Background Report Reference

AP-42 Section Number: 9.6.1

Background Chapter: 4

Reference Number: 7

Title: Whey Dryer Emission Tests at Alto Dairy, Waupun, WI

Badger Laboratories

June 1989

AP-42 Section 9.6.1
Reference
Report Sect. 4
Reference 7

Alto Dairy
Waupun, WI
April 1989

Dried whey production

000

CHEMISTS ENGINEERS BADGER LABORATORIES & ENGINEERING
1110 S ONEIDA STREET • APPLETON, WISCONSIN 54915 • (414) 739-9213
TOLL FREE PHONE IN WISCONSIN 1-800-242-3556

WHEY DRYER EMISSION TEST

at

ALTO DAIRY
Waupun, WI

April 20, 1989

Prepared By:

BADGER LABORATORIES & ENGINEERING CO., INC.
1110 South Oneida Street
Appleton, WI 54915

June 9, 1989

Bruce F. Lamers
Bruce F. Lamers
Project Manager

Stephen C. Taylor
Chief Chemist

Rec'd
6/30/89
SD

Received 7/28/89 Bureau

CORRESPONDENCE/MEMORANDUM

State of Wisconsin
Department of Natural Resources
File: 4530-3

Date: August 3, 1989

To: Files

From: Lynda Wiese LW

Subject: Source Testing Review, Alto Dairy FID# 420038960
Receiv: 7/28/89

I. Facility

Alto Dairy
N3545 CTH EE
Waupun, WI 53963
Facility Location: Town of Alto, CTH EE
Test Date: 4/20/89
Contact(s): Mr. Bruce Westerveld, Manager, Whey Division

II. Source Description

Alto Dairy has installed whey processing division at their plant in the Town of Alto just north of Waupun. The whey dryer permitted under #88-LMW-415 is a Damrow Co. Model F-12,000 Filtermat spray dryer. Capacity of the dryer is 22,000 to 27,000 pounds per hour of 50 to 54% concentrated whey. The whey slurry is sprayed into the drying chamber and falls onto a moving belt where additional drying and cooling takes place. The final product is at 4% moisture. Emissions are controlled by a series of cyclones capturing product and then followed by a counter-current flow, plate-type wet scrubber with an estimated efficiency of 99.93%.

III. Sampling Operation

A. Sampling Firm
Badger Laboratories and Engineering Co., Inc.
1110 Oneida Street
Appleton, WI 54915

Test Crew Chief: Bruce F. Lammers

B. Purpose
The purpose of this test was for demonstration of compliance with the solid and condensible particulate emission limit as required by permit #88-LMW-415.

C. Date of Test
April 20, 1989

D. Test Method
Testing was conducted and samples were analyzed in accordance with procedures specified by the Environmental Protection Agency in the Code od Federal Regulations volume 36, No. 247, December 1971, and

it's subsequent revisions. The testing method used was Method 5 and the back-half particulate emissions were extracted from the impinger catch.

E. Test Witness
The testing was witnessed by Lynda Wiese of the Southern District Air Management Section.

IV. Summary of Results

Emissions are reported in pounds per hour. Isokinetic ratio is in percent.

Test #	Concentration (Lb/Hr)	Isokinetic Ratio
1*	4.23 (4.178)	97.5 (97.5)
2	5.75	99.0
3	5.18	99.2
Average	5.05	

Limit = 16.3 Lb/Hr

*run reviewed by DNR, results in ().

V. Applicable Emission Limits

The emission limit for this process is the more restrictive of NR 415.05(2)(a)1., Wis. Adm. Code: $E = 3.59(P)^{0.62}$ or NR 415.05(1)(m), Wis. Adm. Code: 0.2 pound per thousand pounds exhaust gas. By the attached determination, the more restrictive limit is NR 415.05(2)(a)1. which yields 16.3 lb/hr at the process rate of 11.48 tons per hour achieved during the stack testing.

VI. Discussion

The testing was performed in a competent manner and according to US EPA test methods. Clean-up was performed on site and was done well. The test was performed indoors in a 40" by 113" straight section of uninsulated duct.

Visible emissions were read for 30 minutes during the second run of the stack test. No visible emissions could be detected from the stack outlet. The source meets the visible emission limit of 20% opacity found in NR 431.05(1), Wis. Adm. Code.

During Run 3 the test team was experiencing erratic stack static due to problems in maintaining the spray pattern within the dryer and some plugging problems in the dry powder receiver. This does not appear to have influenced the results of test 3.

Based on this performance demonstration, it is recommended that this source be released for permanent operation.

Attachment
cc: Joe Perez AM/3
US EPA Region V

RECEIVED

AUG - 9 1989

BUREAU OF

ALTO DAIRY

June 26, 1989

Dear Linda,

Enclosed are 2 of the emission reports on our dryer here at Alto.

These are the normal readings on the other monitors which you asked for:

SCRUBBER MONITOR	BAGGER	BIN
.9	.3	3.4

On behalf of the Alto Dairy, I'd like to thank you for your patience and help. I am looking forward to working with you in the future.

Sincerely,

Bruce Westerveld

Bruce Westerveld

Rec'd
6/30/89
SD

NAME OF SOURCE: Alto Dairy

LOCATION OF SOURCE: CTH EE - Waupun

PROCESS TESTED: Whey Dryer

DATE OF TEST: April 20 1989

RUN NUMBER: 1

N NUMBER OF SAMPLING POINTS= 24

VM DGM VOL,METER COND DRY= 37.026 CFD

PB BAR PRESS,STATION= 29.8 IN HG

VL TOTAL VOL OF WATER COLLECTED= 48.2 ML

%CO2 % CARBON DIOXIDE BY VOL,DRY BASIS= .5 %

%O2 % OXYGEN BY VOL,DRY BASIS= 20.3 %

%CO % CARBON MONOXIDE BY VOL, DRY BASIS= 0 %

%N2 % NITROGEN BY VOL,DRY BASIS= 79.2 %

CP PITOT TUBE COEFFICIENT= .8294

PS STACK PRESS= 29.79 IN HG

AS AREA OF THE SAMPLING SITE= 31.2847 SQ FEET

MT TOTAL DRY PARTICULATE= 13.4 GM $\times 10^{-3}$

T TOTAL SAMPLING TIME= 72 MIN

AN AREA OF THE NOZZLE= .0001867 SQ FEET

lto Dairy,Whey Dryer,RUN: 1

CALCULATED RESULTS

'S STACK TEMPERATURE = 122.2917 DEG F

MSTD DGM VOL,STD COND DRY= 36.05889 SCFD

WSTD VOL OF WATER VAPOR,STD COND= 2.268774 SCF

:M % MOISTURE IN STACK GAS BY VOL,STD COND= 5.919416 %

ID MOLE FRACTION OF DRY GAS= .9408058

IWD MOLECULAR WT OF STACK GAS,DRY BASIS= 28.892 LB/LB-MOLE

IWS MOLECULAR WT OF STACK GAS,WET BASIS= 28.24726 LB/LB-MOLE

'S AVE STACK GAS VELOCITY,STACK COND= 53.98269 FPS

}ACT ACTUAL STACK GAS FLOW RATE= 101329.9 CFM

}STD AVE STACK GAS FLOW RATE,STD COND DRY= 86067.65 SCFMD

;EA AVE % EXCESS AIR= 3334.434 %

PMRA AVE PMR BY RATIO OF AREAS METHOD= 4125.226 LB/HR $\times 10^{-3}$

PMRC AVE PMR BY CONC METHOD= 4230.777 LB/HR $\times 10^{-3}$

PMR(AVE) AVE PMR,STD COND DRY= 4178.002 LB/HR $\times 10^{-3}$

: EMISSION CONC,STD COND DRY= 5.734009 GR/SCFD

DGR AVE STACK GAS RATE,STD COND DRY= 386941.2 LB/HR

LB/MLB EMISSION CONC,STD COND DRY= 10.79751 LB/MLB OF DRY GAS

WGR AVE STACK GAS RATE,STD COND WET= 402108.9 LB/HR

LB/MLB EMISSION CONC,STD COND WET= 10.39023 LB/MLB OF WET GAS

%ISR % ISOKINETIC RATIO= 97.50516 %

AIR PERMIT REVIEW CALCULATION SHEET
FORM 4500-89 1-82

DEPARTMENT OF NATURAL RESOURCES

MADE BY: Wirsel DATE: 8/3/89

DISCUSSED WITH & CHECKED BY:

DATE:

APPROVED: DATE:

DATE:

Alto Dairy
Whey dryer

R#

The Particulate emission limit is the more restrictive of:

① NR 415.05(2)(a)1. $E = 3.59\,P^{0.62}$

② NR 415.05(1)(m) 0.2 lb/1000 lbs exhaust gas

by ① with $P = 11.48$ ton/hr during the 4/20/89 stack test

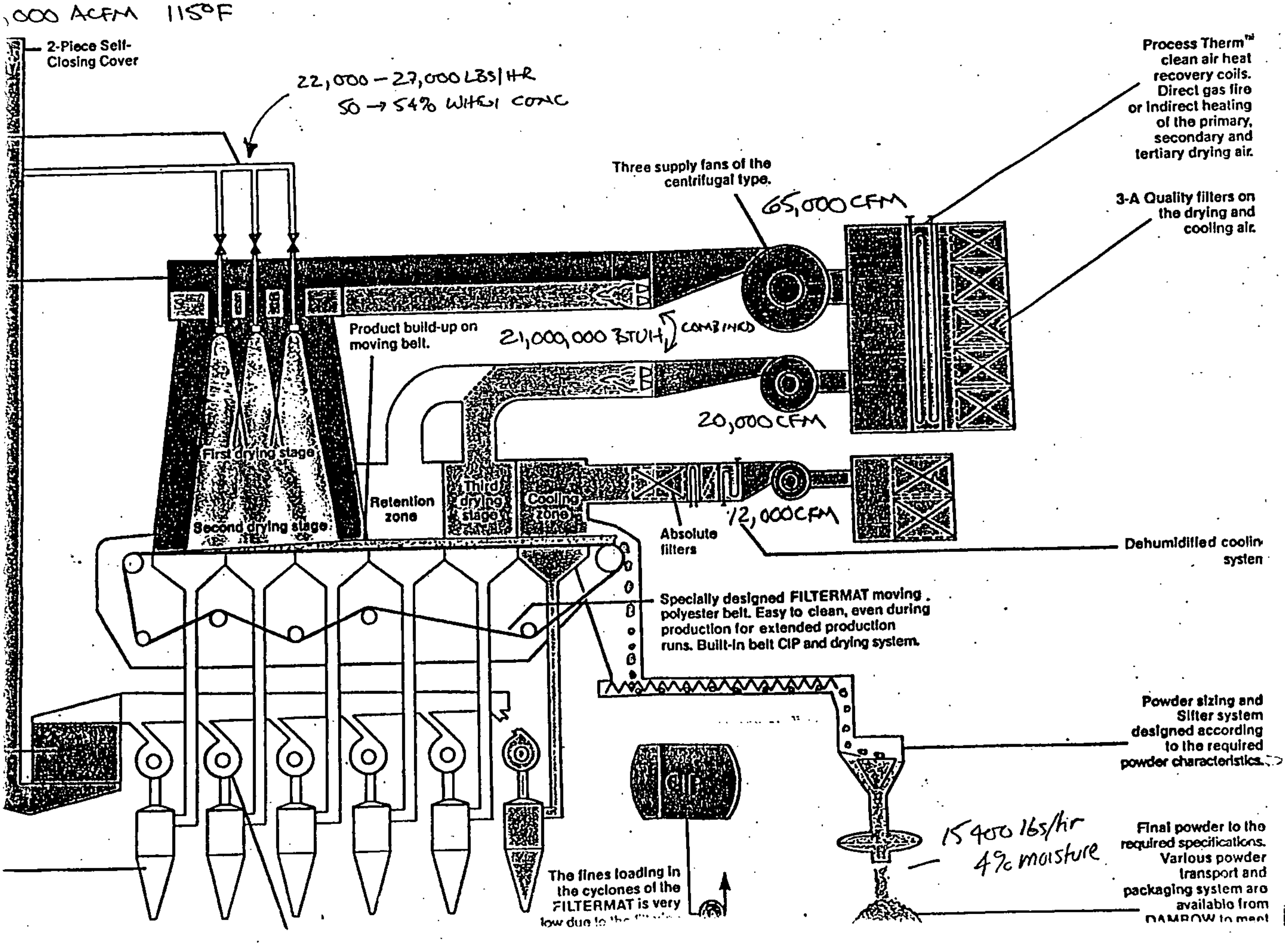
$$E = 3.59\,(11.48)^{0.62} = \underline{16.3\ \text{lb/hr}}$$

by ② with an average flow rate of 101,575 acfm from the stack test

$$\left(\frac{0.2\ \text{lb}}{1000\ \text{lbs}}\right)\left(\frac{101{,}575\ \text{acf}}{\text{min}}\right)\left(\frac{60\ \text{min}}{\text{hr}}\right)\left(\frac{0.075\ \text{lb}}{\text{ft}^3}\right)\left(\frac{460+68}{460+623}\right) = \underline{82.8\ \text{lb/hr}}$$

∴ The more restrictive is the process weight rate

FOOTNOTES/REFERENCES:



,000 ACFM 115°F
2-Piece Self-Closing Cover
22,000 – 27,000 LBS/HR
50 → 54% WHEY CONC
Three supply fans of the centrifugal type.
65,000 CFM
Process Therm™ clean air heat recovery coils. Direct gas fire or indirect heating of the primary, secondary and tertiary drying air.
3-A Quality filters on the drying and cooling air.
Product build-up on moving belt.
21,000,000 BTUH COMBINED
20,000 CFM
First drying stage
Second drying stage
Retention zone
Third drying stage
Cooling zone
Absolute filters
12,000 CFM
Dehumidified coolin system
Specially designed FILTERMAT moving polyester belt. Easy to clean, even during production for extended production runs. Built-in belt CIP and drying system.
Powder sizing and Sifter system designed according to the required powder characteristics.
CIP
15400 lbs/hr
4% moisture
Final powder to the required specifications. Various powder transport and packaging system are available from
The fines loading in the cyclones of the FILTERMAT is very

Alto Dairy - Waupun
Whey Dryer Emission Test

I. Introduction and Summary

Badger Laboratories & Engineering Co., Inc. was retained by Alto Dairy of Waupun, WI to determine the concentration of particulate matter in the exhaust from a Whey Dryer.

Emission tests were conducted April 20, 1989 by Bruce Lamers and Rick Hieptas. Linda Wiese of the Wisconsin Department of Natural Resources witnessed the testing. A total of three test runs were performed following U.S. EPA Methods. Mr. Bruce Westerveld is the company contact.

A summary of the results are as follows:

Particulate Emission Results

Test Run	Volumetric Flow Rate scfh (dry)	Isokinetic Ratio, %	Particulate Emission lb/hr.
1	5.165×10^6	97.5	4.23
2	5.153×10^6	99.0	5.75
3	5.234×10^6	99.2	5.18

The arithmatic average of the three results is 5.05 lb/hr. BTU. The limitation for this source 16.3 lb/hr. BTU.

II. Process Description

The stack carries exhaust gases from a Whey Dryer. Normal production rate is 22,000 - 27,000 lb/hr. at 50 - 54% solid whey concentrate. The production rate during the testing was 22,960 lb/hr. Alto Dairy measured 12,628 lb/hr. powder and 10,332 lb/hr. water during the time from 8:30 AM - 3:00 PM on April 20th.

This production rate gives a limitation for Particulate as follows:

Production Rate Limitation

$$\text{Limitation} = E = 3.59\,p^{0.62} \qquad \text{Where: } p = \text{Tons Production/Hr.}$$

$$= 3.59\,(11.48)^{0.62}$$

$$= 16.3 \text{ lb/hr.}$$

Location:	Alto Dairy Waupun
Date:	4-20-89
Time:	8:30 - 8:52 AM
Test Run:	#1

Stack Gas Data:

Temperature, ^{o}F.	122.3
Velocity, ft./sec.	53.98
Gas Volume, ACFM	101325
Gas Volume, SCFM (Wet)	91463
Gas Volume, SCFH (Dry)	5.165×10^6
Moisture, %	5.9
Carbon Dioxide, % (Dry)	0.5
Oxygen, % (Dry)	20.3
Caron Monoxide + Nitrogen, % Dry	79.2
Molecular Weight (Wet)	28.25

Sampling Data:

Total Time, min.	72
Volume, SCF (Dry)	36.057
Isokinetic Ratio, %	97.5

Particulate:

Amount Collected, mg. (including condensible)	13.4
Concentration, grains/SCF	0.0057
Emission Rate, lb/hr.	4.23

Location:	Alto Dairy Waupun
Date:	4-20-89
Time:	11:00 AM - 12:21 PM
Test Run:	#2

Stack Gas Data:

Temperature, ^{o}F.	124.7
Velocity, ft./sec.	53.96
Gas Volume, ACFM	101287
Gas Volume, SCFM (Wet)	91068
Gas Volume, SCFH (Dry)	5.153×10^{6}
Moisture, %	5.7
Carbon Dioxide, % (Dry)	0.4
Oxygen, % (Dry)	20.8
Carbon Monoxide + Nitrogen, % (Dry)	78.8
Molecular Weight (Wet)	28.27

Sampling Data:

Total Time, min.	72
Volume, SCF (Dry)	36.535
Isokinetic Ratio, %	99.0

Particulate:

Amount Collected, mg. (including condensible)	18.5
Concentration, grains/SCF	0.0078
Emission Rate, lb/hr.	5.75

Location:	Alto Dairy Waupun
Date:	4-20-89
Time:	1:06 - 2:29 PM
Test Run:	#3

Stack Gas Data:

Temperature, ^{o}F.	122.2
Velocity, ft./sec.	54.40
Gas Volume, ACFM	102113
Gas Volume, SCFM (Wet)	92204
Gas Volume, SCFH (Dry)	5.234×10^6
Moisture, %	5.4
Carbon Dioxide, % (Dry)	0.5
Oxygen, % (Dry)	20.0
Carbon Monoxide + Nitrogen, % (Dry)	79.5
Molecular Weight (Wet)	28.29

Sampling Data:

Total Time, min.	72
Volume, SCF (Dry)	37.173
Isokinetic Ratio, %	99.2

Particulate:

Amount Collected, mg. (including condensible)	16.7
Concentration, grains/SCF	0.0069
Emission Rate, lb/hr.	5.18

Table of Contents

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$$\text{Limitation} = E = 3.59\, p^{0.62} \qquad \text{Where: } p = \text{Tons Production/Hr.}$$

$$= 3.59\,(11.48)^{0.62}$$

$$= 16.3 \text{ lb/hr.}$$

III. Stack Testing and Analytical Procedures

The procedure for sampling, testing, instrumentation and analysis as described by the U.S. EPA were followed. The EPA reference methods used in the testing program are summarized below.

Method 1: Sample and Velocity Traverse Locations

The sampling site lies in a straight section of 40" x 112 5/8" inside diameter rectangular stack. The sampling site is approximately 5 diameters downstream from the last distrubance and 2 diameters upstream from the stack top. Twenty-four points were sampled, four on each traverse. Sampling time was 3 minutes per point. The location of the traverse points is shown below:

Location of Traverse Points from Stack Wall

Inside Stack Diameter = 40" x 112 5/8"

Traverse Point No.	Inches from Wall
1	5
2	15
3	25
4	35

Location of Ports from Stack Wall

Port Location	Inches from Wall
1	9.4
2	28.2
3	46.9
4	65.7
5	84.5
6	103.2

Method 2: Stack Gas Velocity and Volumetric Flow Rate

For each test run, a velocity traverse was made with a calibrated Type "S" pitot tube having a co-efficient of 0.829. The velocity head was read on an inclined manometer to the nearest 0.05 inches of water. Temperature was measured with a chromel-alumel thermocouple.

Sampling site barometric pressure obtained from National Weather Service data.

Method 3: Component Gas Analysis

Analyses for Carbon Dioxide (CO_2), Oxygen (O_2), and Nitrogen plus Carbon Monoxide (N_2 + CO) were performed in the field using an Orsat type analyzer. Prior to testing, the Orsat apparatus was checked for leaks and the activity of the absorbing solution was determined to be adequate. Results were read and recorded to the nearest 0.2 percent volume, dry basis.

Method 4: Moisture Content

The moisture content of the stack gas was determined by condensing in three impingers in an ice bath and absorbing any remaining moisture in a fourth impinger containing silica gel.

Method 5: Particulate Emission

Particulate material is withdrawn isokinetically from the stack and collected on a glass fiber filter maintained in the temperature range of 223^{o} F. - 273^{o} F. The sample gas stream is dried as in Method 4 above. The sample gas is then passed through a metering system which measures both the cumulative volume of gas sampled and the instantaneous sampling rate.

Sampling Train

A schematic of the sampling train used in this method is shown in Figure 5-1 (See Page #5). The sampling train consists of the following components:

Stainless steel, buttonhook-type nozzle.
Asbestos gasket.
Stainless steel probe.
Fritted glass filter holder.
Electrically heated enclosed sample box.
Ice-water bath.
Modified Greenburg-Smith impinger.
Greenburg-Smith impinger.
Modified Greenburg-Smith impinger.
Modified Greenburg-Smith impinger.
Check valve.
Vacuum tube.
Vacuum guage.
Vacuum valve.
Leak-free vacuum pump.
By-pass valve.
Dry gas meter.
Calibrated orifice.
Dual manometer.
Type "S" pitot tube.

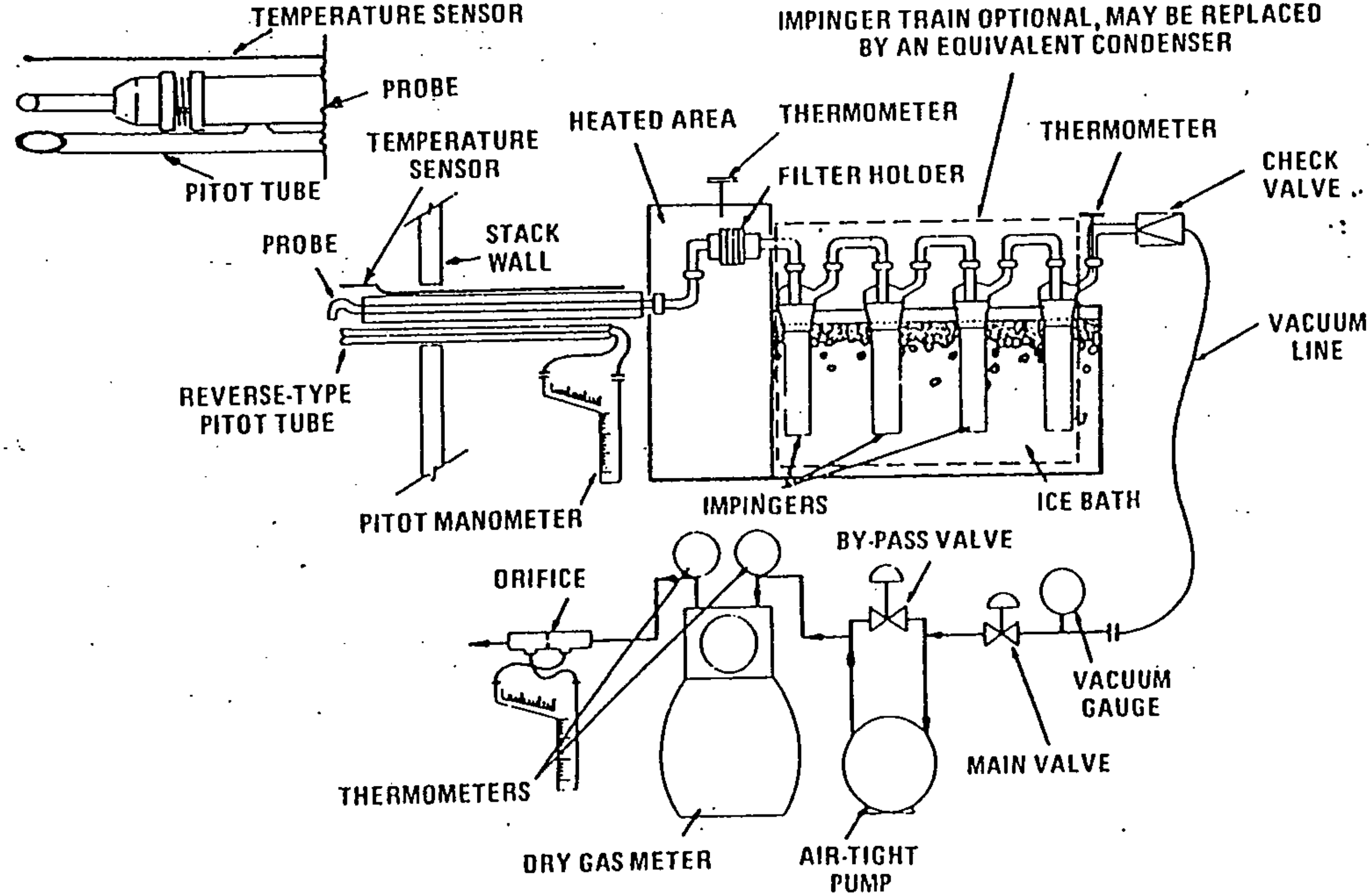


Figure 5-1. Particulate-sampling train.

81

A more detailed description of the sampling train components follows:

1. Probe Nozzle: Stainless steel with sharp, tapered leading edge. A 0.185 inch diameter (as measured on site with a caliper) nozzle was used in all tests.

2. Probe Liner: Stainless steel with a heating system is used to maintain a gas temperature at the exit during sampling of 223°F. to 273°F.

3. Pitot Tube: A Type "S" pitot tube attached to the probe allowed constant monitoring of the stack gas velocity. The pitot tube coefficient of 0.829 was determined by comparison with standard pitot tube on April 7, 1989. ΔP was read from an inclined manometer.

4. Differential Pressure Gauge: A Dwyer magalhelic gauge with a range of 0 - 10 inches water was used to obtain ΔH.

5. Filter Holder: Borosilicate glass, with a glass frit filter support and a silicone rubber gasket.

6. Filter Heating System: Thermostat controlled electrical resistance type heater capable of maintaining a temperature of 223°F. - 273° F. around the filter holder.

7. Impingers: Four pyrex glass impingers connected in series with a leak-free ground glass fitting. The first, third, and fourth impingers were Greenburg-Smith design with a modified (straight) tip. The second impinger was a Greenburg-Smith design with a standard tip. A thermometer was in place to measure the temperature at the outlet of the fourth impinger.

8. Metering System: The vacuum gauge, leak-free pump, thermometer, temperature compensated dry gas meter, and related equipment are shown in Figure 5-1. The sampler is a LSI Model 31.

Sampling Procedures

Prior to testing, the sampling train is cleaned and set up as follows:

A four-inch diameter glass fiber filter was dried in a 105°C. oven overnight. The filter was then placed in a desiccator for two hours and weighed on an analytical balance to the nearest 0.1 milligram (mg.). One hundred milliliters (ml.) of distilled water was placed in each of the first two impingers. Two hundred grams dry silica gel (indicating) was placed in the fourth impinger. The third impinger was left dry and empty. The sampling train was assembled as shown in Figure 5-1 (Page #5). Based on the preliminary velocity and temperature traverse, an appropriate nozzle size was selected to provide an adequate sampling rate.

After assembly, the sampling train was leak-checked at the inlet to the filter holder at 15 inches mercury vacuum. If a leak rate of greater than 0.02 ft.^{3}/min. was observed, the system was checked and leaks corrected. The leak-check procedure was repeated until the leakage rate was less than 0.02 ft.^{3}/min.

Approximately one half hour before the start of the test, the probe and filter box heaters were turned on and allowed to warm up to sampling temperatures. Ice was placed around the impingers. At the start of a test run, the dry gas meter reading was recorded on the data sheet, the probe was placed in the stack at the first sampling point, and the velocity pressure was read. Using an isokinetic flow rate calculator, the desired orifice meter pressure was determined. The sample pump was then turned on and the time was recorded. The main and by-pass valves were immediately adjusted to give the desired sampling rate. For each point, the following data was recorded: Traverse Point Number, Sampling Time, Stack Temperature, Velocity Head, Orifice Meter Reading, Dry Gas Meter Volume, Meter Temperature, Box Temperature, and Pump Vacuum. Near the end of the sampling time (approximately 10 seconds remaining), the nozzle was moved to the next point and exactly at the start of the next sampling period, the dry gas meter volume was recorded. The point by point sampling procedures were then repeated until the test run was completed. While moving between ports, the pump was turned off. At the completion of the test run, the pump was turned off, the dry gas meter volume recorded, and the probe was removed from the stack. The sample train was leak-checked from the sample nozzle at the highest vacuum pulled during the test to verify the leak-free integrity of the system.

Sample Recovery

Sample recovery was accomplished near the sampling site. While the probe and filter holder was cooling, the contents of the first three impingers were measured volumetrically and placed in a clean container. The silica gel in the fourth impinger was transferred to a clean, dry container. This was weighed in the lab at a later time.

The filter was carefully transferred to a petri dish. Any filter material which stuck to the gasket was scraped loose and transferred to the petri dish. The upstream portion of the filter holder was washed with acetone, which was collected in a clean glass container labelled to identify the test run. The probe nozzle was then removed and the inner surfaces rinsed with acetone along with cleaning by a brush until no visible particulate was present in the rinse. The probe liner was washed with acetone and brushing. Both the probe liner and nozzle washes were collected in the same container as the filter holder washings.

Sample Analysis

In the laboratory, the filter and any loose particulate were placed in a dessicator for 24-hours. The material was then weighed on an analytical balance to the nearest 0.1 mg.

The volume of the upstream acetone wash was measured and transferred to a tared beaker. The acetone was evaporated at room temperature. After desiccation, the beaker was reweighed. Simultaneously, a 100 ml. acetone blank was evaporated and the residue weight was determined. The net residue weight of the sample washes has been adjusted for the acetone blank.

The water collected from the first three impingers was measured to the nearest ml. All the sample exposed glassware was rinsed with acetone and placed in a separate clean, dry container. This was evaporated in the same manner as the probe wash. The water collected was extracted with 3-50 ml. portions of methylene chloride. The extracts were evaporated in a tarred beaker @ $20^{\circ}C$. A 100 ml portion of the remaining water was evaporated in a tarred beaker @ $103^{\circ}C$. The two weight gains were included in the total particulate. The total particultate collected is then the sumation of the acetone wash weight gain plus the filter weight gain, plus the water extract weight gain plus the water residue weight gain.

The silica gel from each run was weighed to the nearest 0.1 gm. The weight gain of the silica gel was added to the volume of liquid water collected in the first three impingers to obtain the total amount of water collected.

Data Handling and Calculations

All mathematical calculations were made acccording to accepted techniques using U.S. EPA equations. Standard conditions of 29.92 inches mercury pressure and $68^{\circ}F$. temperature were used. Field calculations were rechecked, and the final results for each test run and are presented in detail in the Appendix.

Appendix

Location:	Alto Dairy Waupun
Date:	4-20-89
Time:	8:30 - 9:52 AM
Test Run:	#19

Stack Gas Data:

Temperature, ^{o}F.	122.3
Velocity, ft./sec.	53.98
Gas Volume, ACFM	101325
Gas Volume, SCFM (Wet)	91463
Gas Volume, SCFH (Dry)	5.165×10^{6}
Moisture, %	5.9
Carbon Dioxide, % (Dry)	0.5
Oxygen, % (Dry)	20.3
Caron Monoxide + Nitrogen, % Dry	79.2
Molecular Weight (Wet)	28.25

Sampling Data:

Total Time, min.	72
Volume, SCF (Dry)	36.057
Isokinetic Ratio, %	97.5

Particulate:

Amount Collected, mg. (including condensible)	13.4
Concentration, grains/SCF	0.0057
Emission Rate, lb/hr.	4.23

Location:	Alto Dairy Waupun
Date:	4-20-89
Time:	11:00 AM - 12:21 PM
Test Run:	#2

Stack Gas Data:

Temperature, °F.	124.7
Velocity, ft./sec.	53.96
Gas Volume, ACFM	101287
Gas Volume, SCFM (Wet)	91068
Gas Volume, SCFH (Dry)	5.153×10^6
Moisture, %	5.7
Carbon Dioxide, % (Dry)	0.4
Oxygen, % (Dry)	20.8
Carbon Monoxide + Nitrogen, % (Dry)	78.8
Molecular Weight (Wet)	28.27

Sampling Data:

Total Time, min.	72
Volume, SCF (Dry)	36.535
Isokinetic Ratio, %	99.0

Particulate:

Amount Collected, mg. (including condensible)	18.5
Concentration, grains/SCF	0.0078
Emission Rate, lb/hr.	5.75

Location:	Alto Dairy Waupun
Date:	4-20-89
Time:	1:06 - 2:29 PM
Test Run:	#3

Stack Gas Data:

Temperature, ^{o}F.	122.2
Velocity, ft./sec.	54.40
Gas Volume, ACFM	102113
Gas Volume, SCFM (Wet)	92204
Gas Volume, SCFH (Dry)	5.234×10^{6}
Moisture, %	5.4
Carbon Dioxide, % (Dry)	0.5
Oxygen, % (Dry)	20.0
Carbon Monoxide + Nitrogen, % (Dry)	79.5
Molecular Weight (Wet)	28.29

Sampling Data:

Total Time, min.	72
Volume, SCF (Dry)	37.173
Isokinetic Ratio, %	99.2

Particulate:

Amount Collected, mg. (including condensible)	16.7
Concentration, grains/SCF	0.0069
Emission Rate, lb/hr.	5.18

Laboratory Data

Company: Alto Dairy - Waupun
Date: 5-16-89
Test Run: #1

Filter:	No. 1		
	Final Weight, mg.	510.3	
	Tare Weight, mg.	504.9	
	Weight Gain, mg.		5.4
Acetone Probe Wash:			
	Final Weight, mg.	82196.0	
	Tare Weight, mg.	82185.2	
	Blank Concentration, mg.	3.2	
	Volume, ml.	52	
	Weight Gain, mg.		7.6
Impinger Acetone Wash:			
	Final Weight, mg.	81362.9	
	Tare Weight, mg.	81359.7	
	Blank Concentration, mg.	4.2	
	Volume, ml.	67	
	Weight Gain, mg.		0.0
Impinger Water Extracts: (CH_2Cl_2)			
	Final Weight, mg.	85897.6	
	Tare Weight, mg.	85894.9	
	Blank Concentration, mg.	4.5	
	Weight Gain, mg.		0.0
Impinger Water Residue: (100 ml. Aliquot)			
	Final Weight, mg.	52360.1	
	Tare Weight, mg.	52358.5	
	Blank Concentration, mg.	1.5	
	Volume, ml.	358	
	Weight Gain, mg.		0.4
	Total Particulate, mg.		13.4

Laboratory Data

Company: Alto Dairy - Waupun
Date: 5-16-89
Test Run: #2

Filter: No. 2			
	Final Weight, mg.	638.8	
	Tare Weight, mg.	623.6	
	Weight Gain, mg.		15.2
Acetone Probe Wash:			
	Final Weight, mg.	82954.1	
	Tare Weight, mg.	82948.6	
	Blank Concentration, mg.	3.3	
	Volume, ml.	53	
	Weight Gain, mg.		2.2
Impinger Acetone Wash:			
	Final Weight, mg.	81905.5	
	Tare Weight, mg.	81902.5	
	Blank Concentration, mg.	5.2	
	Volume, ml.	84	
	Weight Gain, mg.		0.0
Impinger Water Extracts: (CH_2Cl_2)			
	Final Weight, mg.	82659.8	
	Tare Weight, mg.	82658.4	
	Blank Concentration, mg.	4.6	
	Weight Gain, mg.		0.0
Impinger Water Residue: (100 ml. Aliquot)			
	Final Weight, mg.	51684.8	
	Tare Weight, mg.	51683.0	
	Blank Concentration, mg.	1.5	
	Volume, ml.	364	
	Weight Gain, mg.		1.1
	Total Particulate, mg.		18.5

Laboratory Data

Company: Alto Dairy - Waupun
Date: 5-16-89
Test Run: #3

Filter: No. 3			
	Final Weight, mg.	513.7	
	Tare Weight, mg.	500.7	
	Weight Gain, mg.		13.0
Acetone Probe Wash:			
	Final Weight, mg.	78283.3	
	Tare Weight, mg.	78276.1	
	Blank Concentration, mg.	4.7	
	Volume, ml.	76	
	Weight Gain, mg.		2.5
Impinger Acetone Wash:			
	Final Weight, mg.	82924.0	
	Tare Weight, mg.	82922.1	
	Blank Concentration, mg.	4.9	
	Volume, ml.	79	
	Weight Gain, mg.		0.0
Impinger Water Extracts: (CH_2Cl_2)			
	Final Weight, mg.	84515.9	
	Tare Weight, mg.	84513.8	
	Blank Concentration, mg.	4.9	
	Weight Gain, mg.		0.0
Impinger Water Residue: (100 ml. Aliquot)			
	Final Weight, mg.	51923.3	
	Tare Weight, mg.	51921.5	
	Blank Concentration, mg.	1.5	
	Volume, ml.	390	
	Weight Gain, mg.		1.2
	Total Particulate, mg.		16.7

000

Laboratory Data

Company: Alto Dairy
Date: 4-20-89
Test Run: Blank

Filter: No. 4

Final Weight, mg.	614.0	
Tare Weight, mg.	614.0	
Weight Gain, mg.		0.0

Acetone Probe Wash:

Final Weight, mg.	84519.5	
Tare Weight, mg.	84512.4	
Blank Concentration, mg.	7.1	
Volume, ml.	114	
Weight Gain, mg/ml.		0.062

Impinger Acetone Wash:

Final Weight, mg.		
Tare Weight, mg.		
Blank Concentration, mg.		
Volume, ml.		
Weight Gain, mg.		

Impinger Water Extracts:
(CH_2Cl_2)

Final Weight, mg.	82949.7	
Tare Weight, mg.	82947.1	
Blank Concentration, mg.	---	
Weight Gain, mg.		2.6

Impinger Water Residue:

Final Weight, mg.	51176.7	
Tare Weight, mg.	51175.2	
Blank Concentration, mg.	1.5	
Volume, ml.	100	
Weight Gain, mg./ml.		0.015

Thermolcouple Calibration

Room Temperature:	NBS Certified Thermometer	=	69° F.
	Stack Sampler Thermocouple	=	69° F.
Hot Water Temperature:	NBS Certified Thermometer	=	177° F.
	Stack Sampler Thermocouple	=	178° F.

Calibrated April 6, 1989 by Bruce Lamers.

Dry Gas Meter Calibration

Meter calibrated by Wisconsin Public Service in Green Bay on April 4, 1989. Meter read 99% before adjustment. After adjustment it read 100%.

CALCULATIONS FOR: Alto Dairy Date: 4/20/89 Test Run: 1

Dry Gas Meter Volume	V_m = 37.026 ft^3	Particulates Collected	M_n = 13.4 mg
Total Water Collected	V_{lc} = 48.2 ml	Stack Area	A = 31.2247 ft^2
Absolute Stack Pressure	P_s = 29.79 in.Hg	Total Sampling Time	θ = 72 min
Absolute Meter Pressure	P_m = 29.86 in.Hg	Pitot Tube Coefficient	C_p = .8294
Absolute Stack Temperature	T_s = 582.3 °R	Average Velocity Head (√ΔP) avg.	= .9152
Absolute Meter Temperature	T_m = 541.1 °R	Nozzle Area	A_n = .0001867 ft^2

Volume of Sample at Standard Conditions, Dry Basis.

$$(17.647)\, V_m \frac{P_m}{T_m} = (17.647)(37.026)\frac{(29.86)}{(541.1)} = \quad V_{mstd} = 36.057 \text{ ft}^3$$

Volume of Water Vapor in Sample at Standard Conditions.

$$(0.04707)\, V_{lc} = (0.04707)(48.2) = \quad V_{wstd} = 2.26877 \text{ ft}^3$$

Proportion of Water Vapor in Gas Stream.

$$\frac{V_{wstd}}{V_{mstd} + V_{wstd}} = \frac{(2.269)}{(36.057) + (2.269)} = \quad B_{wo} = .059$$

Concentration of Particulate Matter, Dry Basis.

$$(0.0154)\frac{M_n}{V_{mstd}} = (0.0154)\frac{(13.4)}{(36.057)} = \quad c'_s = .0057 \text{ gr/scf}$$

$$(2.205 \times 10^{-6})\frac{M_n}{V_{mstd}} = (2.205 \times 10^{-6})\frac{(13.4)}{(36.057)} = \quad c_s = .819 \times 10^{-6} \text{ lb/scf}$$

Dry Molecular Weight of Stack Gas.

$$0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%CO) = \begin{array}{l} 0.44 \times .5 = .22 \\ 0.32 \times 20.3 = 6.496 \\ 0.28 \times 79.2 = 22.176 \end{array} = \quad M_d = 28.892$$

Molecular Weight of Stack Gas, Wet Basis.

$$M_d\,(1 - B_{wo}) + 18\, B_{wo} = (28.892)(.941) + 18(.059) = \quad M_s = 28.2494$$

Stack Gas Velocity.

$$(85.49)\, C_p\, (\sqrt{\Delta P})\text{ avg.} \sqrt{\frac{T_s}{P_s M_s}} = (85.49)(.8294)(.9152)\sqrt{\frac{(582.3)}{(29.79)(28.249)}} = \quad V_s = 53.9795$$

Volumetric Flow Rate, Dry Basis, Standard Conditions.

$$(63529)(1 - B_{wo})\, V_s A \frac{P_s}{T_s} = (63529)(.941)(53.98)(31.28)\frac{(29.79)}{(582.3)} = \quad Q_s = 5164716 \text{ scfh}$$

Emission Rate.

$$Q_s \times c_s = (5164716)(.819 \times 10^{-6}) = \quad E.R. = 4.23 \text{ lb/hr}$$

Percent of Isokinetic Sampling.

$$\frac{K_1\,(K_2\, V_{lc} + \frac{V_m}{T_m} P_m)\, T_s}{\theta\, V_s\, P_s\, A_n} = \frac{(1.667)\,((.00267)(48.2) + \frac{(37.026)}{(541.1)}(29.86))\,(582.3)}{(72)(53.9795)(29.79)(.0001867)} = \quad I = 97.5\ \%$$

CALCULATIONS FOR: Alto Dairy Date: 4/20/89 Test Run: 2

Dry Gas Meter Volume	V_m = 37.962 ft^3	Particulates Collected	M_n = 18.5 mg
Total Water Collected	V_{lc} = 46.5 ml	Stack Area	A = 31.2847 ft^2
Absolute Stack Pressure	P_s = 29.79 in.Hg	Total Sampling Time	θ = 72 min
Absolute Meter Pressure	P_m = 29.87 in.Hg	Pitot Tube Coefficient	C_p = .8294
Absolute Stack Temperature	T_s = 584.7 °R	Average Velocity Head (√ΔP)	avg. = .913396
Absolute Meter Temperature	T_m = 547.7 °R	Nozzle Area	A_n = .0001867 ft^2

Volume of Sample at Standard Conditions, Dry Basis.

$$(17.647)\ V_m \frac{P_m}{T_m} = (17.647)(37.962)\frac{(29.87)}{(547.7)} = V_{mstd} = 36.5353\ ft^3$$

Volume of Water Vapor in Sample at Standard Conditions.

$$(0.04707)\ V_{lc} = (0.04707)(46.5) = V_{wstd} = 2.1888\ ft^3$$

Proportion of Water Vapor in Gas Stream.

$$\frac{V_{wstd}}{V_{mstd} + V_{wstd}} = \frac{(2.189)}{(36.535) + (2.189)} = B_{wo} = .057$$

Concentration of Particulate Matter, Dry Basis.

$$(0.0154)\frac{M_n}{V_{mstd}} = (0.0154)\frac{(18.5)}{(36.5353)} = c'_s = .0078\ gr/scf$$

$$(2.205 \times 10^{-6})\frac{M_n}{V_{mstd}} = (2.205 \times 10^{-6})\frac{(18.5)}{(36.5353)} = c_s = 1.1165 \times 10^{-6}\ lb/sc$$

Dry Molecular Weight of Stack Gas.

$$0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2+\%CO) = 0.44 \times .4 = .176$$
$$0.32 \times 20.8 = 6.656$$
$$0.28 \times 78.8 = 22.064 \quad = M_d = 28.896$$

Molecular Weight of Stack Gas, Wet Basis.

$$M_d\ (1 - B_{wo}) + 18\ B_{wo} = (28.896)(.943) + 18(.057) = M_s = 28.2749$$

Stack Gas Velocity.

$$(85.49)\ C_p\ (\sqrt{\Delta P})\ avg. \sqrt{\frac{T_s}{P_s M_s}} = (85.49)(.8294)(.9134)\sqrt{\frac{(584.7)}{(29.79)(28.27)}} = V_s = 53.95916$$

Volumetric Flow Rate, Dry Basis, Standard Conditions.

$$(63529)(1 - B_{wo})\ V_s A \frac{P_s}{T_s} = (63529)(.943)(53.96)(31.285)\frac{(29.79)}{(584.7)} = Q_s = 5{,}152{,}549\ scfh$$

Emission Rate.

$$Q_s \times c_s = (5{,}152{,}549)(1.1165 \times 10^{-6}) = E.R. = 5.75\ lb/hr$$

Percent of Isokinetic Sampling.

$$\frac{K_1\ [K_2\ V_{lc} + \frac{V_m}{T_m} P_m]\ T_s}{\theta\ V_s\ P_s\ A_n} = \frac{(1.667)\ [(1.00267)(46.5) + \frac{(37.962)}{(547.7)}(29.87)]\ (584.7)}{(72)(53.96)(29.79)(.0001867)} = I = 99.0\ \%$$

CALCULATIONS FOR: Alto Dairy   Date: 4/20/89   Test Run: 3

Dry Gas Meter Volume	V_m = 38.801 ft^3	Particulates Collected	M_n = 116.7 mg
Total Water Collected	V_{lc} = 44.8 ml	Stack Area	A = 31.2847 ft^2
Absolute Stack Pressure	P_s = 29.79 in.Hg	Total Sampling Time	θ = 72 min
Absolute Meter Pressure	P_m = 29.87 in.Hg	Pitot Tube Coefficient	C_p = .8294
Absolute Stack Temperature	T_s = 582.2 °R	Average Velocity Head (√ΔP) avg	= .92317
Absolute Meter Temperature	T_m = 550.2 °R	Nozzle Area	A_n = .0001867 ft^2

Volume of Sample at Standard Conditions, Dry Basis.

$$[17.647]\, V_m \frac{P_m}{T_m} = [17.647]\,(38.801)\,\frac{(29.87)}{(550.2)} = V_{mstd} = 37.1731\ ft^3$$

Volume of Water Vapor in Sample at Standard Conditions.

$$[0.04707]\, V_{lc} = [0.04707]\,(44.8) = V_{wstd} = 2.1087\ ft^3$$

Proportion of Water Vapor in Gas Stream.

$$\frac{V_{wstd}}{V_{mstd} + V_{wstd}} = \frac{(2.109)}{(37.173) + (2.109)} = B_{wo} = .054$$

Concentration of Particulate Matter, Dry Basis.

$$[0.0154]\,\frac{M_n}{V_{mstd}} = [0.0154]\,\frac{(116.7)}{(37.1731)} = c'_s = .00109\ gr/scf$$

$$[2.205 \times 10^{-6}]\,\frac{M_n}{V_{mstd}} = [2.205 \times 10^{-6}]\,\frac{(116.7)}{(37.1731)} = c_s = .9906 \times 10^{-6}\ lb/sc$$

Dry Molecular Weight of Stack Gas.

$0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2+\%CO)$:

0.44 x	.5	= .22
0.32 x	20.0	= 6.4
0.28 x	79.5	= 22.26

M_d = 28.88

Molecular Weight of Stack Gas, Wet Basis.

$$M_d\,(1 - B_{wo}) + 18\,B_{wo} = (28.88)\,(.946) + 18\,(.054) = M_s = 28.29248$$

Stack Gas Velocity.

$$[85.49]\, C_p\,(\sqrt{\Delta P})\,avg. \sqrt{\frac{T_s}{P_s M_s}} = [85.49]\,(.8294)(.92317)\sqrt{\frac{(582.2)}{(29.79)(28.29)}} = V_s = 54.4034$$

Volumetric Flow Rate, Dry Basis, Standard Conditions.

$$[63529]\,(1 - B_{wo})\,V_s A \frac{P_s}{T_s} = [63529]\,(.946)(54.40)(31.2847)\,\frac{(29.79)}{(582.2)} = Q_s = 5,233,833\ scfh$$

Emission Rate.

$$Q_s \times c_s = (5,233,833)(.9906 \times 10^{-6}) = E.R. = 5.18\ lb/hr$$

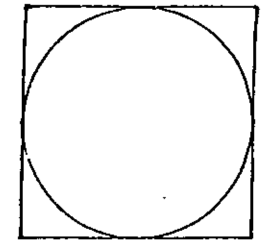
Percent of Isokinetic Sampling.

$$\frac{K_1\,[K_2\,V_{lc} + \frac{V_m}{T_m} P_m]\,T_s}{\theta\, V_s\, P_s\, A_n} = \frac{[1.667]\,[(.00267)(44.8) + \frac{(38.801)}{(550.2)}(29.87)]\,(582.2)}{(72)(54.40)(29.79)(.0001867)} = I = 99.2\ \%$$

COMPANY Alto Dairy
LOCATION Whey Dryer
DATE 8/20/89
TEST RUN # 1
STACK AREA 40" x 112 5/8" 31.2847 ft²
OPERATOR BJ

AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 29.80
ASSUMED MOISTURE, % 11
HEATER BOX SETTING 250
PROBE HEATER SETTING 250
FILTER NUMBER 1

SAMPLE BOX #
METER BOX # D 478 N
METER ΔH@ 1.88
C FACTOR 1
PROBE LENGTH 5.5'
NOZZLE DIAMETER .185 .0001867



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft³)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)	
8:30	1-1	3:00		115	1.0	1.0	.94	725.400	62	62	250	2.0	
33	1-2		-.13	116	1.0	1.0	.97	27.20	80	64			27.00
36	1-3			118	.85	.9220	.83	28.90	85	64			28.62
39/42	1-4			116	.65	.8062	.64	30.49	88	64			30.11
8:44	2-1			119	1.15	1.0724	1.13	31.84	85	65			31.42
47	2-2			116	1.05	1.0257	1.05	33.68	92	65			33.17
50	2-3			120	.9	.9487	.89	35.44	95	66			34.85
53/56	2-4			120	.7	.8367	.69	37.04	96	66			36.40
8:58	3-1			118	1.15	1.0724	1.14	38.41	89	67			37.77
9:01	3-2			120	1.1	1.0488	1.10	40.23	96	68			39.52
04	3-3			123	.95	.9747	.95	41.94	99	68			41.24
07/10	3-4			123	.75	.8660	.75	43.57	100	68			42.85
TOTAL		36	-.13	1424		11.5720	11.08	44.92	1067	787			44.27
AVERAGE													

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL				
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
8:20	.6	20.2		79.2
AVERAGE				

COMMENTS:
leak ck. before
OK at 14"

COMPANY Atlo Dairy

LOCATION whey dryer

DATE 4/20/89

TEST RUN # 1

STACK AREA

OPERATOR RG

AMBIENT TEMPERATURE 60

BAROMETRIC PRESSURE 29.86

ASSUMED MOISTURE, % 11

HEATER BOX SETTING 250

PROBE HEATER SETTING 250

FILTER NUMBER 1

SAMPLE BOX #

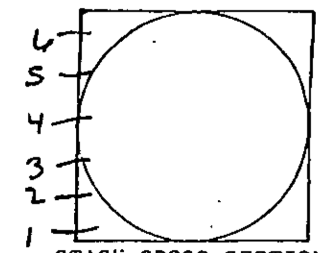
METER BOX #

METER ΔH@ 1.88

C FACTOR 1

PROBE LENGTH

NOZZLE DIAMETER .185



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)	
9:13	4-1	3.00	-.16	125	.95	.9747	.95	44.92	88	69	250		44.27
16	2			125	.9	.9486	.90	46.48	98	70			45.88
19	3			125	.75	.8660	.75	48.05	101	70			47.44
22/25	4			127	.65	.8062	.65	49.50	101	70		4.0	48.86
9:26	5-1			126	.8	.8944	.80	50.87	95	70			50.18
29	2			127	.7	.8367	.70	52.33	100	70			51.65
32	3			126	.65	.8062	.65	53.73	102	70			53.03
35/38	4			126	.6	.7746	.60	55.08	103	71		4.0	54.35
9:40	6-1			127	.8	.8944	.80	56.45	95	71			55.62
43	2			126	.85	.9220	.85	57.97	101	72			57.09
46	3			125	.8	.8944	.80	59.55	103	72			58.61
49/52	4			126	.6	.7746	.60	61.06	105	72		3.5	60.08
TOTAL		72	-.16	1511		10.3928	9.05	762.426	1192	847			61.35
AVERAGE			-.145	122.3		.9152	.939	37.026	81.1				

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL	—	—	240	208.2
INITIAL	100	100	.	200
NET H_2O			40	8.2
TOTAL H_2O COLLECTED, ml				48.2

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
9:17	.4	20.4		79.2
AVERAGE	.5	20.3		79.2

COMMENTS:

leak ck after at 4.5" .005 CFM

pitot line OK at 3.5"

COMPANY Alto Dairy
LOCATION Whey Dryer
DATE 4/20/89
TEST RUN # 2
STACK AREA 31.28
OPERATOR BJ

AMBIENT TEMPERATURE 65
BAROMETRIC PRESSURE 29.8
ASSUMED MOISTURE, % 6
HEATER BOX SETTING 250
PROBE HEATER SETTING 250
FILTER NUMBER 2

SAMPLE BOX #
METER BOX #
METER ΔH@ 1.88
C FACTOR 1
PROBE LENGTH
NOZZLE DIAMETER .185

STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	INLET (T_{mi}, °F)	OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)	
11:00	6-1	3:00		125	.85	.9220	.90	762.625	79	75	250	4.0	
03	2			127	.85	.9220	.89	64.22	92	75			64.19
06	3			125	.85	.9220	.90	65.83	96	75			65.74
09/12	4		0.0	125	.65	.8062	.70	67.44	97	74			67.30
11:14	5-1			124	.80	.8944	.84	68.83	89	73			68.67
17	2			126	.80	.8944	.85	70.40	96	72			70.17
20	3		-.05	128	.70	.8367	.75	71.90	98	72			71.69
23/26	4			127	.60	.7746	.64	73.39	100	72		3.5	73.11
11:27	4-1			125	1.0	1.0	1.07	74.78	95	72			74.42
30	2			125	.9	.9487	.97	76.51	102	72			76.12
33	3		-.07	125	.75	.8660	.81	78.17	104	73			77.74
36/39	4			126	.65	.8062	.70	79.69	105	73			79.22
TOTAL			-.12	1508		10.5932	10.02	81.07	1153	878			80.59
AVERAGE													

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL				
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
11:05	.2	20.8		79.0
AVERAGE				

COMMENTS:
leak ch before at 14"
OK

0020984

COMPANY Alto Dairy

LOCATION whey Dryer

DATE 4/20/89

TEST RUN # 2

STACK AREA

OPERATOR BDJ

AMBIENT TEMPERATURE

BAROMETRIC PRESSURE 29.8

ASSUMED MOISTURE, % 6

HEATER BOX SETTING 250

PROBE HEATER SETTING 250

FILTER NUMBER 2

SAMPLE BOX #

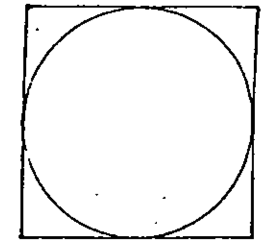
METER BOX #

METER $\Delta H@$ 1.88

C FACTOR 1

PROBE LENGTH 5.5'

NOZZLE DIAMETER .185



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, ^oF)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, ^oF)	DRY GAS METER OUTLET (T_{mo}, ^oF)	BOX TEMP (^oF)	PUMP VACUUM (in.Hg)	
11:42	3-1	3:00		124	1.05	1.0247	1.12	81.07	95	73	250	4.0	80.59
45	2		-.17	124	1.05	1.0247	1.13	82.82	103	75			82.33
48	3			124	.90	.9487	.98	84.55	107	75			84.08
51/54	4			126	.70	.8367	.76	86.17	107	75			85.70
11:56	2-1			124	1.10	1.0488	1.17	87.59	99	75			87.13
59	2			124	1.05	1.0247	1.13	89.36	107	76		4.0	88.91
12:02	3			124	.85	.9220	.93	91.13	109	77			90.66
05/08	4			124	.70	.8367	.77	92.76	109	77			92.24
12:09	1-1			122	1.0	1.0	1.09	94.19	103	77			93.68
12	2		-15	121	.95	.9747	1.04	95.94	109	77			95.39
15	3			124	.85	.9220	.93	97.65	110	77			97.07
18/21	4			124	.60	.7746	.64	99.23	110	77			
TOTAL		72	-.32	1485		11.3283	11.69	800.587	1268	911			
AVERAGE			-.09	124.7		.9133916	.905	37.962	87.7				

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL			238	208.5
INITIAL	100	100		200
NET H_2O			38	8.5
TOTAL H_2O COLLECTED, ml				46.5

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
12:11	.6	20.8		78.6
AVERAGE	.4	20.8		78.8

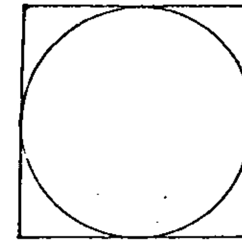
COMMENTS:

leak ch after all

5" - <.005 CFM

pitot tube OK

COMPANY Alto Dairy | AMBIENT TEMPERATURE 60 | SAMPLE BOX # ____
LOCATION whey dryer | BAROMETRIC PRESSURE 29.80 | METER BOX # ____
DATE 8/20/89 | ASSUMED MOISTURE, % 6 | METER ΔH@ 1.88
TEST RUN # 3 | HEATER BOX SETTING 250 | C FACTOR ____
STACK AREA 31.28 | PROBE HEATER SETTING 250 | PROBE LENGTH ____
OPERATOR BSJ | FILTER NUMBER 3 | NOZZLE DIAMETER .185


STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft³)	INLET (T_{mi}, °F)	OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)	
1:06	1-R	3:00		114	1.0	1.0	1.05	800.768	78	77	250	4.0	
09	2			117	.95	.9747	1.02	2.50	96	77			2.45
12	3		-.07	125	.8	.8944	.88	4.24	102	77			4.12
15/18	4			123	.6	.7746	.66	5.82	103	77			5.65
1:20	2-1			123	1.1	1.0488	1.19	7.18	99	77			6.99
23	2			123	1.0	1.0	1.09	9.02	103	77			8.78
26	3		-.12	124	.90	.9487	.98	10.76	105	76		4.5	10.80
29/32	4			126	.65	.8062	.71	12.39	104	76			12.12
1:34	3-1			123	1.05	1.0247	1.14	13.86	97	76			13.51
37	2			122	1.05	1.0247	1.15	15.66	105	76			15.26
40	3			126	.90	.9487	.98	17.49	107	77			17.02
43/46	4			124	.70	.8367	.77	19.15	107	76			18.65
TOTAL			-.19	1470		11.2822	11.54	20.62	1208	918			20.09
AVERAGE			-.12										

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL				
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

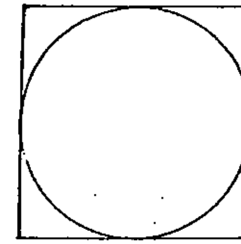
ORSATS TIME	CO_2	O_2	CO	N_2
1:11	0.0	20.6		79.4
AVERAGES				

COMMENTS:
Leak ck before st
15" OK

COMPANY Alto Dairy
LOCATION whey Dryer
DATE 7/20/89
TEST RUN # 3
STACK AREA 31.2847
OPERATOR BG

AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 29.75
ASSUMED MOISTURE, % 6
HEATER BOX SETTING 250
PROBE HEATER SETTING 125
FILTER NUMBER 3

SAMPLE BOX #
METER BOX #
METER H@ 1.88
C FACTOR
PROBE LENGTH
NOZZLE DIAMETER .185



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)	
1:49	4-1	3:00	-.25	123	1.0	1.0	1.09	20.62	96	76	250	4.5	20.09
52	2			122	.95	.9747	1.04	22.33	106	77			21.80
55	3			123	.80	.8944	.88	24.02	108	77			23.48
58/2:01	4			123	.70	.8367	.77	25.56	109	77			25.02
2:03	5-1			121	.85	.922	.93	27.01	102	77			26.45
04	2			123	.80	.8944	.88	28.60	107	78			28.03
09	3		-.05	121	.70	.8367	.77	30.20	109	78		4.0	29.57
12/15	4			123	.65	.8062	.72	31.73	109	78			31.02
2:17	6-1			121	.90	.9487	.98	33.18	102	78			32.41
20	2			122	.95	.9747	1.04	34.75	107	78			34.03
23	3			121	.90	.9487	.99	36.44	109	78			35.71
24/29	4			120	.70	.8367	.77	38.08	110	78			37.34
TOTAL		72	-.3	1463		10.8739	10.86	83.9569	1274	930			38.79
AVERAGE			-.12	122.2		.92317	.93	38.801	90.2				

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL			237	207.8
INITIAL	100	100		200
NET H_2O			37	7.8
TOTAL H_2O COLLECTED, ml				44.8

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
2:08	1.0	19.4		79.6
AVERAGE	.5	20.0		79.5

COMMENTS:
leak ck after
at 5.0"
<.015 CFM
pitot lines OK

PITOT TUBE CALIBRATION

Date 4/7/89 Calibrated by BSZ

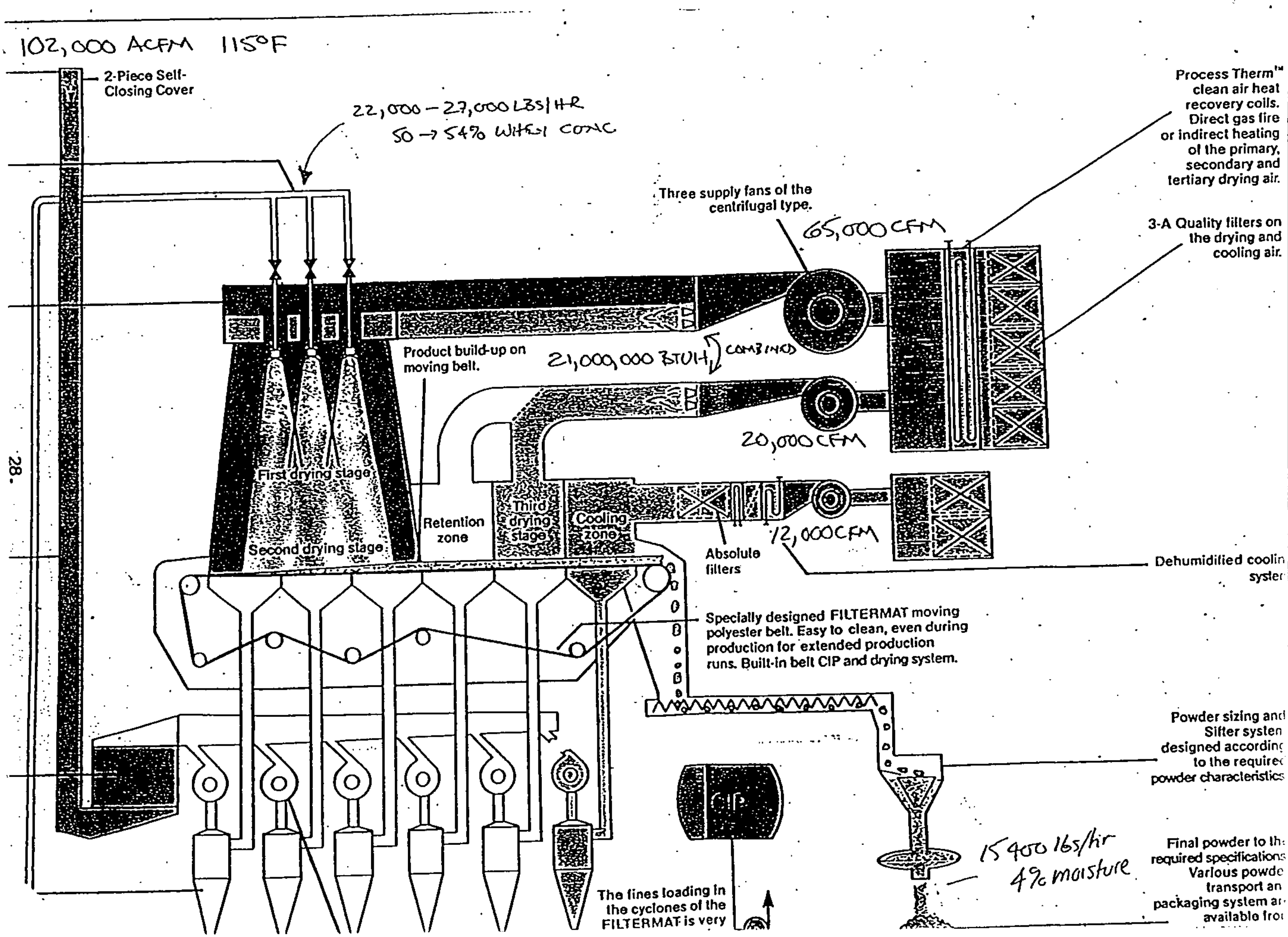
1. Face opening alignment OK? ________
2. External tubing diameter D_t = ________ in.
3. Base-to-opening plane distances P_A = ________ in.
   P_B = ________ in.
4. Pitot-nozzle distance X = ________ in.
5. Pitot-probe sheath distance Y = ________ in.
6. Pitot-thermocouple distance Z = ________ in.

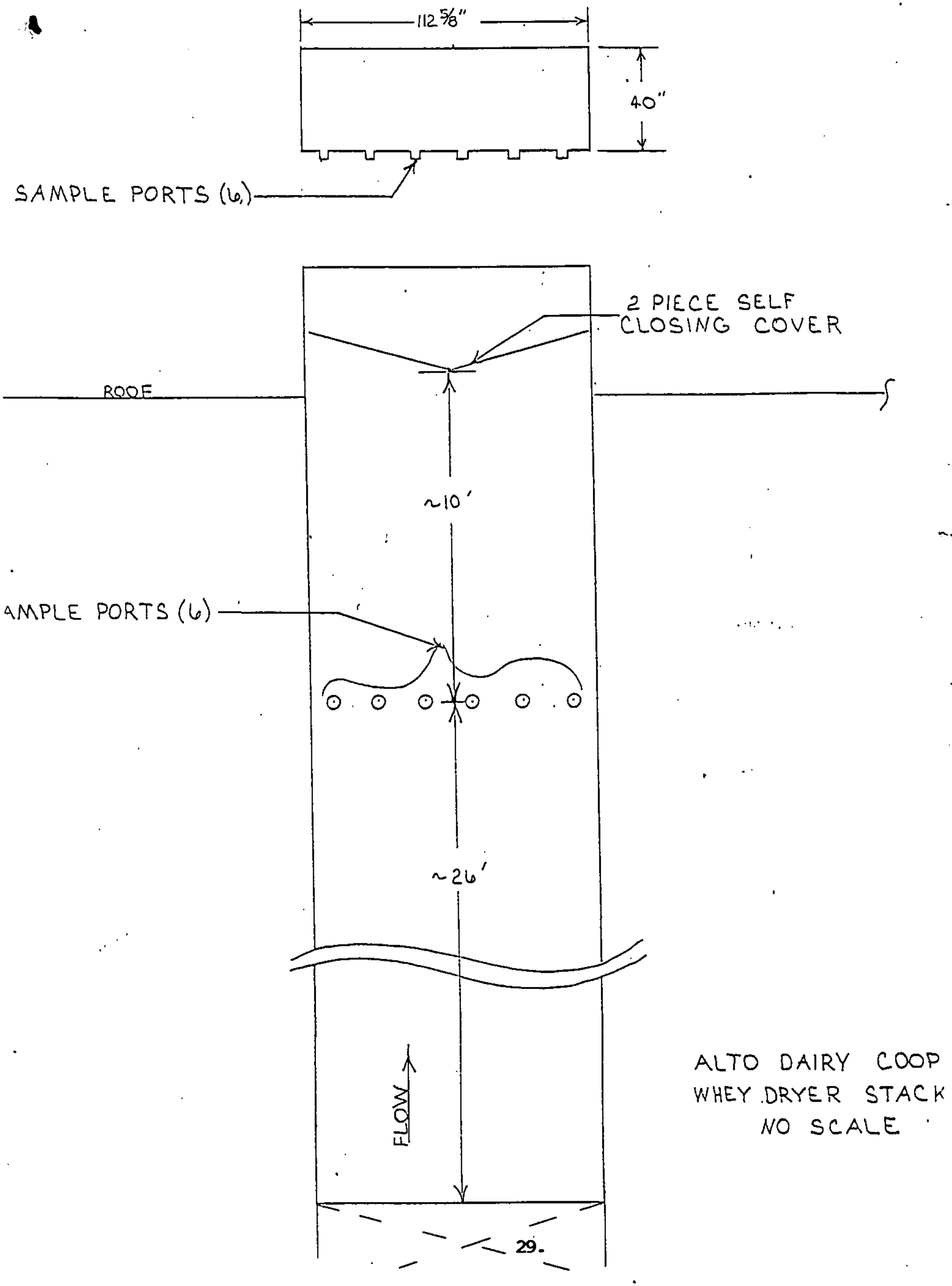
"A" SIDE CALIBRATION

RUN NO.	ΔP_{std} in.H_2O	ΔP_{s} in.H_2O	$\Delta P_{std}/\Delta P_{(s)}$	$C_{p(s)}$	DEVIATION $\lvert C_{p(s)} - \bar{C}_p(A) \rvert$
1	.04	.055	.72727	.84427	.0149
2	.025	.035	.71429	.83170	.0073
3	.03	.045	.666666	.80833	-.0211
	.035	.05	.7	.82829	-.0011
			$\bar{C}_p(A)$ = .8294		σ = .01549

$$C_{p(s)} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{(s)}}}$$

$$\sigma(A) = \frac{\sum^{3} \lvert C_{p(s)} - \bar{C}_p(A) \rvert}{3}$$


102,000 ACFM 115°F
2-Piece Self-Closing Cover
22,000 – 27,000 LBS/HR
50 → 54% WHEY CONC
Three supply fans of the centrifugal type.
65,000 CFM
Process Therm™ clean air heat recovery coils. Direct gas fire or indirect heating of the primary, secondary and tertiary drying air.
3-A Quality filters on the drying and cooling air.
Product build-up on moving belt.
21,000,000 BTUH COMBINED
20,000 CFM
First drying stage
Second drying stage
Retention zone
Third drying stage
Cooling zone
Absolute filters
12,000 CFM
Dehumidified coolin
syster
Specially designed FILTERMAT moving polyester belt. Easy to clean, even during production for extended production runs. Built-in belt CIP and drying system.
Powder sizing and
Sifter systen
designed according
to the requirec
powder characteristics
CIP
15400 lbs/hr
4% moisture
Final powder to th
required specifications
Various powde
transport an
packaging system ar
available fro
The fines loading in the cyclones of the FILTERMAT is very


112 5/8"
40"
SAMPLE PORTS (6)
2 PIECE SELF CLOSING COVER
ROOF
~10'
AMPLE PORTS (6)
~26'
FLOW
ALTO DAIRY COOP
WHEY DRYER STACK
NO SCALE