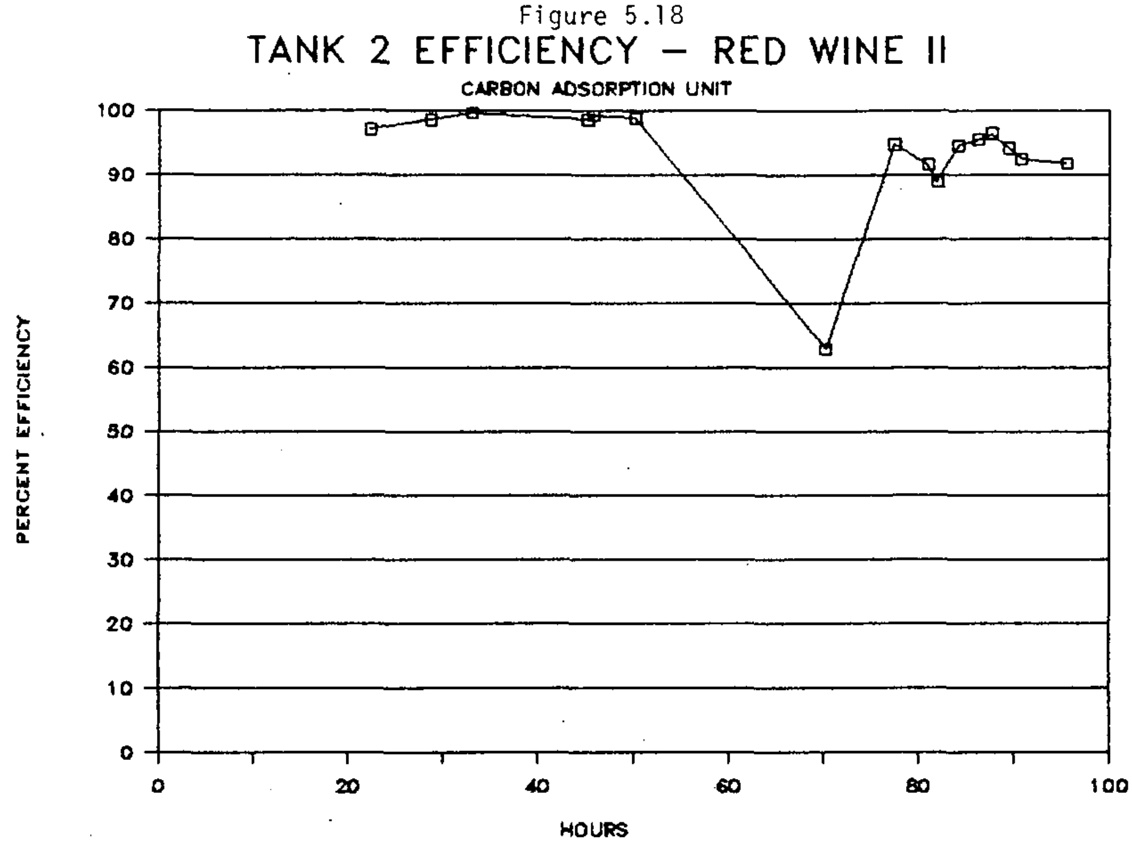


Figure 5.19

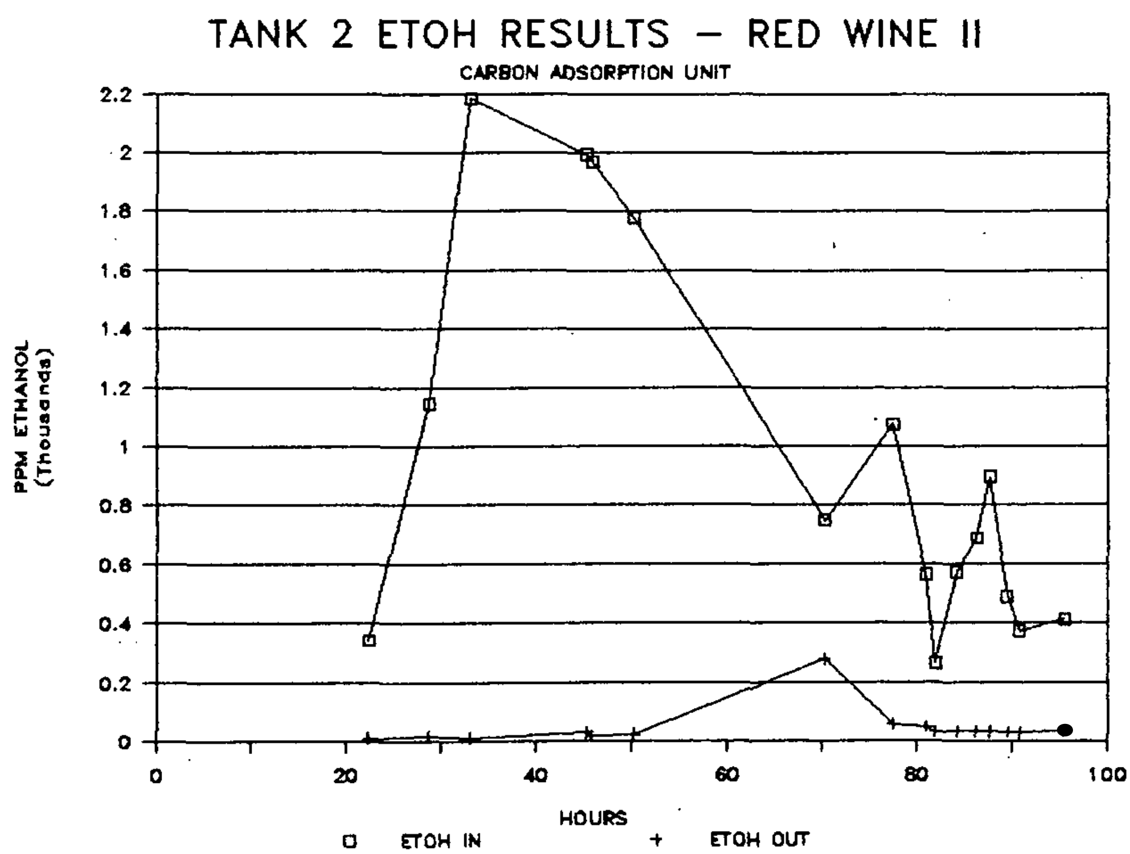


Figure 5.20

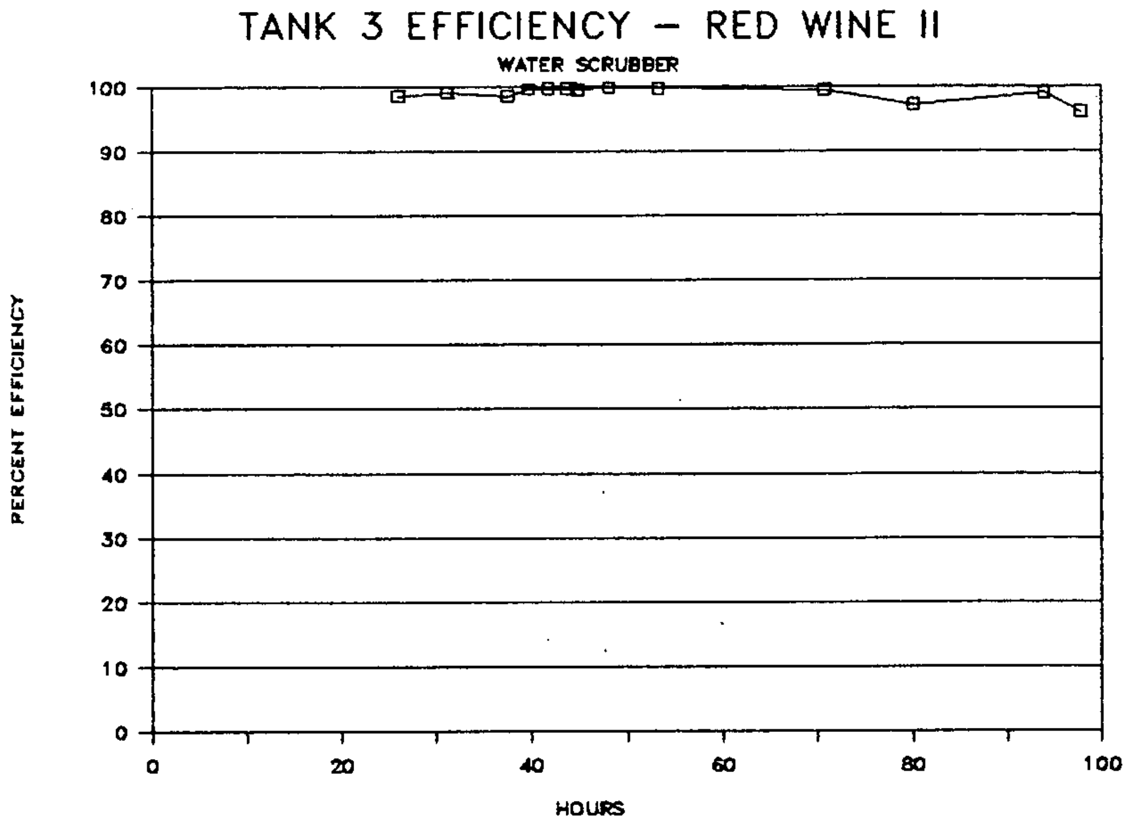


Figure 5.21

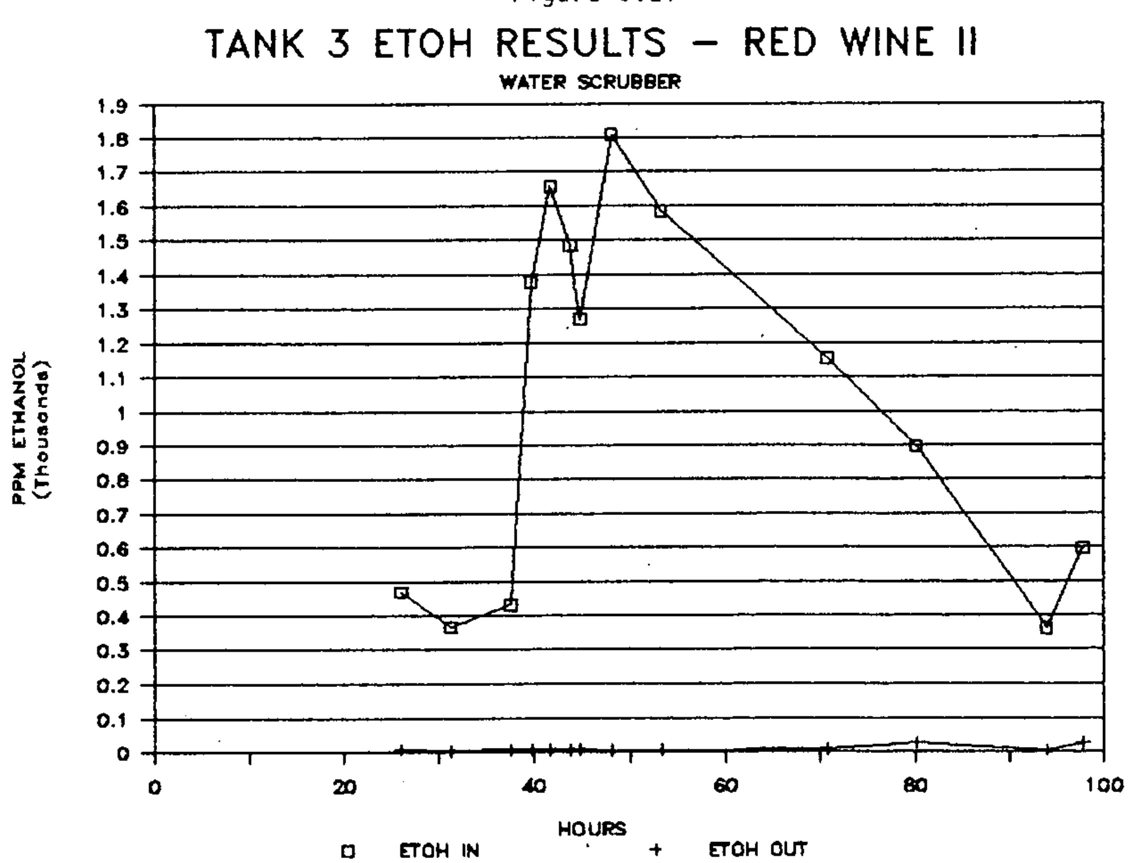
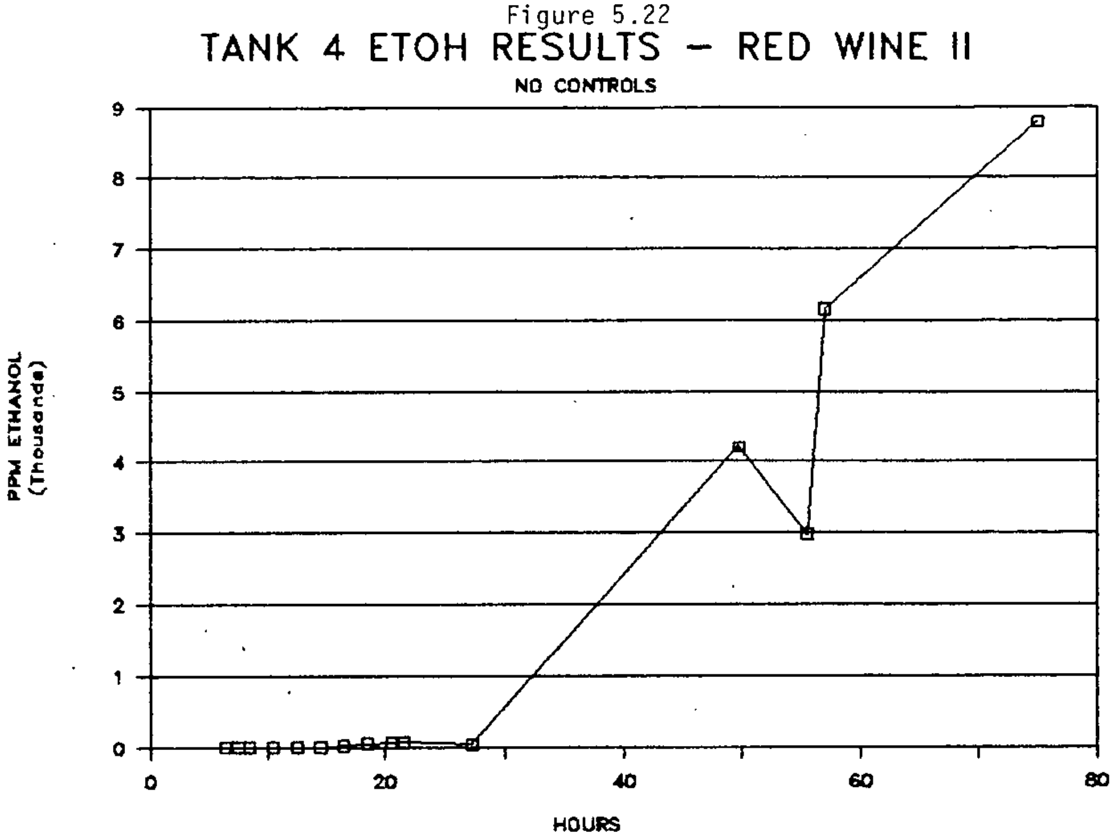


Figure 5.22



TANK 4 ETOH RESULTS — RED WINE II
NO CONTROLS
PPM ETHANOL
(Thousands)
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
HOURS

WHITE WINE II

White grape juice for this fermentation was provided by Gallo via tank truck. The tanks were filled and fermentation initiated on September 16, 1987.

Inlet hydrocarbon concentration on the afternoon of September 16 was found to be high due to contamination from the in-line impinger. The impingers were then removed from the sampling lines.

Fresno APCD personnel assisted with data collection on Saturday, September 19. Instruments were shut down at 1615 hours due to water in the sample lines and pump. Water in the lines was probably due to water carryover from the scrubber. Problems with the scrubber continued throughout the remainder of the fermentation.

The refrigeration unit compressor went out about noon on September 20. It was repaired by 1500 hours. This refrigeration unit is used to keep the fermentation tanks within the optimum temperature range for wine fermentation. While the unit was being repaired, cold water was run over the tops of the tanks to slow down the rise in temperature.

The fermentations were completed on September 24. The data for this fermentation was recorded every 5 minutes by a datalogger. The data is summarized in Tables 5.8 through 5.11 and plotted in Figures 5.23 through 5.29.

TANK 1

The catalytic incinerator achieved better than 95% efficiency for this fermentation. The low efficiencies shown in Figure 5.23 from 0 to 80 hours into the fermentation are a result of measurement error present in comparing low ppm ethanol emissions. The incinerator exhaust temperatures ranged from 525 to 600 deg F.

TANK 2

The carbon adsorption unit averaged better than 95% efficiency, in spite of some data points showing breakthrough of the carbon bed. Again, efficiencies shown in Figure 5.25 from 0 to 80 hours into the fermentation may not be representative of actual conditions.

TANK 3

After the 80 hour mark, the water scrubber averaged better than 95% efficiency, in spite of operational problems with the scrubber as noted earlier.

TANK 4

Figure 5.29 shows that emissions peaked at about 120 hours, the same as the other three tanks. However, Tank 4 emissions did not drop off significantly until after 200 hours, while the other three tanks had a considerable drop in EtOH concentration at 140 hours.

Table 5.8
WHITE WINE II - EMISSION DATA FOR CATALYTIC INCINERATOR

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	O2 IN (%)	O2 OUT (%)	CO2 IN (%)	CO2 OUT (%)	OUTLET TEMP (DEG F)
1	15-Sep-87	11:00	0.0								
	16-Sep-87	16:45	29.8	13.0	7.4	42.58	20.7	20.4	0.0	0.1	535
	17-Sep-87	08:15	45.3	0.9	5.7	---	20.5	20.9	0.1	0.3	530
	17-Sep-87	11:55	48.9	2.2	0.0	100.00	20.0	20.4	0.3	0.5	525
	17-Sep-87	16:35	53.6	3.9	4.8	---	20.1	20.5	0.1	0.3	535
	18-Sep-87	08:35	69.6	2.3	3.1	---	20.4	19.8	1.2	1.4	530
	18-Sep-87	13:30	74.5	18.7	4.5	75.72	18.9	19.4	7.0	6.8	540
	19-Sep-87	02:00	87.0	48.4	1.1	97.65	17.9	19.0	12.7	11.2	545
	19-Sep-87	04:00	89.0	57.5	0.7	98.70	18.3	18.9	12.5	11.8	550
	19-Sep-87	06:00	91.0	70.4	0.7	99.07	18.0	18.7	13.4	12.8	550
	19-Sep-87	08:15	93.3	76.6	0.4	99.54	18.1	18.8	12.9	12.5	550
	20-Sep-87	13:40	122.7	1782.9	5.6	99.69	14.9	54.5	26.1	25.8	600
	20-Sep-87	22:00	131.0	1079.7	6.8	99.37	16.5	16.6	22.2	22.5	590
	21-Sep-87	00:00	133.0	806.4	2.5	99.68	16.9	17.6	19.9	19.1	580
	21-Sep-87	02:00	135.0	748.3	1.2	99.84	16.6	17.5	19.9	19.6	575
	21-Sep-87	04:00	137.0	661.8	0.2	99.97	16.7	17.7	19.0	18.7	570
	21-Sep-87	07:00	140.0	524.1	5.8	98.89	17.3	18.2	18.5	16.8	560
	21-Sep-87	11:05	144.1	869.9	6.0	99.31	17.6	18.0	17.9	16.3	565
	21-Sep-87	19:30	152.5	615.9	0.0	100.00	18.2	17.4	15.0	13.6	580
	22-Sep-87	12:00	169.0	473.2	7.5	98.42	19.1	19.6	10.4	9.3	555
	22-Sep-87	15:00	172.0	383.7	7.9	97.94	19.3	19.4	9.0	7.9	555
	23-Sep-87	09:35	190.6	284.9	2.2	99.23	19.4	19.5	8.0	8.7	540
	23-Sep-87	13:30	194.5	269.2	1.3	99.52	19.4	19.7	7.8	7.2	545
	24-Sep-87	08:15	213.3	47.2	0.6	98.70	20.2	20.9	2.3	2.3	

Table 5.9
WHITE WINE II - EMISSION DATA FOR CARBON ADSORPTION UNIT

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	O2 IN (%)	O2 OUT (%)	CO2 IN (%)	CO2 OUT (%)
2	15-Sep-87	11:00	0.0							
	17-Sep-87	18:30	55.5	0.8	0.9	---	20.4	20.5	0.1	0.3
	18-Sep-87	09:30	70.5	9.8	2.9	70.30	19.7	20.7	4.7	1.5
	18-Sep-87	17:45	78.8	21.4	10.8	49.63	19.5	19.4	7.7	6.1
	19-Sep-87	12:25	97.4	141.8	5.5	96.11	17.2	18.4	16.7	14.3
	20-Sep-87	14:25	123.4	2037.3	20.8	98.98	14.2	54.5	27.6	31.0
	21-Sep-87	10:00	143.0	896.2	5.3	99.41	17.5	18.6	18.8	14.4
	21-Sep-87	12:20	145.3	948.6	6.8	99.28	17.5	18.6	18.3	14.3
	21-Sep-87	17:10	150.2	901.8	113.1	87.46	17.9	17.7	15.6	12.1
	21-Sep-87	22:00	155.0	426.2	1.9	99.55	18.3	19.0	13.7	10.9
	22-Sep-87	00:00	157.0	365.8	0.6	99.84	18.4	19.4	11.8	9.8
	22-Sep-87	02:00	159.0	363.6	1.1	99.70	18.0	19.5	11.0	9.6
	22-Sep-87	04:00	161.0	366.5	0.6	99.83	17.6	19.5	10.8	9.7
	22-Sep-87	06:30	163.5	364.2	0.5	99.87	17.8	19.5	10.7	9.7
	22-Sep-87	13:45	170.8	520.3	6.4	98.77	19.1	19.5	11.9	8.9
	22-Sep-87	16:50	173.8	401.9	12.6	96.86	19.0	19.1	11.5	8.3
	23-Sep-87	11:05	192.1	272.6	6.4	97.64	19.4	20.0	7.3	6.3
	23-Sep-87	15:10	196.2	239.8	14.7	93.89	19.5	20.0	7.8	5.5
	24-Sep-87	00:00	205.0	136.7	27.7	79.71	19.9	20.5	4.0	3.9
	24-Sep-87	02:00	207.0	162.1	20.9	87.13	19.4	20.4	5.2	4.7
	24-Sep-87	04:00	209.0	147.9	16.6	88.80	19.4	20.5	4.9	4.4
	24-Sep-87	06:40	211.7	126.9	13.6	89.28	19.4	20.5	4.5	4.0

Table 5.10

WHITE WINE II - EMISSION DATA FOR WATER SCRUBBER

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	O2 IN (%)	O2 OUT (%)	CO2 IN (%)	CO2 OUT (%)
3	15-Sep-87	11:00	0.0							
	17-Sep-87	09:45	46.8	1.3	0.0	100.00	20.2	20.7	0.0	0.2
	17-Sep-87	15:10	52.2	2.8	3.1	---	20.0	20.7	0.2	0.3
	17-Sep-87	19:45	56.8	0.0	0.8	---	20.5	20.6	0.5	0.5
	18-Sep-87	10:30	71.5	15.0	2.8	81.02	19.5	20.0	5.6	3.6
	18-Sep-87	22:00	83.0	64.9	1.3	98.02	19.1	17.8	13.4	7.2
	18-Sep-87	23:00	84.0	79.7	0.0	100.00	18.2	15.4	14.3	6.9
	19-Sep-87	16:15	101.3	448.0	3.5	99.22	16.0	19.4	21.9	7.2
	20-Sep-87	16:20	125.3	2139.8	7.9	99.63	14.8	21.0	24.1	0.6
	21-Sep-87	08:30	141.5	437.9	5.2	98.81	18.4	21.2	15.1	0.9
	22-Sep-87	16:00	173.0	361.1	23.8	93.40	19.4	20.2	8.4	2.6
	23-Sep-87	11:45	192.8	311.8	22.5	92.78	19.2	20.5	9.2	3.3
	23-Sep-87	16:15	197.3	174.7	5.4	96.90	19.7	20.6	6.0	1.6

Table 5.11

WHITE WINE II - NO CONTROLS

TANK	DATE	TIME	HOURS	ETOH IN (PPM)	ETOH OUT (PPM)	% EFF	O2 IN (%)	O2 OUT (%)	CO2 IN (%)	CO2 OUT (%)
4	15-Sep-87	11:00	0.0							
	16-Sep-87	15:30	28.5	24.1	22.5		20.7	20.6	0.1	0.2
	16-Sep-87	19:45	32.8	0.7	-0.4		20.6	20.3	0.0	0.1
	16-Sep-87	22:00	35.0	0.7	2.3		20.8	20.8	0.0	0.2
	17-Sep-87	00:00	13.0	0.5	2.0		20.8	20.8	0.0	0.2
	17-Sep-87	02:00	39.0	4.5	3.8		20.7	20.8	0.0	0.3
	17-Sep-87	04:00	41.0	4.5	3.2		20.8	20.8	0.0	0.3
	17-Sep-87	06:30	43.5	3.8	3.0		20.8	20.9	0.1	0.3
	17-Sep-87	11:00	48.0	4.1	3.4		20.0	20.5	0.6	0.8
	17-Sep-87	16:00	53.0	8.5	9.4		20.0	20.5	0.7	0.8
	17-Sep-87	22:00	59.0	11.5	11.5		20.3	21.0	1.4	1.3
	18-Sep-87	00:00	37.0	18.2	18.1		20.1	21.0	2.2	2.1
	18-Sep-87	02:00	63.0	27.2	27.2		19.8	20.6	4.1	3.8
	18-Sep-87	04:00	65.0	34.2	31.1		19.2	20.0	7.1	6.5
	18-Sep-87	06:45	67.8	35.0	30.6		18.3	19.2	11.4	10.8
	18-Sep-87	11:45	72.8	123.7	117.7		10.8	11.6	33.3	44.4
	20-Sep-87	18:40	127.7	5568.0	5564.5		-0.1	-0.4	33.1	52.2
	21-Sep-87	14:30	147.5	5126.0	---		-0.5	-0.2	36.6	46.5
	22-Sep-87	08:30	165.5	4298.7	4573.3		-0.2	0.0	36.8	52.0
	22-Sep-87	09:30	166.5	4934.4	5114.0		-0.3	0.0	35.8	51.7
	22-Sep-87	18:30	175.5	5122.9	5123.3		-0.3	0.0	39.1	52.2
	22-Sep-87	20:05	177.1	4626.0	4742.4		-0.3	0.0	39.2	52.1
	22-Sep-87	22:00	179.0	4190.9	4025.6		-0.4	0.0	39.3	52.0
	23-Sep-87	00:00	157.0	3958.7	4121.8		1.0	1.3	39.2	51.9
	23-Sep-87	02:00	183.0	4297.5	4560.5		-0.2	0.0	39.4	52.0
	23-Sep-87	04:00	185.0	4260.1	4548.5		-0.3	-0.1	39.2	52.0
	23-Sep-87	06:45	187.8	4218.9	4501.1		-0.4	-0.1	39.3	52.0
	23-Sep-87	18:45	199.8	5020.3	5668.7		-0.3	-0.1	53.8	52.1
	24-Sep-87	09:15	214.3	1425.4	---		5.0	5.9	32.9	31.6

Figure 5.23

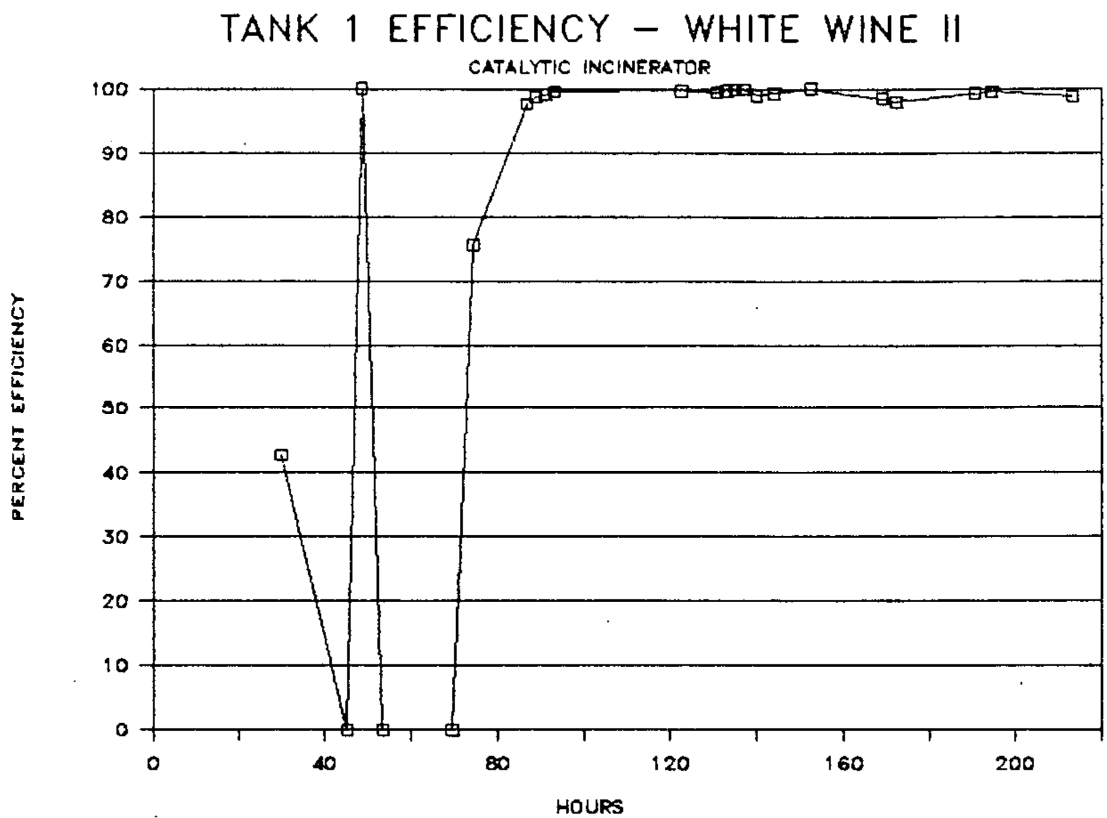


Figure 5.24

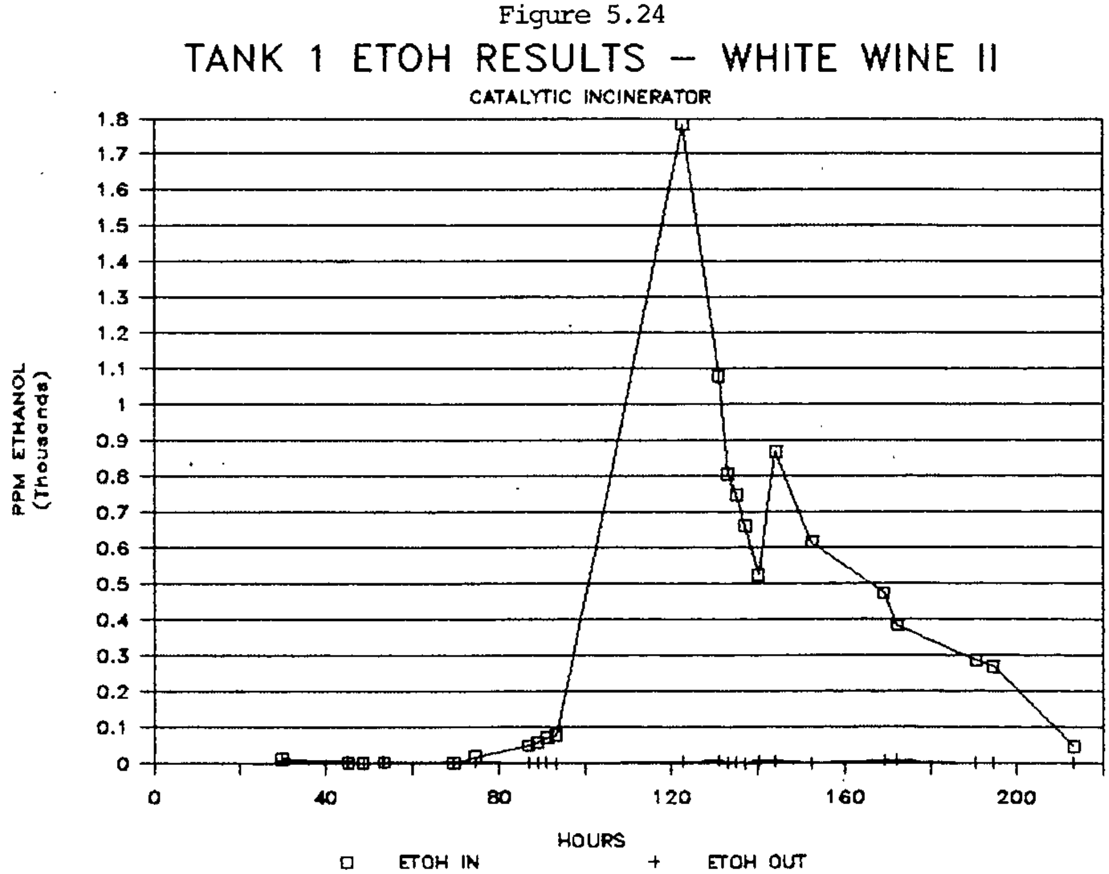


Figure 5.25

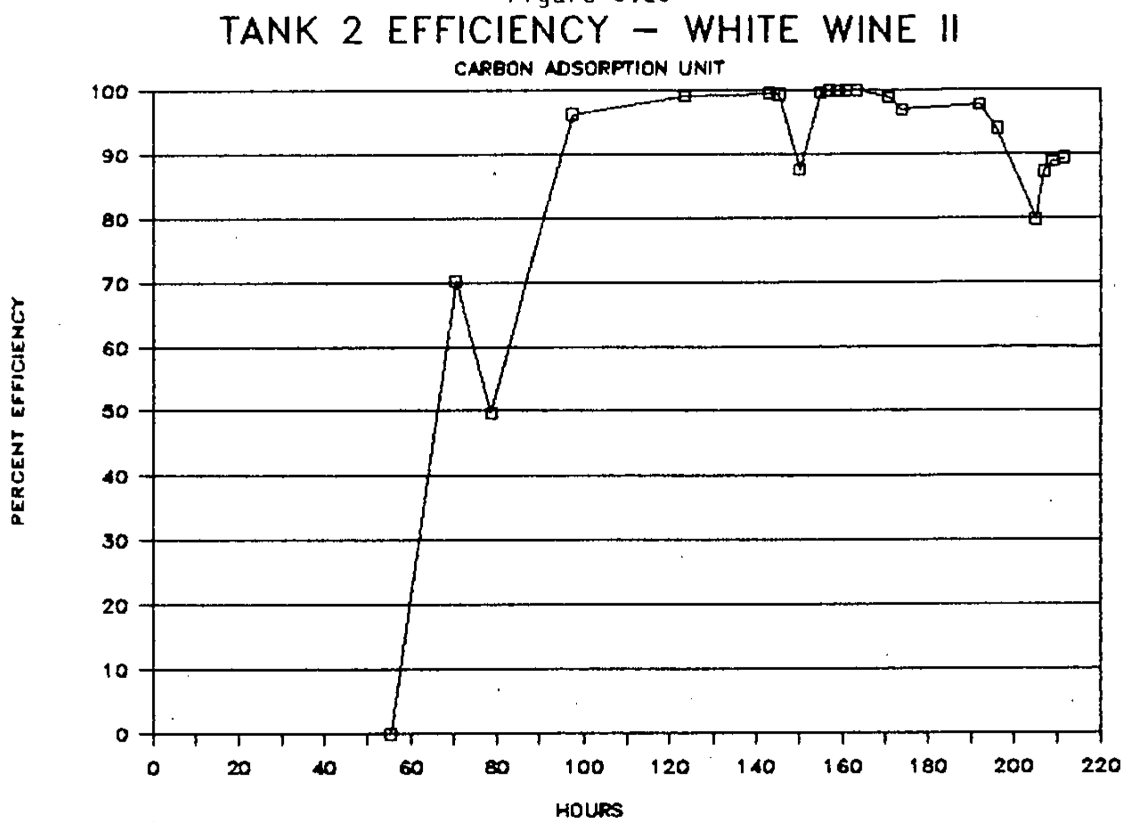


Figure 5.26

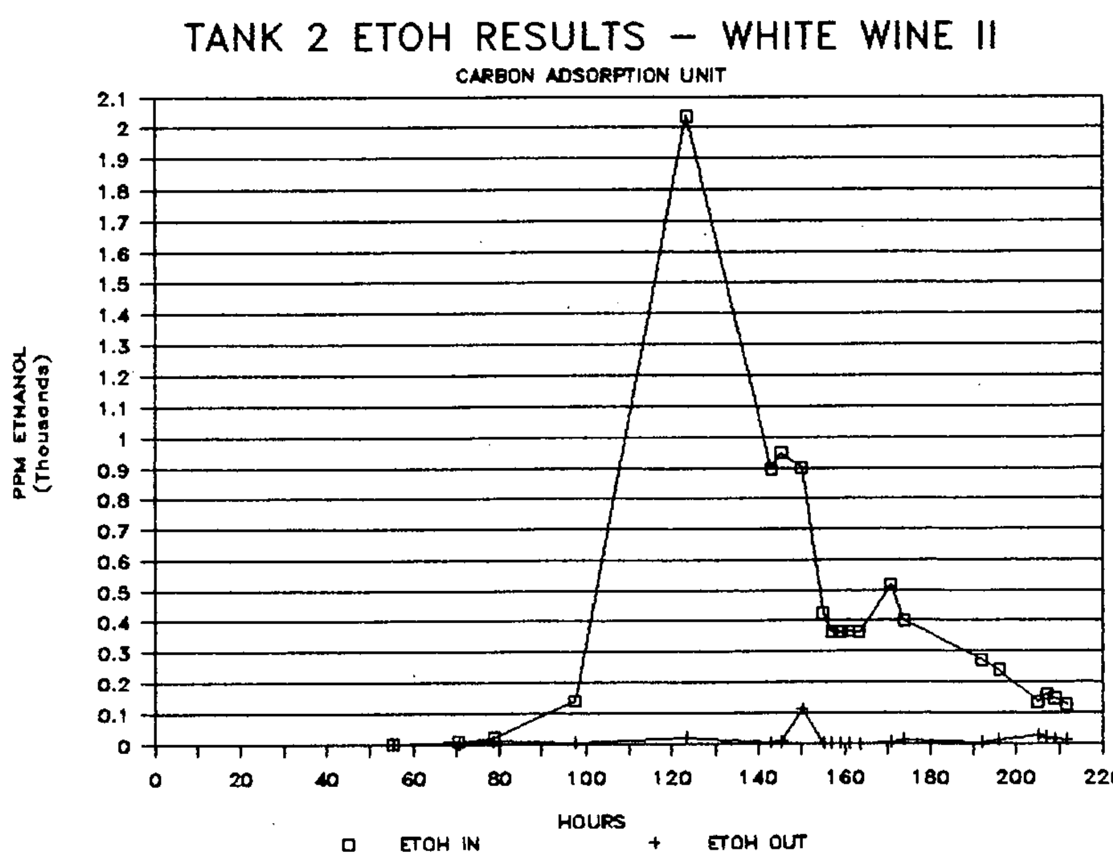


Figure 5.27

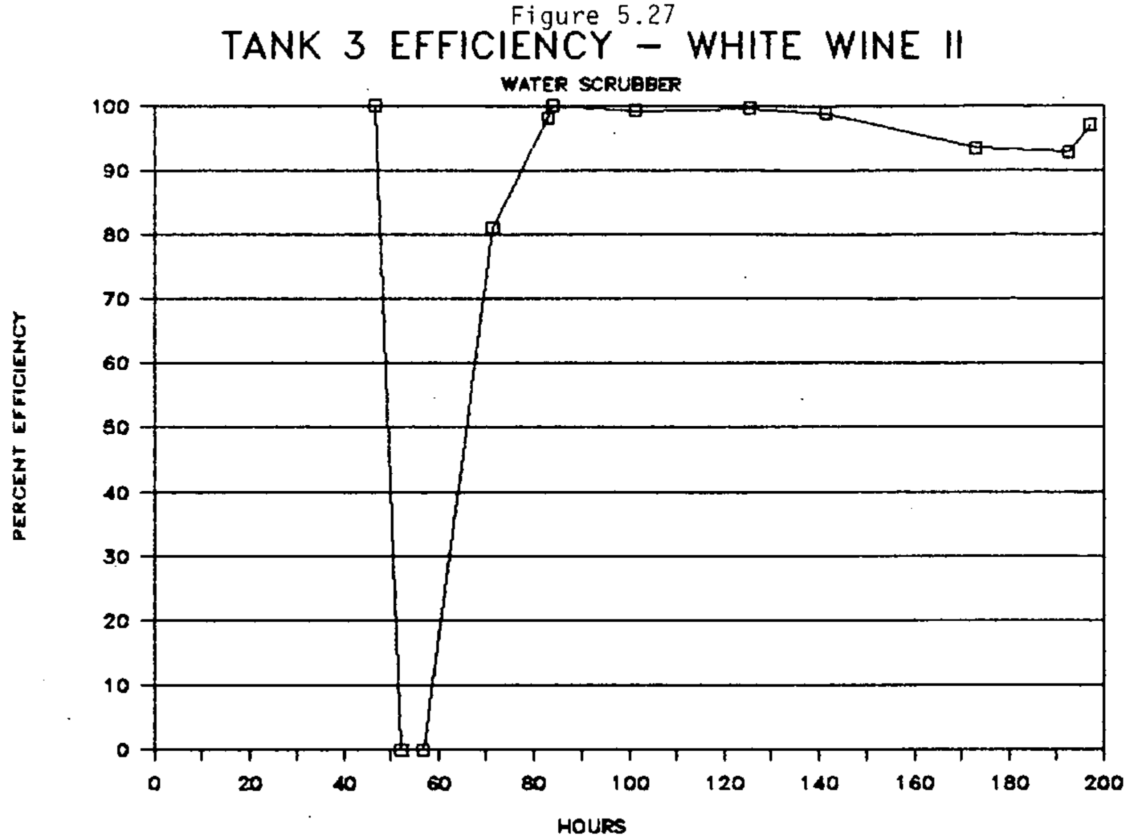


Figure 5.28

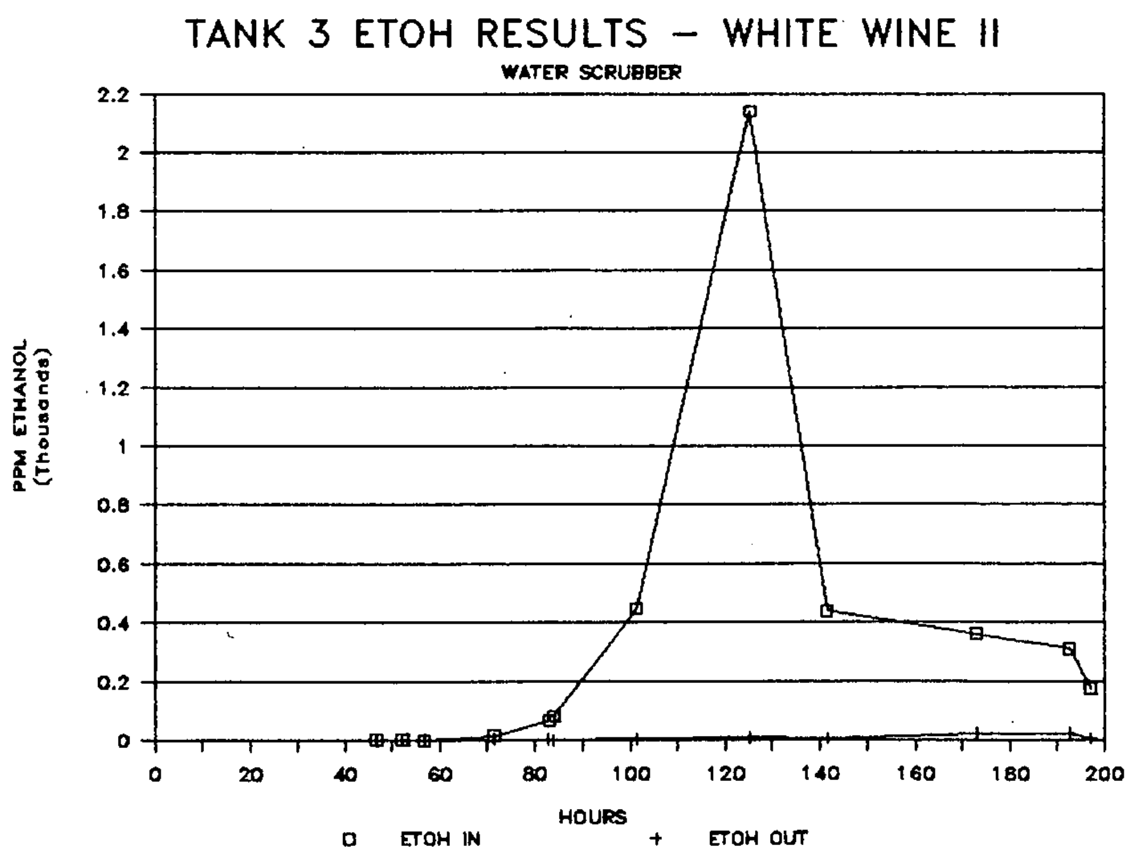
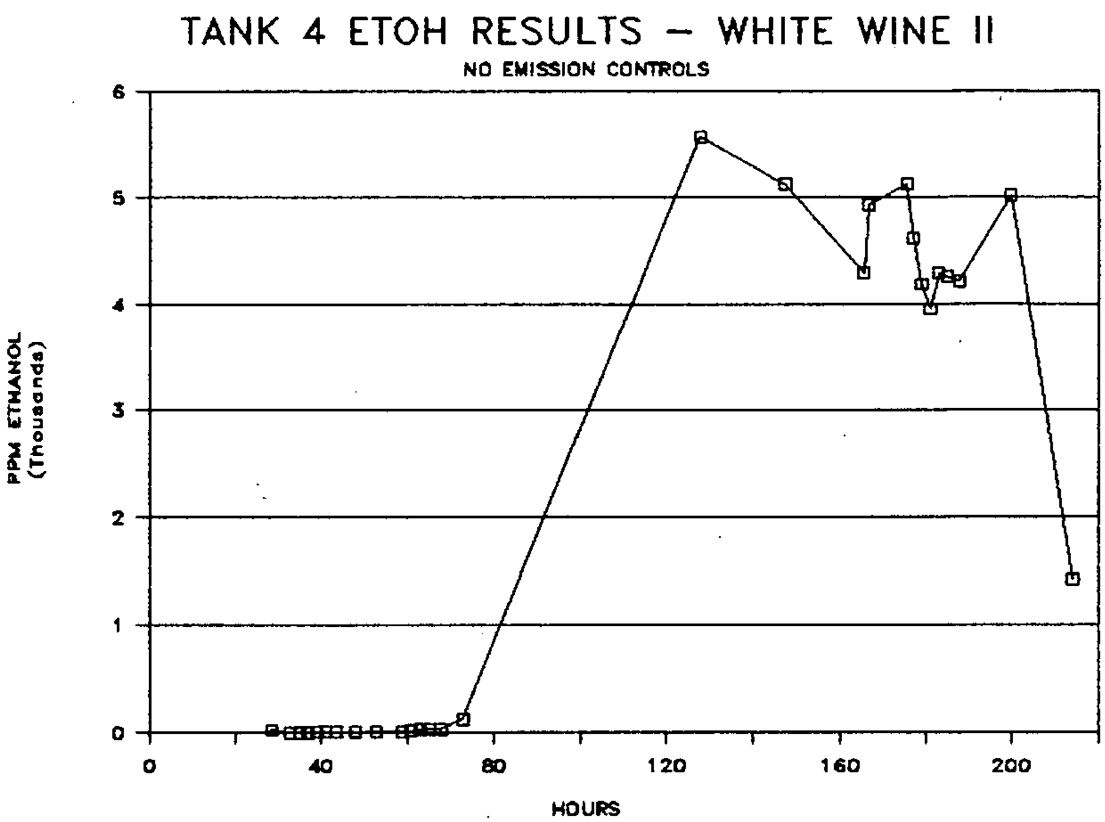


Figure 5.29


TANK 4 ETOH RESULTS – WHITE WINE II
NO EMISSION CONTROLS
PPM ETHANOL
(Thousands)
0
1
2
3
4
5
6
0
40
80
120
160
200
HOURS

B. FLOW RATE AND MOISTURE CONTENT DATA

Tables 5.12 through 5.15 provide observed (uncorrected) gas flows together with corresponding temperature and pressure data. For the three tanks with control equipment (Tanks 1, 2 and 3), the gas flow measurements were made by in-line rotameters located near the inlets to the control equipment. For Tank 4 (no control equipment), the flow from the vent was measured periodically using a Roots gas flow meter.

Table 5.16 summarizes the Method 4 moisture train results. As might be expected, the moisture content was close to saturation for Tank 4 (no control equipment, therefore no dilution air) and Tank 3-OUT (the water scrubber outlet).

TABLE 5.12

FLOW DATA - WHITE WINE I

		TANK 1			TANK 2			TANK 3			TANK 4			
DATE	TIME	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	AMBIENT TEMP (F)
8-19-87	1600	10.3			6.8			4.6						
	0900	7			7			4						
	1030	7	79		6.75	75		4	78					
	1130	7	94		6.8	83		4.3	94					
	1300	7	88		6.8	80		3.5	87		0	78		80
	1500	7			6.75			3.5						
	1600	7	95		6.8	88		3.5	90		0			87
	1700	7	93		6.8	86		3.3	88					88
8-21-87	0730	7	64		7			2.75	62		0			6
	0900	7	75		7	76		2.75	73					70
	1000	7	81		7	100		2.75	80					73
	1230	7	96		6.75	88		3.75	98		0			
	1410	7	102		6.75	100		3.25	100					87
	1620	7	99		6.8			3.25	92		0	106		92
8-22-87	0805	7	64		7	69		2.75	65			75		64
	1000	7.25	82		7			3	80		0.14	90	0.02	75
	1450	7	98		7			3.5	93			109		88
	1615	7	98		7			3	92		0.13	113	0.04	92
8-23-87	0830	7.25	64		7.25	70		2.25	66		0.21	76		64
	1040	7	87		7	80		2.75	89		1.12	100		79
	1415	7	98		7	92		3	100		1.18	109	0.05	86
8-24-87	0845	7	67		7	73		2.5	67		1.1	81	0.05	66
	1035	6.75	89		7			2.5	92		1.1	104		83
	1345	6.75	101	-5	7		-16	(2	105	-2	1.1	111	0.05	88
	1730	7	103	-6	7		-16	3.25	89	-2	1	103	0.05	95
8-25-87	0645	7		-5.5	7		-16	2.1		-2.5	0.75		(.05	
	1211	5	101	-4	7		-16	3.5	102	-3	0.77	107	0.01	90
	1618	7	106		7			3	98		0.8	117	0.02	96
8-26-87	0730	7		-5.5	7		-16	3.3		-3	0.53		(.05	
	1315	7	105	-5.5	7		-16	2.2	107	-2.4	0.56	117		95
	1655	7	105		7	100		2.75	97		0.49	114	(.02	100
8-27-87	0703	7	67	-5.5	7		-16	2.25	65	-2.5	0.4	63	(.02	67
	0945	7	86		7	88		2.25	85		0.38	97	(.02	79
	1300	6.75	103		7			4.25	105		0.24	112	(.01	90
	1728	7	105		7	99		2	97			115		100
8-28-87	0740	7	67	-6	7	66	-17	(2	68	-0.01	0.24	69	(.01	67

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TABLE 5.13

FLOW DATA - RED WINE I

		TANK 1			TANK 2			TANK 3			TANK 4			
DATE	TIME	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	AMBIENT TEMP (F)
8-31-87	1945	0	93		0			0	92		0.05	92	0.02	93
9-1-87	0630	LINES DISCONNECTED DUE TO EXPECTED FOAMOVERS												
	1650	6.25	105	-5	7		-18	4.5	101	-4	2.5	111	(.01	102
	1900	6	94		7			5	89					95
9-2-87	0635	7	73	-6	7		-17	5.75	73	-5	2.9	73	0.10	73
	1200	7	104		7			5	105		1.6	118	0.06	97
	1500	7	99		7			4.25	97		1.3	108	0.05	97
	1919	7.75	87	-6	7		-16	4.75	87	-4	1.6	86	0.02	88
9-3-87	0705	7	71		7			4.75	71		0.99	68	0.02	71
	1130	7	100		7			4.75	101		0.2	112	0.02	93
	1600	7	108	-5.5	7		-16	5	102	-5	0.91	114	0.02	102
	2005	7	87		7			5.25	85		0.63	84	0.02	87
9-4-87	0700	7	62	-5.5	7		-16	5	63	-5	0.67	60	0.02	62
	1025	7	87		7			5.25	92		0.59	102	0.02	84

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TABLE 5.14

FLOW DATA - RED WINE II

DATE	TIME	TANK 1 FLOW (CFM)	TANK 1 TEMP (DEG F)	TANK 1 PRESSURE (IN H2O)	TANK 2 FLOW (CFM)	TANK 2 TEMP (DEG F)	TANK 2 PRESSURE (IN H2O)	TANK 3 FLOW (CFM)	TANK 3 TEMP (DEG F)	TANK 3 PRESSURE (IN H2O)	TANK 4 FLOW (CFM)	TANK 4 TEMP (DEG F)	TANK 4 PRESSURE (IN H2O)	AMBIENT TEMP (F)
9-10-87	1605	7.6	93	-6	7.8		-13	5.25	88	-5	0	103		87
9-11-87	0715	7.25	56		7	57			56		0	56		56
	0925	7.25	70		7.25	82			82		0	88		69
	1245	7	92		7.25	84		7.25	95		0	97		86
	1525	7	93		7	88		7	90		0	105		86
	1700	6.75	90		7	87		5.5	86		0	100		86
	2025	7	74		7	76		5	73		0	71		74
9-12-87	0805	7	58	-6	7.5	60	-17.5	6.5	58	-6	1.72	65	0.25	57
	1350	7	88	-6	7.25	82	-17.3	7.25	90	-7.5	2.5	111	0.50	77
	1600	7	89	-6	7	85	-18	6.75	87	-6	2.95	105	0.60	84
	2010	7	76		7	75		7	74		2.8	76	0.50	75
9-13-87	0710	7	53		7	56		6.5	55		1.7	62	0.04	54
	0950	7	69	-6	7	76	-17.5	7.5	76	-7.5	1.5	82	0.06	69
	1450	7	85		6.75	81		7	84		1.3	109	0.04	78
	1750	7	80	-6	6.75	80	-18	7.25	79	-7	1.2	91	0.04	79
	2025	7.25	71	-6	6.75	71	-17.5	7	71	-7.5	0.97	71	0.04	72
9-14-87	0700	7	57		6.75	58		6.75	58		0	56		57
	1110	6.75	81	-5.5	6.75	79	-17	7.25	86	-6.5	0	90		75
	1320	6.5	88	-5.5	6.75	82	-16.5	7	94	-7	0	96		82

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TABLE 5.15

FLOW DATA - WHITE WINE II

		TANK 1			TANK 2			TANK 3			TANK 4			
DATE	TIME	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	FLOW (CFM)	TEMP (DEG F)	PRESSURE (IN H2O)	AMBIENT TEMP (F)
9-16-87	1315	7	95		7	84		6.5	99			105		86
	1550	7	96	-6	7	88	-16	6	92	-6.5	0	107		88
	1730	6.75	92		7	86		7	86		0	101		89
	2000	7	76	-6	7	73	-17	7	74	-6.5	0	73		75
9-17-87	0645	7	53	-6	7	53	-16	7	5353	-7	0	50		54
	1035	7	86	-5.5	7	87	-16	7.25	94	-7	0	99		86
	1345	6.75	100	-6	7	89	-16	7	103	-6	0	109		92
	1630	7	100		7	93		7	92		0	108		94
	1950	7	79	-6	7	76	-16	7	76	-7	0	76		78
9-18-87	0715	7	59		7	58		7	58		0	55		60
	1030	6.75	83	-6	7	87	-17	7	90	-7	0	99		82
	1225	7	100		7	91		4.75	103		0	110		91
	1840	7	85		7	89		7	84		0.38	83		85
	2300	7	72		7	68		7	71		0.46	68		74
9-19-87	0826	6.8	72		7.2	75		7	71		0.4	82		72
	1245	6.8	101		6.8	91		6.8	103		0.7	119		95
	1630	6.9	101		6.9	95		6.8	94		0.87	111		96
	2010	6.8	79		7.1	76		5.5	76		0.74	75		79
9-20-87	0825	7.2	67		7	65		6	64		1.09	72		64
	1225	6.75	102	-6	7	93	-18	7.25	104	-7	1.85	120	0.06	92
	1630	6.75	101		7	94		6.25	94		2.08	119		95
	1930	6.75	80	-5.5	7	78	-18	7	79	-6	1.36	77	0.04	81
9-21-87	0700	7	58	-6	7	57	-17.5	7.5	58	-7	0.91	58	0.04	58
	1009	7	83		7	90		6.75	93		0.98	105	0.05	86
	1354	6.75	103		7	91		4.75	105		0.80	120	0.03	94
	1721	7	98	-6	7	94	-18	4	93	-4	0.86	109	0.03	92
	1952	7	78	-6	7	79	-17	5.75	77	-6	0.76	74	0.02	78
9-22-87	0705	7	62	-6	7	62	-17.5	6	62	-5.5	0.71	59	0.03	62
	1010	7.5	86		7	90		<2	95		0.79	106	0.03	89
	1324	7	104		7	96		2.75	107		0.64	124	0.05	97
	1603	7	99	-5	7	95	-16	2	97	-2		107		95
	2034	7	76		7	74		2	75		0.48	73	0.03	76
9-23-87	0712	7.5	64	-6	7	63	-16	3.5	64	-6	0.50	62	0.01	63
	1016	6.75	83	-5.5	7	85	-17	4.5	88	-3	0.48	96	0.03	83
	1307	6.75	97		7	90		<2	98		0.53	110	0.01	90
	1615	6.75	93		7	88		3	90			103		90
	2132	7	75		7	73		<2	74		0.33	72		76
9-24-87	0710	7.25	61	-6	7	60	-16	4.5	61	-4	0.36	59	0.02	62

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Table 5.16

MOISTURE TRAIN DATA

FERM	DATE	TIME	LOCATION	PERCENT MOISTURE CONTENT	GAS TEMP (DEG F)
RED I	8/22/87	1325	1-OUT	1.1	217
	8/22/87	1610	2-OUT	0.4	90
	8/23/87	1133	3-OUT	1.7	78
	8/23/87	1336	4	1.6	108
	8/25/87	1608	3-IN	0.3	95
	8/25/87	1811	3-OUT	0.7	89
	8/26/87	1600	2-IN	1.9	
	8/26/87	1720	2-OUT	0.8	
	8/27/87	1626	1-OUT	1.1	370
	8/27/87	1602	1-IN	1.2	108
	8/27/87	1733	4	1.6	115
WHITE I	9/2/87	940	1-IN	2.9	80
	9/2/87	1105	1-OUT	1.4	570
	9/2/87		2-IN	2.3	
	9/2/87	1317	3-IN	3.0	106
	9/2/87	1530	2-OUT	4.0	97
	9/2/87	1836	3-OUT	4.1	86
	9/3/87	1119	4	7.6	105
RED II	9/11/87	1023	1-OUT	2.4	550
	9/11/87	1217	3-OUT	3.9	83
	9/11/87	1459	3-OUT	3.9	90
	9/11/87	1630	4	1.7	104
	9/13/87	1034	1-IN	0.5	68
	9/13/87	1110	2-IN	1.5	76
	9/13/87	1524	3-IN	1.6	84
	9/13/87	1649	4	2.3	105
WHITE II	9/21/87	1037	1-OUT	1.7	560
	9/21/87	1130	1-IN	1.6	90
	9/21/87	1420	2-IN	1.3	91
	9/21/87	1530	2-OUT	1.7	90
	9/22/87	0953	3-IN	0.3	95
	9/22/87	1141	3-OUT	2.1	87
	9/22/87	1318	4	5.0	124
	9/22/87	1430	4	3.3	124
	9/23/87	1408	2-IN	2.4	89
	9/23/87	1540	3-IN	1.0	95

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C. BAG SAMPLE DATA

Table 5.17 contains hydrogen sulfide concentrations found in Tedlar bag samples analyzed in the ARB mobile laboratory. These samples were collected and analyzed on September 21, 1987, about 150 hours into the White Wine II fermentation.

Table 5.18 shows the concentrations of selected volatile organic compounds for Tank 1 inlet and outlet, the area where the tanks were located and inside the cellar building. With the exception of 1,1,1-trichloroethane (TCA), none of the selected volatile organic compounds were detected. The detection of TCA was attributed to its use as a cleaning solvent in the vicinity.

TABLE 5.17

BAG SAMPLE RESULTS FOR HYDROGEN SULFIDE

SAMPLE LOCATION	CONC. (PPBV)	REPORTING LIMIT	SAMPLE ID
TANK 1 INLET	200	50	1-I-21
TANK 1 OUTLET	360	50	2-O-21
TANK 2 INLET	500	50	5-I-21
TANK 2 OULET	550	50	6-O-21
TANK 3 INLET	500	50	4-I-21
TANK 3 OUTLET	ND	50	3-O-21
AMBIENT UPWIND	ND	50	7-A-21
NEAR MOBILE LAB	ND	50	VAN AMB

ND -Not Detected

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TABLE 5.18

BAG SAMPLE RESULTS FOR SELECTED HALOGENATED AND AROMATIC ORGANIC COMPOUNDS

Bag samples collected September 8, 1987

Location / Sample ID	Ambient Cellar 1AC	Ambient 2A	Ambient Cellar 3A	Tank 1 Inlet 4-I-1	Tank 1 Outlet 5-O-1	Reporting Limit (ppb)
Vinyl chloride	ND	ND	ND	ND	ND	2.5
Benzene	**	**	**	**	**	--
Chloroform	ND	ND	ND	ND	ND	5.1
Carbon tetrachloride	ND	ND	ND	ND	ND	5.3
1,1,1-trichloroethane	22+4.7*	ND	ND	ND	ND	4.9
1,2-dichloroethane	ND	ND	ND	ND	ND	20
Trichloroethene	ND	ND	ND	ND	ND	5.0
1,2-dibromoethane	ND	ND	ND	ND	ND	5.1
Tetrachloroethene	ND	ND	ND	ND	ND	5.0

* probably contamination from cleaning solvent used to clean chart recorder

** coelution problems - not analyzed

ND - Not detected

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D. AQUEOUS SAMPLE DATA

Table 5.19 provides a quality control check on the ethanol concentration measured by the continuous hydrocarbon analyzer. The amount of ethanol found in the impingers of each water train is used to backcalculate the average concentration of ethanol in the sampled gas stream. This back-calculated ethanol concentration is shown in the EQUIV PPM column. The PPM ON CHART is the concentration measured by the hydrocarbon continuous analyzer.

The comparison shows a reasonable agreement between the two methods, with the continuous analyzer value often lower. This might be due to condensation of water in the sample lines and absorption of ethanol in the water. Also, for some of the testing, an iced dry impinger was placed as a knock-out upstream of the analyzers and again condensation and absorption could account for some of the lost ethanol.

Table 5.20 lists the ethanol concentrations found in the scrubber water effluent.

All of these aqueous samples were analyzed at the Air and Industrial Hygiene Laboratory (AIHL) in Berkeley using gas chromatography.

TABLE 5.19

COMPARISON OF ETOH CONCENTRATION OF WATER TRAIN IMPINGERS
TO HYDROCARBON READINGS BY CONTINUOUS ANALYZERS

FERM	SAMPLE ID	% ETOH	TANK	DATE	START TIME	END TIME	IMP VOL	GAS VOL	ETOH CONC	EQUIV PPM	PPM ON CHART	TIME
WW I	I- 1	<0.05	1-OUT	8-22-87	1125	1325	200.5	23.86	<5.67E-05	< 56.7	9	1000
	I- 3	<0.05	2-OUT	8-22-87	1410	1610	201	26.45	<5.13E-05	< 51.3	2	1500
	I- 4	<0.05	3-OUT	8-23-87	0930	1133	201	14.43	<9.40E-05	< 94	4	1148
	I- 5	0.39	4	8-23-87	1205	1336	201	16.94	6.25E-04	625		
	I- 6	<0.05	3-OUT	8-25-87	1640	1811	202	13.7	<9.95E-05	< 99.5	2	1400
	I- 7	0.17	2-IN	8-26-87	1429	1559	203	26.15	1.78E-04	178	110	1430
	I- 8	<0.05	1-OUT	8-22-87	1246	1446	205	46	<3.01E-05	< 30.1	5	1700
	I- 8B	1.01	4	8-27-87	1630	1733	205	27.35	1.02E-03	1020	600	1415
	I- 9	0.12	1-IN	8-27-87	1505	1602	205	28.49	1.17E-04	117	70	1700
	I- 10	1.09	1-IN	8-27-87	0854	0938	205	19.33	1.56E-03	1560	500	1840
RW I	I- 11	<0.05	1-OUT	9-2-87	1005	1105	207	29.39	<4.75E-05	< 47.5	25	1840
	I- 12	2.48	3-IN	9-2-87	1156	1317	220	36.48	2.02E-03	2020	930	1605
	I- 13	<0.05	2-OUT	9-2-87	1438	1530	220	26.11	<5.69E-05	< 56.9	1500	1315
	I- 14	1.15	2-IN	9-2-87			207	17.57	1.83E-03	1830	1950	1315
	I- 15	0.37	3-OUT	9-2-87	1654	1836	1495	30.78	2.43E-03	2430	10	1605
	I-15B	10.1	4	9-3-87	1024	1119	240	23.81	1.39E-02	13900	4500	1630
RW II	I- 17	0.09	1-OUT	9-11-87	0918	1023	207	14.12	1.94E-04	193.9	48	1120
	I- 18	<0.05	2-OUT	9-11-87	1054	1217	207	21.21	6.59E-05	65.87	6	1010
	I- 19	<0.05	3-OUT	9-11-87	1358	1459	204	4.96	2.78E-04	277.6	214	1725
	I- 20	<0.05	4	9-11-87	1535	1630	204	10.99	1.25E-04	125.2	26	1245
	I- 21	<0.05	BLANK	9-11-87								
	I- 22	0.61	1-IN	9-13-87	0944	1034	203	30.35	5.56E-04	556.2	171	0600
	I- 23	0.59	2-IN	9-13-87	1110		205	15.65	1.05E-03	1053.	435	1000
	I- 24	0.86	3-IN	9-13-87	1434	1524	207	21.93	1.11E-03	1106.	521	1820
	I- 25	<0.05	BLANK	9-13-87								
	I- 26	8.38	4	9-13-87	1556	1649	232	20.65	1.27E-02	12710	5500	1230
WW II	I- 27	0.14	1-OUT	9-21-87	951	1037	208	22.34	1.82E-04	182.2	6	1105
	I- 28	0.98	1-IN	9-21-87	1050	1130	208	23.35	1.19E-03	1188.	870	1105
	I- 29	0.46	2-IN	9-21-87	1340	1420	203	11.95	1.07E-03	1073.	948	1220
	I- 30	<0.05	2-OUT	9-21-87	1450	1530	207	20.63	<6.77E-05	<67.72	7	1220
	I- 31	0.62	3-IN	9-22-87	0907	0953	206	102.43	1.71E-04	170.7	361	1600
	I- 32	<0.05	3-OUT	9-22-87	1055	1141	207	15.48	<9.03E-05	<90.26	24	1600
	I- 33	3.71	4	9-22-87	1205	1318	220	18.71	5.89E-03	5889.	4932	930
	I- 34	2.14	4	9-22-87	1404		206	9.5	6.29E-03	6287.	5123	1830
	I- 35	0.13	2-IN	9-23-87	1336	1408	204	9.35	4.01E-04	400.5	240	1510
	I- 36	0.17	3-IN	9-23-87	1503		202	11.41	4.16E-04	415.8	175	1615

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TABLE 5.20

SCRUBBER WATER ETHANOL CONCENTRATIONS

SAMPLE ID	DATE	TIME	% ETOH (v/v)
SW- 1	21-Aug	1240	< 0.5
SW- 2	22-Aug	1200	< 0.5
SW- 3	23-Aug	1115	< 0.5
SW- 4	24-Aug	1136	0.09
SW- 5	25-Aug	1230	0.101
SW- 6	26-Aug	1400	0.06
SW- 7	27-Aug	1130	< 0.5
SW- 8	28-Aug	0730	< 0.5
SW- 9	02-Sep	0650	1.86
SW-10	02-Sep	1400	1.40
SW-11	03-Sep	0830	0.08
SW-12	03-Sep	1250	0.55
SW-13	03-Sep	1700	0.47
SW-14	04-Sep	0645	0.14
SW-15	11-Sep	1650	0.083
SW-16	11-Sep	2100	0.242
SW-17	12-Sep	1000	1.06
SW-18	12-Sep	1730	0.097
SW-19	13-Sep	0800	0.656
SW-20	13-Sep	1450	0.717
SW-21	13-Sep	2100	0.534
SW-22	14-Sep	0730	0.146
SW-23	14-Sep	1530	0.526
SW-24	16-Sep	1545	< 0.5
SW-25	17-Sep	1240	< 0.5
SW-26	18-Sep	1430	< 0.5
SW-27	20-Sep	1630	2.032
SW-28	21-Sep	0910	0.892
SW-29	22-Sep	1000	0.369
SW-30	22-Sep	2045	< 0.5
SW-31	23-Sep	0730	0.888
SW-32	23-Sep	2130	< 0.5

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E. CARBON TUBE DATA

Carbon tubes were used for sampling ethanol, aromatic hydrocarbons and halogenated hydrocarbons. The ethanol results were inconclusive and are not included here. It is believed that the high moisture content of the sampling stream interfered with the ability of ethanol to absorb on the carbon tubes.

The results for the aromatic hydrocarbon carbon tubes are shown in Tables 5.21 and 5.22. Traces of many of the aromatic compounds were found, with concentrations of toluene and xylene in the mid-ppb range.

Over 20 sets of tubes were taken for analysis of halogenated volatile organic compounds. None of the carbon tubes showed levels of halogenated compounds significantly different from the blank levels.

TABLE 5.21

AROMATIC HYDROCARBON CARBON TUBE RESULTS (micrograms per sample)
Corrected blank values (subtracted 2 x blank value)

	SAMPLE LOC	CARBON * TUBE ID	DATE	TIME	BENZENE	TOLUENE	ETHYL BENZENE	P-XYLENE	M-XYLENE	CUMENE	O-XYLENE	MESI-TYLENE	NAPTH-THALENE	SAMPLE VOL (l)
WW I	1-OUT	CT-10	9-2,3	1543-	....	....	....	....	....	....	....	....	....	109.2
		CT-10B		0730	....	....	....	....	....	....	....	....	....	
	2-OUT	CT-11	9-2,3	1645-	....	....	....	0.05	....	....	....	....	....	87
		CT-11B		0730	....	....	....	....	....	....	....	....	....	
	3-OUT	CT-12	9-2,3	1700-	0.33	....	0.35	0.13	0.19	....	0.14	0.03	....	125.4
		CT-12B		0730	....	....	....	....	....	....	....	....	....	
	BLANK	CT-13	9-3		....	....	....	....	....	....	....	....	....	
	4	CT-16	9-3	1200-	....	....	....	....	....	0.06	0.09	0.29	0.03	40.2
		CT-16B		2000	....	....	....	....	....	....	....	....	....	
RW II	1-IN	CT-21	9-12	1835-	....	0.55	....	....	1.50	....	....	....	....	13.67
		CT-21B		2045	....	....	....	....	....	....	....	....	....	
	2-IN	CT-22	9-12	1837-	1.44	4.50	....	....	4.50	....	1.20	0.06	0.04	13
		CT-22B		2045	....	....	....	....	0.10	....	....	....	....	
	3-IN	CT-23	9-12	1840-	....	0.50	....	....	1.55	....	....	....	....	27.03
		CT-23B		2045	....	....	....	....	....	....	....	....	....	
	4	CT-24	9-12	1843-	....	2.15	....	....	0.40	....	....	....	0.06	26.64
		CT-24B		2045	....	....	....	....	....	....	....	....	0.06	
	BLANK	CT-25	9-12		....	....	....	....	....	....	....	....	....	
	1-OUT	CT-26	9-12,13	2100-	....	....	....	....	0.60	....	....	....	....	57.17
		CT-26B		0630	....	....	....	....	....	....	....	....	....	
	3-OUT	CT-27	9-12,13	2100-	....	....	....	....	....	....	....	....	....	54
		CT-27B		0630	....	....	....	....	0.15	....	....	....	....	
	2-OUT	CT-32	9-13	0905-	....	1.90	....	....	0.75	....	....	....	0.01	19.61
		CT-32B		1115	....	....	....	....	....	....	....	....	....	
	2-OUT	CT-38	9-13	0905-	....	0.10	....	....	1.00	....	....	....	....	18
		CT-38B		1115	....	....	....	....	....	....	....	....	....	
	2-IN	CT-39	9-13	1555-	....	0.05	....	....	0.50	....	....	....	....	26.71
		CT-39B		1650	....	....	....	....	....	....	....	....	....	
WW II	1-IN	CT-66	9-22	1700-	....	1.15	0.08	0.05	0.45	....	0.05	0.01	....	17.88
		CT-66B		1945	....	....	....	....	....	....	....	....	....	
	2-IN	CT-67	9-22	1700-	....	1.40	0.08	....	0.20	....	0.10	....	....	36.36
		CT-67B		1945	....	....	....	....	....	....	....	....	....	
	3-IN	CT-68	9-22	1700-	....	0.10	....	....	....	....	....	....	....	18.19
		CT-68B		1945	....	....	....	....	....	....	....	....	....	
	4	CT-69	9-22	1700-	0.01	1.80	0.13	0.20	0.40	....	0.05	0.01	0.06	18.23
		CT-69B		1945	....	....	....	....	0.04	....	0.02	....	....	
	BLANK	CT-70	9-22	1700	....	....	....	....	....	....	....	....	....	
	1-OUT	CT-71	9-22,23	2030-	1.46	6.30	0.88	0.80	2.60	0.06	0.80	0.06	....	73.95
		CT-71B		0845	....	....	....	....	....	....	....	....	....	
	2-OUT	CT-72	9-22,23	2030-	....	....	....	....	....	....	....	....	....	73.87
		CT-72B		0845	....	....	....	....	....	....	....	....	....	
	3-OUT	CT-73	9-22,23	2030-	0.26	0.35	0.08	....	0.20	....	0.12	0.04	....	138.44
		CT-73B		0845	....	....	0.03	....	....	....	....	....	....	

* B denotes back-up carbon tube
.......for values lower than twice the blank value or not detected.

TABLE 5.22

AROMATIC HYDROCARBON CARBON TUBE RESULTS (PPB)

SAMPLE LOC	CARBON * TUBE ID	DATE	TIME	BENZENE	TOLUENE	ETHYL BENZENE	P-XYLENE	M-XYLENE	CUMENE	O-XYLENE	MESI-TYLENE	NAPTH-THALENE
WW I 1-OUT	CT-10	9-2,3	1543-	....	....	....	....	....	....	....	....	....
	CT-10B		0730	....	....	....	....	....	....	....	....	....
2-OUT	CT-11	9-2,3	1645-	....	....	....	0.13	....	....	....	....	....
	CT-11B		0730	....	....	....	....	....	....	....	....	....
3-OUT	CT-12	9-2,3	1700-	0.81	....	0.63	0.23	0.34	....	0.25	0.05	....
	CT-12B		0730	....	....	....	....	....	....	....	....	....
BLANK	CT-13	9-3		....	....	....	....	....	....	....	....	....
4	CT-16	9-3	1200-	....	....	....	....	....	0.30	0.51	1.44	0.14
	CT-16B		2000	....	....	....	....	....	....	....	....	....
RW II 1-IN	CT-21	9-12	1835-	....	10.50	....	....	24.86	....	....	....	....
	CT-21B		2045	....	....	....	....	....	....	....	....	....
2-IN	CT-22	9-12	1837-	34.11	90.35	....	....	78.41	....	20.91	0.92	0.58
	CT-22B		2045	....	....	....	....	1.74	....	....	....	....
3-IN	CT-23	9-12	1840-	....	4.83	....	....	12.99	....	....	....	....
	CT-23B		2045	....	....	....	....	....	....	....	....	....
4	CT-24	9-12	1843-	....	21.07	....	....	3.40	....	....	....	0.42
	CT-24B		2045	....	....	....	....	....	....	....	....	0.42
BLANK	CT-25	9-12		....	....	....	....	....	....	....	....	....
1-OUT	CT-26	9-12,13	2100-	....	....	....	....	2.38	....	....	....	....
	CT-26B		0630	....	....	....	....	....	....	....	....	....
3-OUT	CT-27	9-12,13	2100-	....	....	....	....	....	....	....	....	....
	CT-27B		0630	....	....	....	....	0.63	....	....	....	....
2-OUT	CT-32	9-13	0905-	....	25.29	....	....	8.66	....	....	....	0.10
	CT-32B		1115	....	....	....	....	....	....	....	....	....
2-OUT	CT-38	9-13	0905-	....	1.45	....	....	12.58	....	....	....	....
	CT-38B		1115	....	....	....	....	....	....	....	....	....
2-IN	CT-39	9-13	1555-	....	0.49	....	....	4.24	....	....	....	....
	CT-39B		1650	....	....	....	....	....	....	....	....	....
WW II 1-IN	CT-66	9-22	1700-	....	16.79	1.01	0.63	5.70	....	0.63	0.11	....
	CT-66B		1945	....	....	....	....	....	....	....	....	....
2-IN	CT-67	9-22	1700-	....	10.05	0.50	....	1.25	....	0.62	....	....
	CT-67B		1945	....	....	....	....	....	....	....	....	....
3-IN	CT-68	9-22	1700-	....	1.43	....	....	....	....	....	....	....
	CT-68B		1945	....	....	....	....	....	....	....	....	....
4	CT-69	9-22	1700-	0.17	25.77	1.62	2.49	4.97	....	0.62	0.11	0.62
	CT-69B		1945	....	....	....	....	0.50	....	0.25	....	....
BLANK	CT-70	9-22	1700	....	....	....	....	....	....	....	....	....
1-OUT	CT-71	9-22,23	2030-	6.08	22.24	2.70	2.45	7.96	0.16	2.45	0.16	....
	CT-71B		0845	....	....	....	....	....	....	....	....	....
2-OUT	CT-72	9-22,23	2030-	....	....	....	....	....	....	....	....	....
	CT-72B		0845	....	....	....	....	....	....	....	....	....
3-OUT	CT-73	9-22,23	2030-	0.58	0.66	0.13	....	0.33	....	0.20	0.06	....
	CT-73B		0845	....	....	0.05	....	....	....	....	....	....

* B denotes back-up carbon tube
.......for values lower than twice the blank value or not detected.

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

FERMENTATION	TANK 1 POUNDS IN	TANK 1 POUNDS OUT	TANK 1 OVERALL EFF	TANK 2 POUNDS IN	TANK 2 POUNDS OUT	TANK 2 OVERALL EFF	TANK 3 POUNDS IN	TANK 3 POUNDS OUT	TANK 3 OVERALL EFF	TANK 4 POUNDS OUT
White 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
White Wine II	3.71	0.04	99%	4.24	0.10	98%	3.71	0.06	98%	3.71

FERMENTATION	TANK 1 # DATA POINTS	TANK 1 HOURS COVERED BY DATA COLLETION	TANK 1 PERCENT OF FERM COVERED	TANK 2 # DATA POINTS	TANK 2 HOURS COVERED BY DATA COLLETION	TANK 2 PERCENT OF FERM COVERED	TANK 3 # DATA POINTS	TANK 3 HOURS COVERED BY DATA COLLETION	TANK 3 PERCENT OF FERM COVERED	TANK 4 # DATA POINTS	TANK 4 HOURS COVERED BY DATA COLLETION	TANK 4 PERCENT OF FERM COVERED
White 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%
White 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

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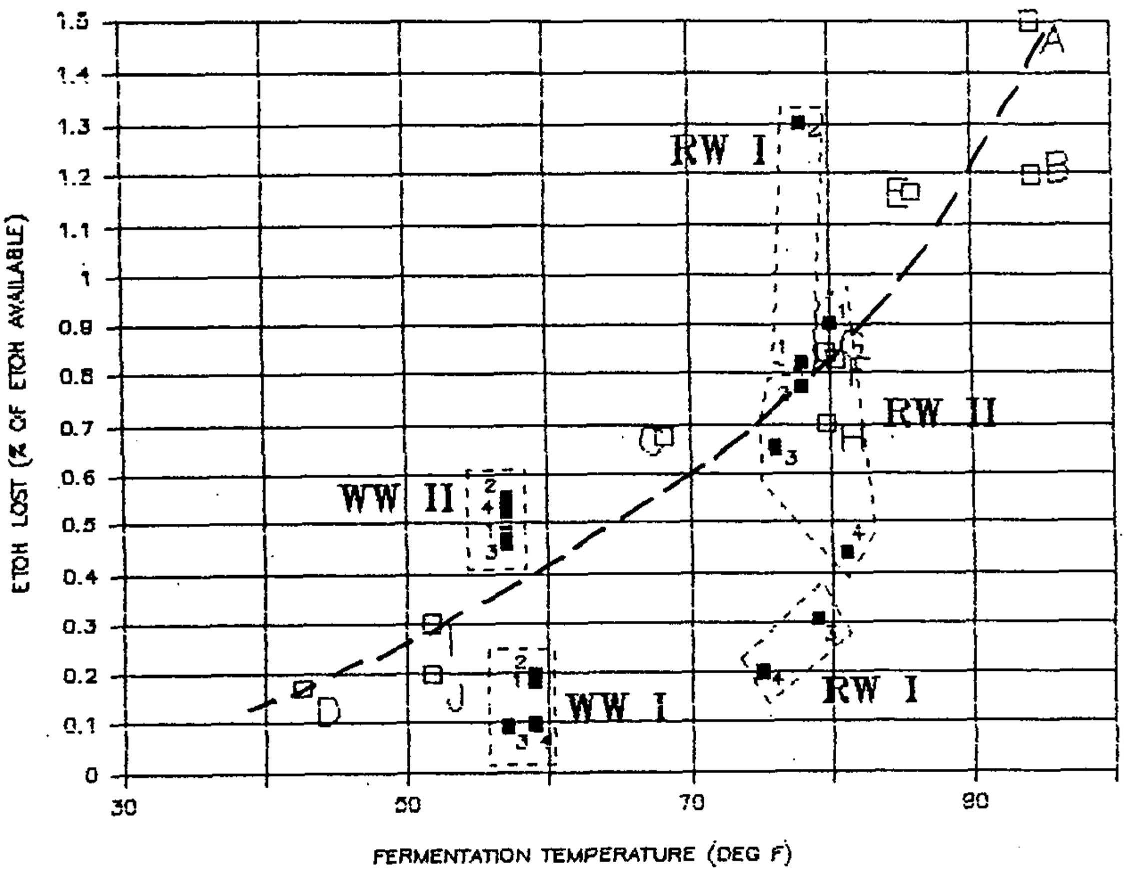
Figure 5.30

PERCENT ETOH LOST VS. FERMENTATION TEMP



■ ARB DATA -1987 PHASE I STUDY (by tank number)

□ PREVIOUS STUDIES

A. Mathieu and Mathieu

B, C & D. Flanzey and Boudet

E & F. Workentin and Nury

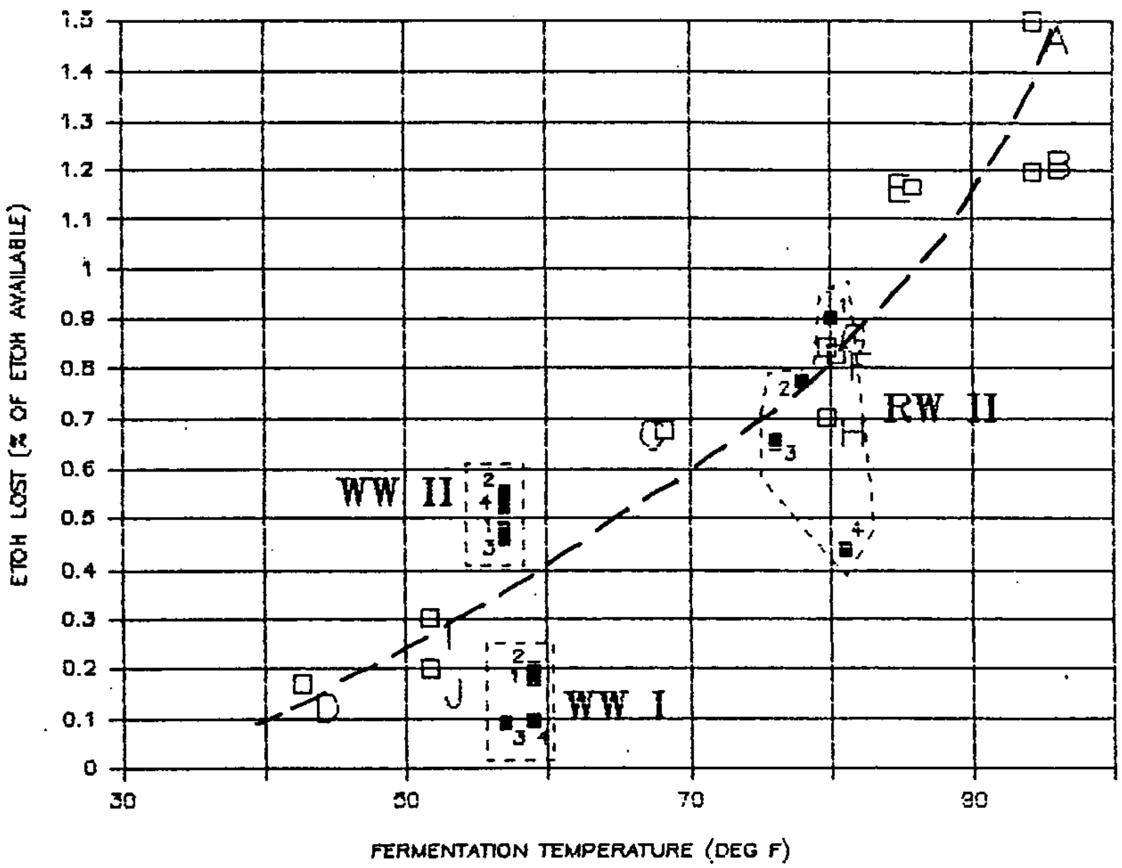
G & H. Zimmerman, Rossi and Wick

I. ARB, 1981 (Markentin & Nury Formula)

J. ARB, 1981 (based on measured EtOH loss)

Figure 5.31

PERCENT ETOH LOST VS. FERMENTATION TEMP



■ ARB DATA –1987 PHASE I STUDY (by tank number)

□ PREVIOUS STUDIES

A. Mathieu and Mathieu

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E & F. Warkentin and Nury

G & H. Zimmerman, Rossi and Wick

I. ARB, 1981 (Markentin & Nury Formula)

J. ARB, 1981 (based on measured EtOH loss)

VI. QUALITY CONTROL

Quality Control (QC) procedures are necessary to minimize random and systematic errors in sampling that could lead to incorrect results, or incorrect conclusions. Procedures to document the accuracy of reported sampling and analytical results have been established by the ARB in Air Monitoring Quality Assurance Volume VI, Standard Operating Procedures for Stationary Source Emission Monitoring and Testing. These quality control procedures include the use of audit samples, field and laboratory blank samples, and multipoint calibration of continuous monitors.

Specific QC procedures used in the wine fermentation sampling program are discussed below.

A. ANALYZER Q.C.

Prior to movement to the sampling site, the field analyzers were turned on and inspected. Any necessary repairs or maintenance were noted in the analyzer logbook. Onsite the instruments were turned on, inspected , and zeroed and spanned with nitrogen and calibration gases. The instruments were also zeroed and spanned when switching from one tank or control device to the next. Different concentrations of span gases for the hydrocarbon analyzers were maintained on-site to allow the span of those analyzers to increase and decrease as ethanol concentrations increased and decreased throughout the fermentations. In addition, the hydrocarbon analyzers were checked to insure that high carbon dioxide levels did not interfere with the measurement of ethanol. And the hydrocarbon analyzers were calibrated to develop a response relationship between propane, the analyzer span gas, and ethanol.

B. GRAB SAMPLES Q.C.

Grab samples include moisture trains, tube samples, bag samples and other collected samples such as water from the scrubber. All grab samples were labelled upon collection. The labels included the job number, sampling date, sample number, sample location, type of samples, chain of custody log numbers for the samples, and initials of the person collecting the sample. The samples were then logged into a chain of custody logbook and a copy of the label placed onto a chain of custody sheet. The logbook remained onsite and the chain of custody sheet traveled with the sample. As the sample changed hands, the chain of custody sheet was initialed by the next handler. If any samples were damaged or the integrity questioned, a note is made and initialed by the person delivering the sample. Field blanks and spikes were handled the same as other samples.

Prior to bag sampling, new sampling bags were made out of Tedlar. The new bags were purged 10 times with nitrogen, left inflated over 24 hours to check for leakage, and then sampled by gas chromatography to check for contamination.

C. LABORATORY QC

From the time the samples were collected, they were logged and a chain of custody was maintained by the field personnel until the samples reached the laboratory. At that point laboratory personnel maintained a separate log sheet. This way the time between collection and analysis can be determined. Precision and accuracy of the measured concentrations can be affected by the amount of time lapsed between collection and analysis, sample handling, the condition of the container, and instrument accuracy. Instrument accuracy is determined by the laboratory personnel using known standards, audit samples, field and laboratory blanks and multipoint calibration.

APPENDIX A

WINERY TEST DATA SHEETS

CHAIN OF CUSTODY
LOG BOOK

Job # C87-041

Proj. Wine Fermentation Emissions

Log#	Sample#	Serial/ Lab #	Action/Description	Date	Time	Given by	Taken by

AIR RESOURCES BOARD

Winery Fermentation Tank Test - CSUF

FLOWMETER, TEMPERATURE, PRESSURE DATA SHEET

TANK:____________________

Fermentation:____________ Date______________

Time	Temperature		Pressure		Rotameter Reading	Flow	Readings Taken by:
	Inlet	Outlet	Inlet	Outlet			

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AIR RESOURCES BOARD

Winery Fermentation Tank Test - CSUF

CONTINUOUS ANALYZER DATA SHEET

Fermentation:____________ Date______________

Time	Sample Point	THC (ppm propane)	CO2 (percent)	CO2 Dilution Flow	CO (ppm)	O2 (percent)	Readings taken by:
Concentration range:							
Calibration gas conc:							
Calibration gas ID:							

C-87-041

State of California

AIR RESOURCES BOARD

Stationary Source Control Division
Engineering Evaluation Branch

File No. C87-041

Date ______

Tank ______

Location IN OUT

WATER VAPOR CALCULATIONS

Standard Conditions 68 F and 29.92 in. Hg

Ambient Conditions ___°F and _____ in. Hg

Time	Gas Volume Through Meter (Vm), Ft^3	Impinger Temp. (Ti), °F	Meter Temp. (Tm), °F	Orifice Pressure (Δh), in. H_2O	Volume of Water Collected in Impinger (V_{1c}), ml
					Final
	-				Initial
					Net (V_{1c})

Assume 1 gram $H_2O \approx$ 1 ml H_2O

A. Gas Volume Metered ($V_{m_{std}}$)

$$P_{ma} = P_{bar} + (\Delta H/13.6) = (\quad) + \frac{(\quad)}{13.6} = \_\_\_\_\_\_ \text{ in. Hg}$$

$$V_{m_{std}} = \frac{528 \text{ °R}}{29.92 \text{ in. Hg}} \cdot \frac{V_m P_{ma}}{T_m} = (17.65) \frac{(\quad)(\quad)}{(\quad)} = \_\_\_\_\_\_ \text{ SDCF}$$

B. Volume of Water Collected ($V_{w_{std}}$)

$$V_{w_{std}} = (0.0471 \frac{Ft^3}{ml}) (V_{1c}) = (0.0471) (\quad) = \_\_\_\_\_\_ \text{ SCF}$$

C. Moisture Content in Stack Gas (Bw) in Percent

$$Bw = \frac{B}{A + B} \times 100 = \frac{(\quad)}{(\quad)} \times 100 = \_\_\_\_\_\_$$

D. If calculated moisture content (C) is greater than at saturation temperature (e.g. 212°F or below) use the table for moisture content.

% OF H_2O AT SATURATION

TEMP. °F	% H_2O	TEMP. °F	% H_2O	TEMP. °F	% H_2O
50	1.2	130	15.1	180	51.1
60	1.7	140	19.7	185	57.0
70	2.5	150	25.3	190	63.6
80	3.5	155	28.7	195	70.8
90	4.8	160	32.3	200	78.6
100	6.5	165	36.4	205	87.0
110	8.7	170	40.8	210	96.2
120	11.5	175	45.7	212	100.0

Sample # ____________   Meter # ____________

Station ____________   Operator ____________

GRAB SAMPLE MONITORING DATA SHEET
(STUDY NO. c87-041)

Date	Time (Start Stop)	Measured Flow, Start	Stop	(lpm)	Avg. Flow (lpm)	Sample Time (Min.)	Tot. Vol. (l)	Sample Wt.(ug)	Sample Conc. (ug/l)	Sample Conc. (ppm)*

ments:

$$* \; ppm = \frac{24.05 \times ug/l}{\text{Compound Mole. Wt.}} \quad @\ 294° \ K\ (68°F) \text{ and } 760 \text{ mm Hg } (1 \text{ atm})$$

AIR RESOURCES BOARD

Winery Fermentation Tank Test - CSUF

H_2S PORTABLE ANALYZER DATA SHEET

Fermentation:____________ Date__________

Sample Point	Time	H_2S Concentration	Readings taken by:

Concentration range:			
Calibration gas conc:			
Calibration gas ID:			

C-87-041

APPENDIX B

CALCULATION OF ETHANOL LOSS

APPENDIX B

Calculation of Ethanol Lost

This section outlines the procedure used to integrate the ethanol concentration curves for each fermentation.

1. Calculate the time interval between consecutive ethanol measurements at a tank.
2. Take the arithmetic average of the ethanol concentration at the beginning and at the end of the time interval.
3. Multiply the average ethanol concentration from step 2 by the time interval of step 1 to give a number with units of ppm-hours.
4. Multiply by the flowrate and appropriate conversion factors to give an ethanol mass value for that time interval.
5. Sum all the mass values of each time interval to get the total mass of ethanol lost during the fermentation.

Intermediate values for these calculations are displayed in the following tables.

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-87	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-87	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%

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 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	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

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