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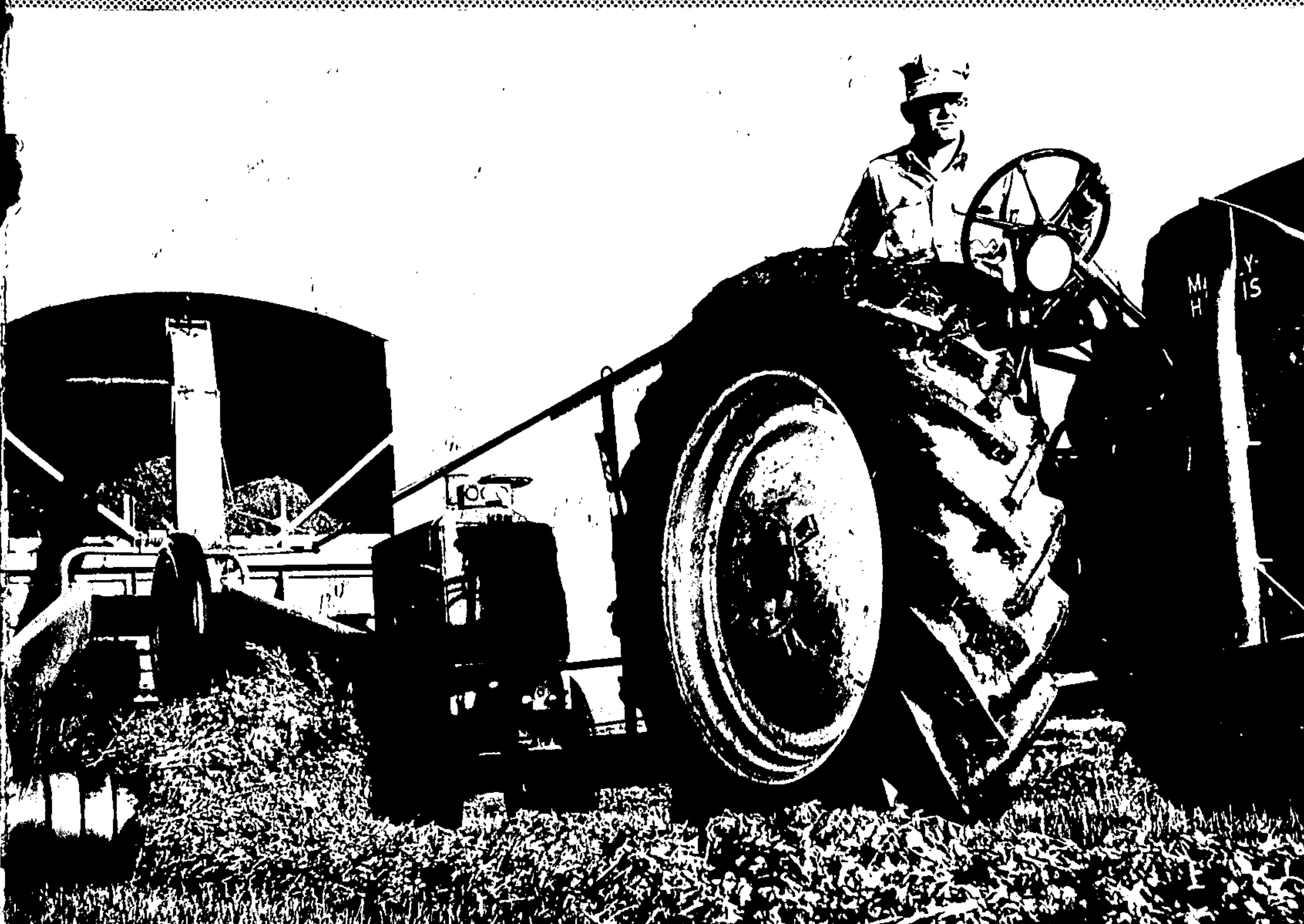
The Robert A. Taft
Sanitary Engineering Center

TECHNICAL REPORT

A60-4

SOURCES
AGRICULTURE
EMISSION
ORGANIC
PARTICULATE

AIR POLLUTION FROM ALFALFA DEHYDRATING MILLS



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

AIR POLLUTION
from
ALFALFA DEHYDRATING MILLS

Prepared by
Engineering Research and Development Unit
Air Pollution Engineering Research

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of State Services
Division of Engineering Services

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1960

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INTRODUCTION

In cooperation with the Kansas State Board of Health and the American Dehydrators' Association, the Air Pollution Engineering Program of the U.S. Public Health Service conducted an evaluation of atmospheric emissions from alfalfa dehydrating mills.

This report discusses the quantity and size distribution of dust discharged to the atmosphere from these mills, as determined by a study of a group of representative plants in Kansas and Ohio. It also discusses dust collection practices at typical plants and the relationship between these dust collection practices and the protein and carotene (pro-vitamin A) content of the meal produced

BACKGROUND

Dehydrated alfalfa is a meal product dried rapidly by artificial means at temperatures above 212°F. No sun-cured alfalfa is mixed in the meal product. Alfalfa meal is used in chicken rations, cattle feed, hog rations, sheep feed, turkey mash, and other formula feeds.(1)

More than ninety-six percent of this nation's alfalfa crop is produced in eighteen states with California, Colorado, Kansas, and Nebraska producing 69 percent of the total crop (Table 1). A typical dehydrating unit requires the yield from approximately 1000 acres of alfalfa to operate profitably during the normal season which runs from late April or early May to late October. (1)

A typical plant (Fig. 1) operates 24 hours per day, 7 days per week, during the season. The general method of operation is to harvest the alfalfa with a self-propelled or tractor-drawn chopping machine. The chopped alfalfa is then transported as quickly as possible to the dehydrating plant where it is dumped onto an automatic feeding device and fed into a dryer at a uniform rate. Practically all of the dryers are of the direct-fired, rotary type; the products of combustion leave the combustion chamber of the furnace (most units are gas- or oil-fired) at a temperature in the neighborhood of 1800 to 2000°F. The chopped, wet alfalfa is discharged from the feeder into this hot flue gas stream which is being pulled through the dryer by a fan at the outlet end. After passing through the rotating drum section, the moisture content of the material will be in the neighbor-

Table 1. Annual Production of Dehydrated Alfalfa Meal*

States	Short Tons
Arizona and New Mexico	10,700
Arkansas and Tennessee	11,900
California	82,600
Colorado	87,500
Illinois and Indiana	16,400
Iowa	23,500
Kansas	131,600
Michigan and Wisconsin	16,700
Minnesota	15,900
Missouri	42,000
Nebraska	391,300
Ohio	71,700
Oklahoma	9,700
Pennsylvania	34,200
Texas	27,000
Washington and Utah	10,000
Other States	21,400
Total	1,004,100

*Data received from U.S. Department of Agriculture, Marketing Service, Grain Division, Kansas City 6, Missouri, dated December 1958.

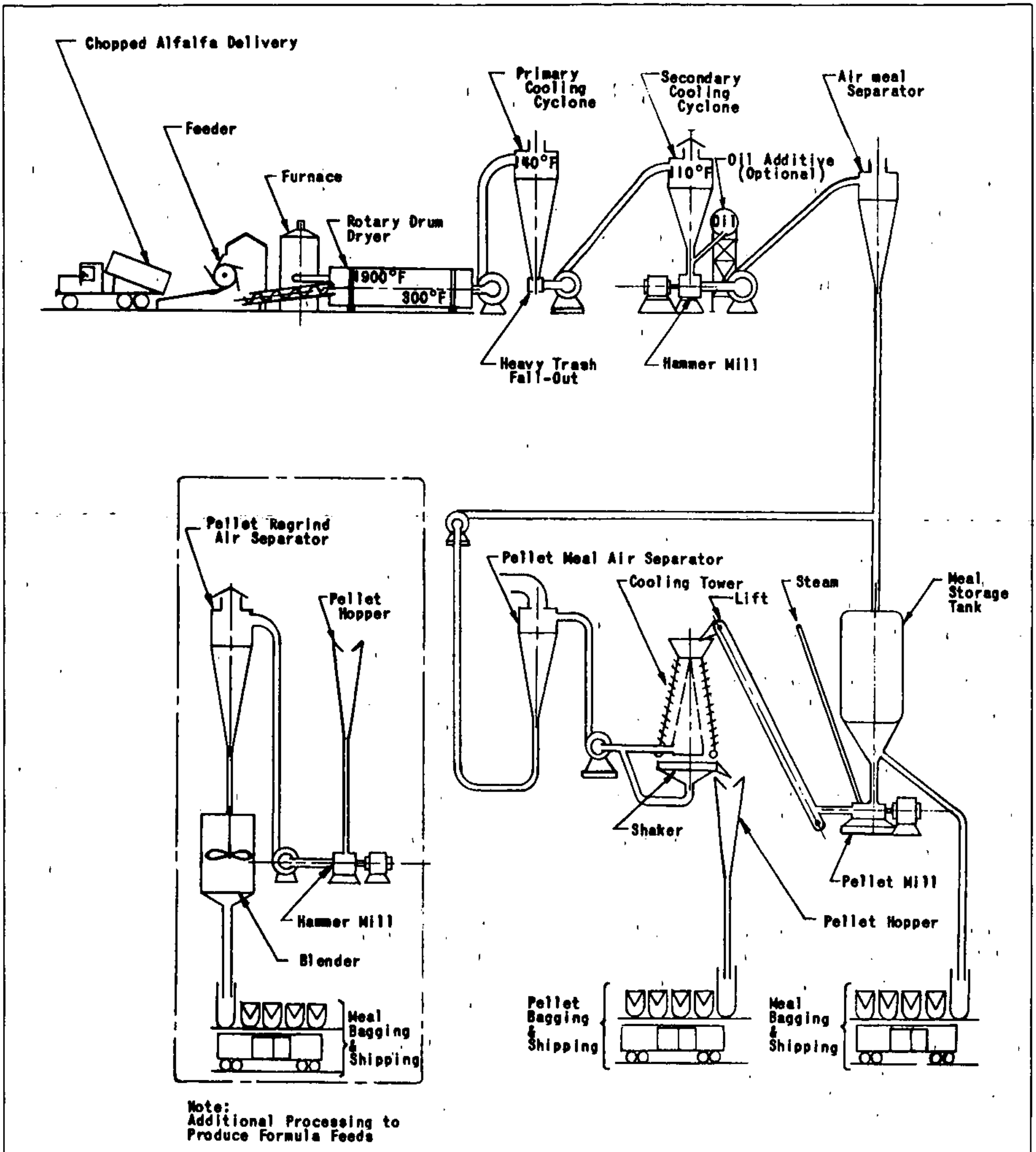


Figure 1. ALFALFA DEHYDRATING PROCESS FLOW DIAGRAM

hood of 7 to 9 percent and the flue gas temperature will be 250 to 350°F. Customarily, the material is then blown to a primary cooling cyclone in which the dried material is separated from the now moisture laden flue gas stream. The effluent from this cyclone (Fig. 2), usually billowing clouds of condensed steam, is the first of a series of atmospheric emissions from the alfalfa dehydrating plant.

The dry meal separated in the primary cooling cyclone is at a temperature of approximately 140^{o}F. New carrier gas - cool, dry air - is pulled into the system through an opening at the bottom of the primary cooling cyclone and conveys the dehydrated alfalfa to a secondary cooling cyclone (Fig. 3) which discharges the material at about 110^{o}F. into the plant's grinding equipment, normally a hammer mill. The effluent from the top of the secondary cooling cyclone is the second potential air pollution source in the process. Some mill operators have, at the request of certain customers, added vegetable oil or animal fat to the alfalfa meal at the hammer mill. The oil additive preserves the carotene content of the meal and helps to control the dust production associated with subsequent handling and storage operations.

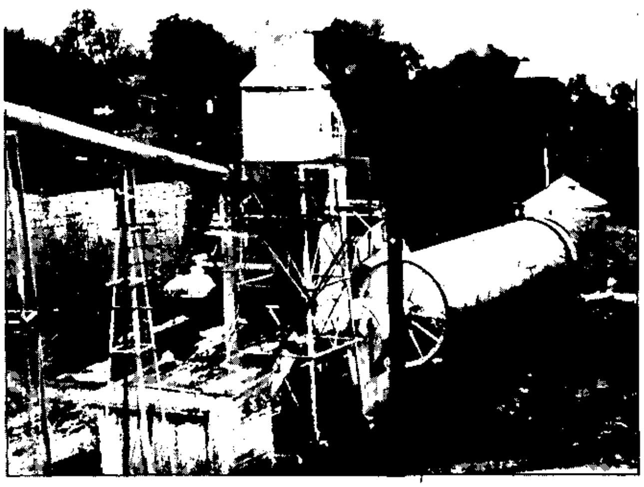


Figure 2. PRIMARY COOLING CYCLONE WITH ROTARY DRUM DRYER AND FURNACE IN BACKGROUND

The high speed grinder or hammer mill, located below the exit duct of the secondary cooling cyclone, reduces the dehydrated chops to a relatively fine powder and a blower just downstream from the grinder delivers the meal to a third cyclone which collects the meal for bagging, bulk storage, or pelletizing. The top discharge from this cyclone (Fig. 4) is the third air contamination source from a dehydrating plant. In some plants the air discharged from this cyclone is led to an auxiliary dust separator of the fabric filter or multiple cyclone type to remove more of the dust load prior to discharging the carrier air to the atmosphere.

To minimize storage and shipping space requirements, the meal is often steam extruded into pellets which are subsequently air cooled. The coolant air entrains small pellet chips and unpelletized meal. This particulate matter is then separated from the coolant air stream and

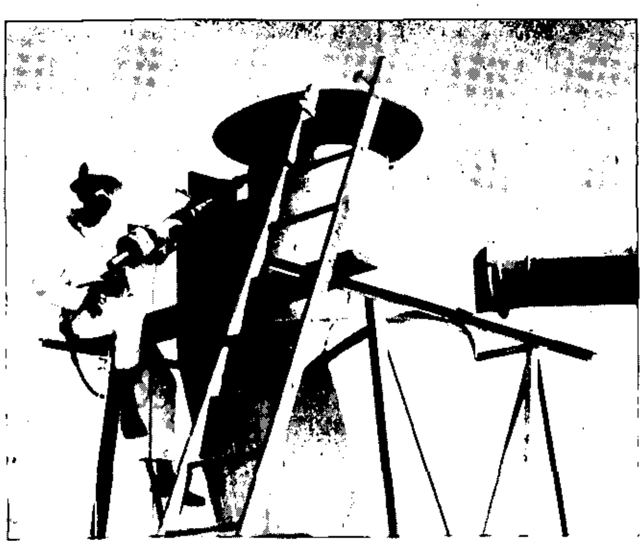


Figure 3. COLLECTING DUST SAMPLE AT SECONDARY COOLING CYCLONE

Figure 4. SAMPLING POINT - AIR MEAL SEPARATOR

recycled to the pelletizer. Separation is accomplished in a fourth cyclone (Fig. 5), the pellet meal air separator, which constitutes a fourth potential source of air contamination.[2,3].

For formula feeds the pellets are reground, an operation found only in the larger dehydrating mills. This process consists of conveying the pellets from storage to a hammer mill, grinding the pellets into a meal, and pneumatically conveying the meal to the pellet regrind air separator, and thence to the blender, bagging equipment, or to bulk shipping facilities. The discharge from the pellet regrind air separator is a possible fifth source of air pollution.

Figure 5. SAMPLING POINT - PELLET MEAL AIR SEPARATOR

Air Pollution Problems

Plant managers and air pollution control officials have received many complaints from people living in the vicinity of alfalfa dehydrating plants. These people object to the dust emissions because of the soiling effect of settled alfalfa meal dust on their houses, furniture, washing, and the like. Further objections also arise from odors of volatile matter driven off the alfalfa with the moisture and the combustion products emitted to the atmosphere. Some of the complaints allege damage to health, allergic reactions, and discomfort.[4]

Plant Surveys

To obtain information on dehydrating plant effluents, a group of representative plants in Kansas and Ohio were surveyed (Table 2). The sampling equipment consisted of a motor driven vacuum pump, a totalizing volumetric dry gas meter, a water-cooled condenser, a sampling probe, a high efficiency cyclone collector, a glass fiber filter assembly, a calibrated orifice assembly, manometer, and flow rate control valve (Fig. 6).[5, 6]

Based on a determination of the rate of gas volume passing per unit time, the weight of particulate carried by a unit volume of this gas was determined from which the total weight of particulate discharged from the stack during any given period was calculated. A measured amount of gas was withdrawn from the stack and the particulate was separated from the measured sample. Every effort was made to sample the gas isokinetically[7] and in no case was the duration of the test less than 30 minutes. At the end of the test period, the bypass valve was closed and the vacuum pump stopped. The sampling probe was removed from the stack, held in an upright position and then rapped to knock any dust in the tube into the sample particulate trap. Care was taken to remove and include in the sample all of the dust from inside the nozzle and tube, brushing the latter if necessary. All of the particulate collected was then weighed and recorded.

The sampled gas volume was calculated and corrected to include the equivalent vapor volume represented by the amount of water collected in the condenser. This total sampled gas volume was divided into the total weight of the particulate collected to obtain the dust concentration.

From a Pitot traverse, the total gas volume was known. This volume multiplied by the dust

TABLE 2. GENERAL SUMMARY OF PLANTS SURVEYED

Plant	Location	Date Surveyed	Prod. rate (lbs product per hour)	Effluent sampling location	Control equipment
Company A	Kansas	July 9-13, 1957	2970 (meal) 4500 (pellets)	Primary cooling cyclone . . Secondary cooling cyclone . Air meal separator . . . . . Pellet meal air separator .	None None Multi-tube collector[(a)] None
Company B	Kansas	July 15-16, 1957	2100 (meal) 5000 (pellets)	Primary cooling cyclone . . Secondary cooling cyclone . Air meal separator . . . . . Pellet meal air separator .	None None None None
Company C	Kansas	July 17, 1957	14000 (pellets)	Pellet regrind air separator	None
Company D	Ohio	May 21, 1958	5000 (meal)	Secondary cooling cyclone . Air meal separator . . . . . Baghouse	None Bag filter ----
Company E	Ohio	May 22-23, 1958	3500 (pellets)	Secondary cooling cyclone . Air meal separator . . . . . Baghouse	None Bag filter ----

(a) Multi-tube collector operates on the skimmer discharge of the air meal separator cyclone.

concentration gave the particulate discharge rate from the stack.

During sampling at the primary cooling cyclone, the water vapor in the flue gas condensed within the high efficiency cyclone collector and on the glass fiber filter of the sampling train. With a dew point of approximately 170°F., it was not possible to eliminate this condition using the available field equipment. Because of this, a satisfactory sample for particle size analysis could not be obtained, although it was possible to determine the particulate concentration in the flue gas. At standard conditions of 29.92" hg. and 70°F., the particulate concentration was determined as 0.1 and 0.2 grains/SCF respectively at the two plants where such measurements were made.

Except for the primary cooling cyclone effluent, the samples of the particulate collected were dry. It was possible, therefore, to run a particle size analysis and total particulate concentration for each stack emission.

The total loss of dried product to the atmosphere was between 1 and 3-1/2 weight percent of the dry meal production (Table 3). Because wet-hay feed rates were not recorded, the product loss is stated in terms of output, rather than input. Particulate discharges varied widely between various plants surveyed, e.g., the air meal separator discharge varied from 0.2 to 2.3 grains per SCF.

The protein content of the lost product was approximately 50 percent higher than that of the market product (Table 4), and the carotene content was about the same for both. This shows that the product lost to the atmosphere is a quality product.

A recording, photometric sedimentation particle-size analyzer was used for particulate size distribution analyses. The variation in particle size distribution was not found to be great between the several plants tested (Fig. 7-11). The average particle size for the secondary cooling cyclone was 5 to 7 microns equivalent Stokes' diameter; for the air meal separator, the average size was 1.5 to 3 microns; and for the pellet meal air separator, the average size was 6 to 10 microns in diameter. The average size for the one pellet regrind cyclone sampled was 3 microns. The maximum size in any sample was 20 microns equivalent Stokes' diameter. The dust density, measured in Dow Corning 200 Fluid, was between 1.23 and 1.32 (Table 5).

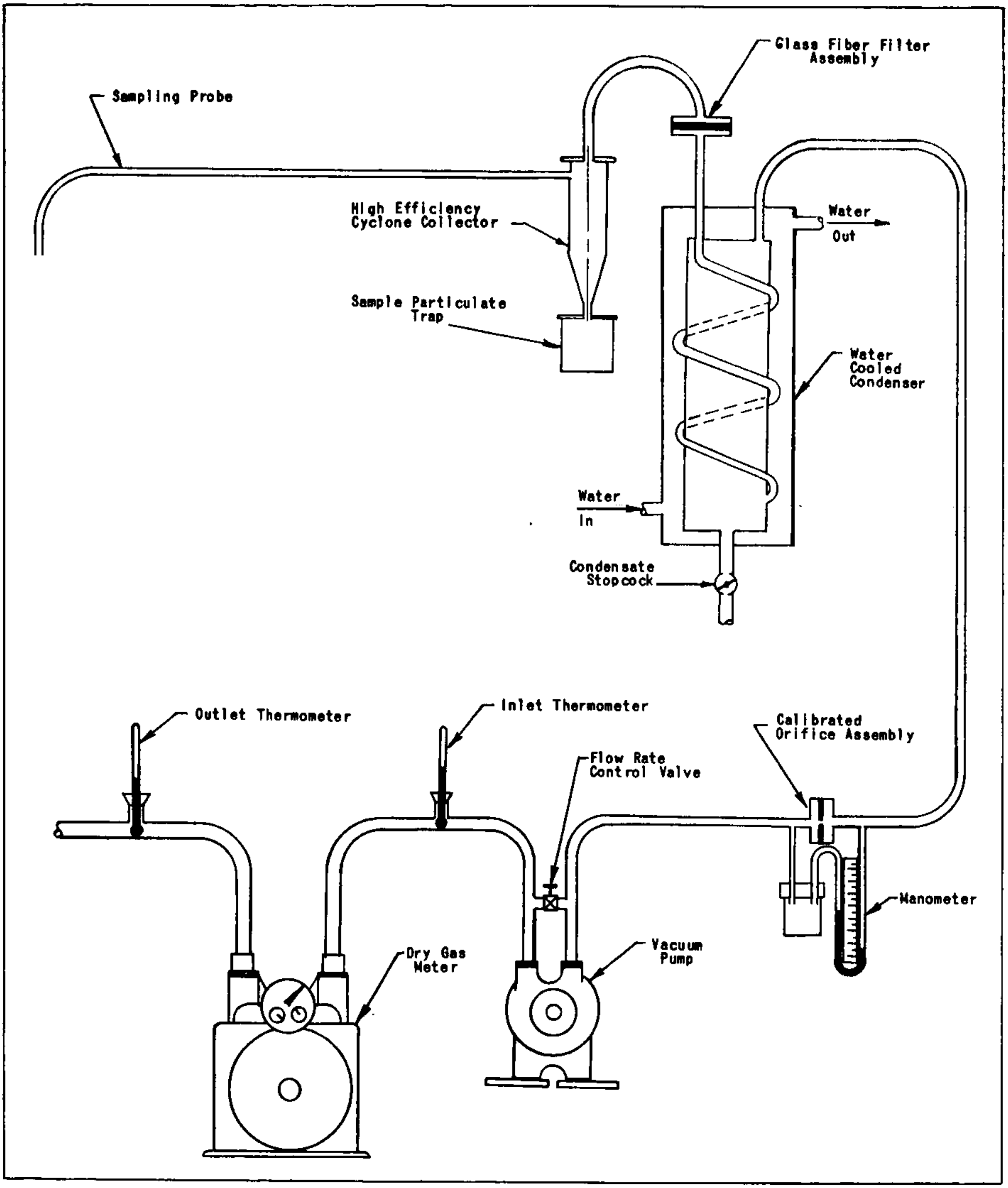


Figure 6. SAMPLING APPARATUS

TABLE 3. SUMMARY OF SAMPLING RESULTS

Plant Effluent sampling location	Volumetric discharge rate SCFM	Temperature dry bulb °F	Temperature wet bulb °F	Dew point °F	Absolute humidity lbs/lbs.	Particulate concentration Grains/SCF	Particulate discharge rate lbs/hr	Particulate discharge rate lbs/ton
Company A, primary cooling cyclone:								
vertical exhaust	11700	341	168	163	.340	0.1	10	7
horizontal exhaust	3620	300	175	172	.480	0.1	3	2
TOTAL	15320						13	9
Company B, primary cooling cyclone . .	8090	340	152	144	.174	0.2	14	13
Company A, secondary cooling cyclone .	1840	125	87	75	.019	0.5	7	5
Company B, secondary cooling cyclone .	1140	140	85	68	.013	0.3	3	3
Company D, secondary cooling cyclone .	...	...	...	...	...	0.1	...	...
Company E, secondary cooling cyclone .	...	...	...	...	...	0.1	...	...
Company A, air meal separator:								
cyclone(a)	3730	85	75	72	.016	0.2	5	3
skimmer collector(b) . .	2640	139	90	74	.019	0.4	9	6
TOTAL	6370						14	9
Company B, air meal separator	2580	118	87	78	.020	2.3	49	47
Company D, air meal separator	...	...	...	...	...	0.7	...	...
Company E, air meal separator	...	...	...	...	...	2.1	...	...
Company A, pellet meal air separator. .	3820	110	95	93	.033	0.1	3	1
Company B, pellet meal air separator. .	4870	127	94	86	.027	0.4	16	6
Company C, pellet regrind air separator	1000	120	90	82	.024	1.7	14	2
Company D, reverse jet filter (Housed) .	...	...	...	...	...	0.003	0.3*	0.1*
Company E, reverse jet filter (Unhoused)	...	...	...	...	...	0.0002	0.02*	0.01*

* Based on estimated air volume of 12000 CFM.
(a) Discharge of cyclone to atmosphere; i.e., that portion of air flow which is not diverted to skimmer collector.
(b) Discharge to atmosphere from skimmer collector.

TABLE 4. PARTICULATE AND PRODUCT ANALYSES

Particulate source	Protein content percentage	Carotene content (IU/lb)*
Company A, Air meal separator	21.20	107,600
Company B, Air meal separator	21.60	77,300
Company A, Pellet meal air separator. .	18.90	88,900
Company B, Pellet meal air separator. .	19.25	84,900
Company C, Pellet regrind air separator	26.60	145,900
Product		
Company A, Pellets	15.0	100,000
Company B, Pellets	14.1	88,000
Company C, Meal	17.3	132,000

*International Unit, IU, for carotene (pro-vitamin A) is defined as the biological activity of 0.6 microgram of β-carotene.

TABLE 5. DUST DENSITY

Dust Sample Source	Density(9) (Grams/cu. centimeter)
Secondary cooling cyclone discharge .	1.23
Air meal separator discharge	1.32
Pellet meal air separator discharge .	1.31
Pellet regrind air separator discharge	1.24

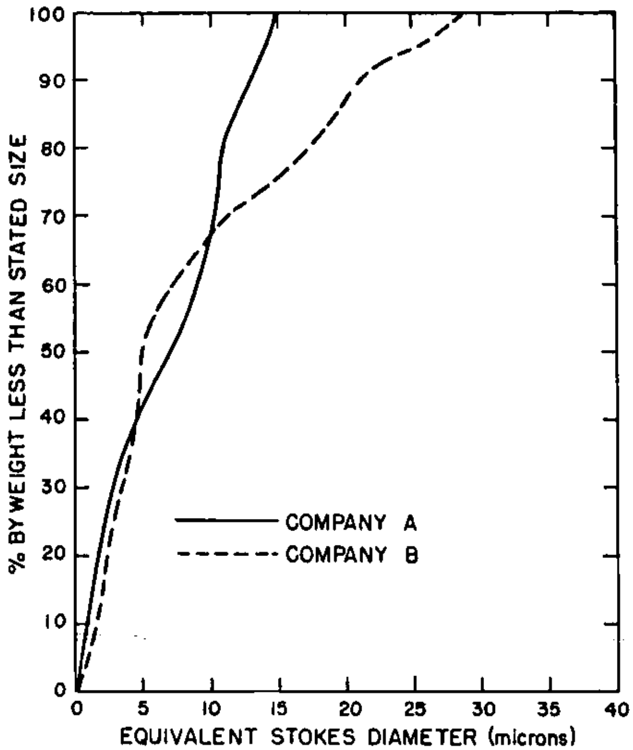


Figure 7. PARTICLE SIZE DISTRIBUTION, SECONDARY COOLING CYCLONE

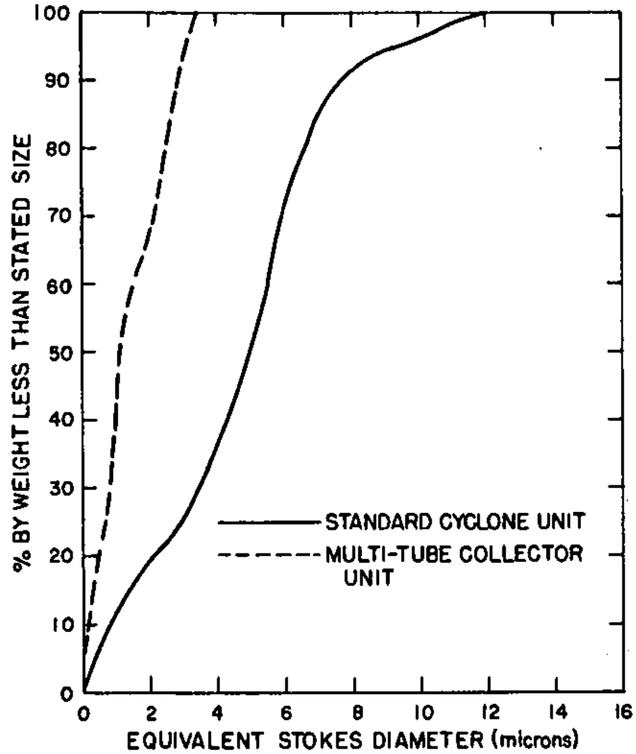


Figure 9. PARTICLE SIZE DISTRIBUTION AIR MEAL SEPARATOR, COMPANY A

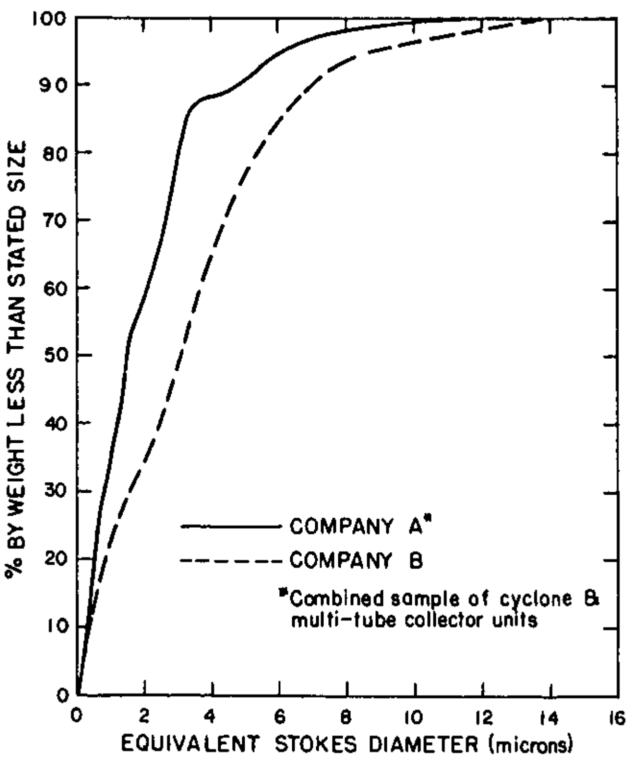


Figure 8. PARTICLE SIZE DISTRIBUTION, AIR MEAL SEPARATOR

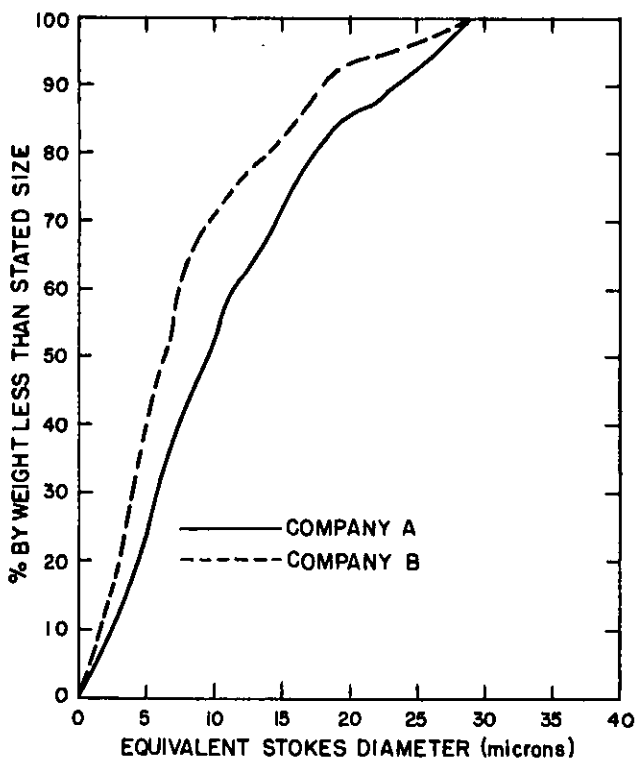


Figure 10. PARTICLE SIZE DISTRIBUTION, PELLET MEAL AIR SEPARATOR

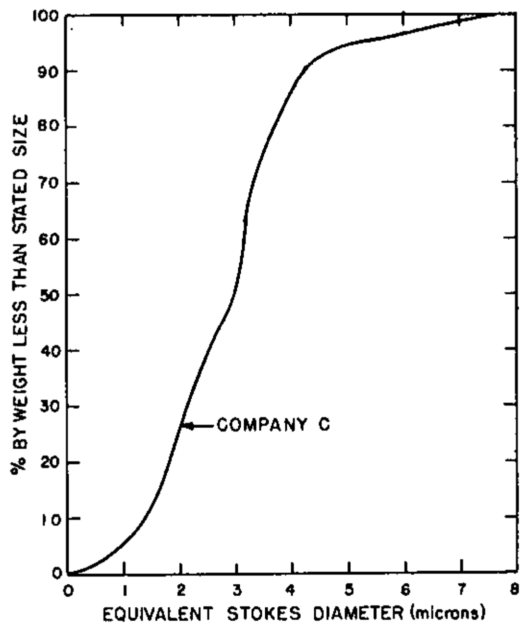


Figure 11. PARTICLE SIZE DISTRIBUTION, PELLET REGRIND CYCLONE

Air Pollution Control Measures

Since all the objectionable particulate effluents of an alfalfa dehydrating plant come from dust separators, the most obvious means of reducing dust discharge is to use more efficient equipment for each of the five separation steps, in lieu of the conventional cyclone separators usually employed. An alternative means is to lead the gases discharged from conventional individual cyclones to secondary high efficiency dust separators. There are several justifications for the use of a conventional cyclone in conjunction with a high efficiency separator. Space considerations may make complete replacement of the conventional cyclone with more bulky high efficiency equipment difficult in an existing plant, but the effluents from several individual cyclones may be manifolded into a large, common, high efficiency secondary collector. When a very high premium is placed on continuity of plant operation, the cyclone may be used alone if a breakdown of the secondary high efficiency collector occurs. Otherwise, it may be uneconomical to retain a low efficiency primary collector when a high efficiency collector of the same gas handling capacity is added to the gas stream.

An intermediate approach is to take advantage of the fact that dust in a cyclone outlet is concentrated near the outlet wall and to employ a skimmer to direct only the outer fraction of the cyclone discharge to a secondary high efficiency collector.[10] One plant studied (Company A) used this approach by utilizing a cyclone collector on the air-meal separator outlet (Fig. 16) and did effect a significant reduction of particulate discharge to the atmosphere as indicated by a comparison of Company A and Company B (Table 3). In this respect it should be noted that the use of a cloth bag filter as the secondary collector would have reduced the discharge still further.

Cloth filtration methods have been somewhat unpopular with plant operators because they have acquired the reputation of being subject to occasional fires from sparks or hot pieces of tramp metal. This hazard, however, can be and in various installations has been minimized by careful design incorporating flame-proofed or flame resistant filter media and built-in fire extinguisher devices. In both the Ohio plants studied,[11] continuous and automatic self-cleaning baghouses (reverse-jet cleaning type) were used as secondary collectors after conventional cyclones as primary collectors. In one of these plants (Company D - Figs, 12, 20) the baghouse serves as a secondary collector for two air meal separators and a secondary cooling cyclone. In the other (Company E - Fig. 21), it serves as the secondary collector for two air meal separators. Managers of both these plants expressed the opinion that with an alert and careful operator the chance of fire in the collector is very remote. Both these plants had tried multiple cyclones as secondary collectors before installing baghouses and both found that they did not provide sufficiently high collection efficiency for the fine dust in the individual cyclone effluents.

At Company D, an oil additive is sometimes used in the dehydrating process. This additive has an undesirable effect on bag filter operation: it causes clogging of the bag interstices; the pressure drop increases above operational limits (4 inches of water); and the reverse jets are not able to clean the bag properly with one pass. When the pressure drop exceeds the operational maximum, the stack dampers in the air meal separators and the cooling cyclone above the regrind mill have to be partially opened and dust is discharged directly to the atmosphere. This problem is alleviated during shutdown periods by continuing operation of the reverse jets, thus cleaning the bags sufficiently to allow operations to resume with the dampers in the closed position (Fig. 20). As long as oil is not used in the dehydrating process, cloth bag filters operate efficiently under normal operational limits.

Vegetable oil or animal fat, sometimes used to preserve the carotene content in stored meal and to reduce dustiness in subsequent material handling and storage, does promote agglomeration of the dust particles and thereby assists in particulate removal by the cyclone collectors. Where it has an adverse effect on the operation of a secondary collector as noted above, however, it may be advantageous to blend it with the meal just prior to bagging.

Other methods suitable for control of effluents discharged to the atmosphere include incineration and electrical precipitation, but in general these are more costly than bag filter units.

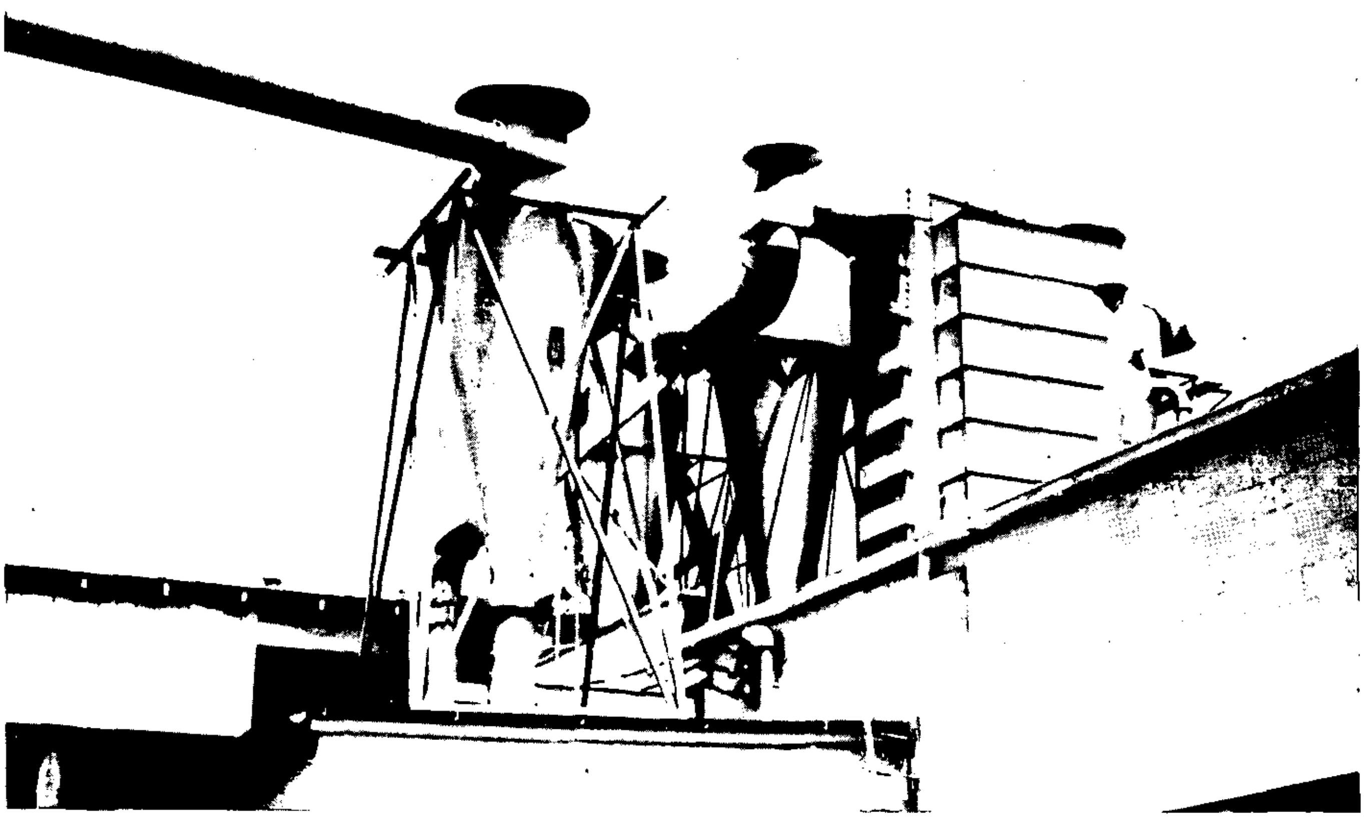


Figure 12. CLOTH BAG FILTER (HOUSED) AND AIR MEAL SEPARATORS

Economic Aspects of Control

Dust control in the alfalfa dehydrating industry is possible and feasible. As evidenced by the experience of Ohio plants, dust control can be satisfactorily accomplished by the use of cloth filter bag equipment. The incorporation of the reverse jet principle for automatic bag cleaning makes possible continuous operation of the dust control equipment. Effluents from all secondary cooling cyclones and separators can be discharged through a single baghouse.

The reclaimed high-quality dust can be blended with the dehydrated meal product and thereby offset part of the cost for control equipment. For an average size plant producing 2 tons of meal per hour, it is estimated that about one-half ton of meal could be saved per working day, or about 1% of the meal produced. At a product cost of $40 per ton, daily savings amount to about $20 per day.

For a dust control system similar to that used at the Ohio plants, an estimated cost breakdown for an average size plant producing two tons of meal per hour would be as follows:

Equipment Cost for 24-hour bag reverse-jet filter unit:

Equipment	$5,000	
Installation	3,000	
Amortized at 6% over 10-year life		$1,090/year

Maintenance and Operation Cost:

Flame-proof felt bags . .	$1,000	
Amortized at 6% over 2-year life		$ 550/year
Operation Cost (Estimated at $15/day for 180 operating days) . .		2,700/year
TOTAL COST:		$4,340/year
Return on reclaimed product for 180 operating days at $20 per day.		$3,600/year

These estimates indicate that, although the return on the reclaimed product does not balance the cost of control, it offsets a large share of these costs, which, together with improving the quality of air in the neighborhood and in the plants themselves, should justify the adoption of control methods by the industry where air pollution problems exist.

Conclusion

For a typical plant with five individual exhaust locations, each with about the same rate of dust discharge, four of these five are amenable to control by utilizing standard cloth filter bag collectors. Thus a reduction of about 80% of the pollution may be effected by relatively simple and economic means. In many locations this reduction may be adequate to eliminate local nuisances without attempting to control the moist, high temperature effluent from the fifth source--the primary cooling cyclone.

Appendix

Detailed Layout and Description of Plants and Particulate Sampling Points

COMPANY A:

The alfalfa dehydrating process at Company A (Fig. 13 and Table 6) is essentially the same as that described earlier in this report (Fig. 1). The dry meal production rate was approximately 3000 pounds per hour.

The primary cooling cyclone exhausts directly into the atmosphere above the cyclone and through a horizontal, square cross-section duct to an 85-foot stack (Fig. 14). This set-up was peculiar to this plant and the reason for the two outlets could not be ascertained. With the damper in the horizontal duct in the closed position, the direct discharge into the atmosphere above the cyclone was sampled for particulate matter. The dust concentration found in this sample was applied to the air flow in the horizontal duct. Air flow rates were determined by a pitot tube traverse in the duct concerned. This gave a means for determining the amount of dust emitted by the primary cooling cyclone through the 85-foot stack. To obtain the total contribution to air pollution from this source, the discharge rates at these two outlets were added together.

The top of the secondary cooling cyclone (Fig. 15) is tightly sealed and all of the dust is discharged through the 85-foot stack. A particulate sample was obtained in the horizontal, circular cross-section duct connecting the cyclone collector and the stack.

The outlet from the air meal separator (Fig. 16) operates as a skimmer, the secondary collector being a multiple cyclone collector unit. An orifice plate with a ten-inch diameter hole is located in the stack of the cyclone above the take-off to the multi-tube centrifugal collector to form the skimmer. Emissions from both the orifice and the multiple cyclone outlet were sampled.

The pellet meal air separator exhausts to the atmosphere through a horizontal, square cross-section duct (Fig. 17). A particulate sample was taken at this horizontal outlet. The pellet production rate at the time of this survey was 4500 pounds per hour.

COMPANY B:

Company B produced dry meal at a rate of 2100 pounds per hour and pellets at a rate of 5000 pounds per hour. The flow diagram (Fig. 18 and Table 7) is self-explanatory and compares with that in Figure 1.

Samples of particulate discharges were taken at the following points: primary cooling cyclone, secondary cooling cyclone, air meal separator, and pellet meal air separator.

COMPANY C:

Although Company C was the largest of the three Kansas plants surveyed, it was the opinion of the survey team that sufficient discharge samples from the primary cooling cyclone, secondary cooling cyclone, air meal separator, and pellet meal air separator had been taken at Company A and Company B. Therefore, only the discharge from the pellet regrind air separator was sampled at Company C.

Details of the pellet regrind segment of Company C are shown in Fig. 19 and Table 8. Vegetable oil, in a measured amount of 1% by weight, is added to the reground pellet meal. The reground meal production rate, at the time of survey, was 14,000 pounds per hour.

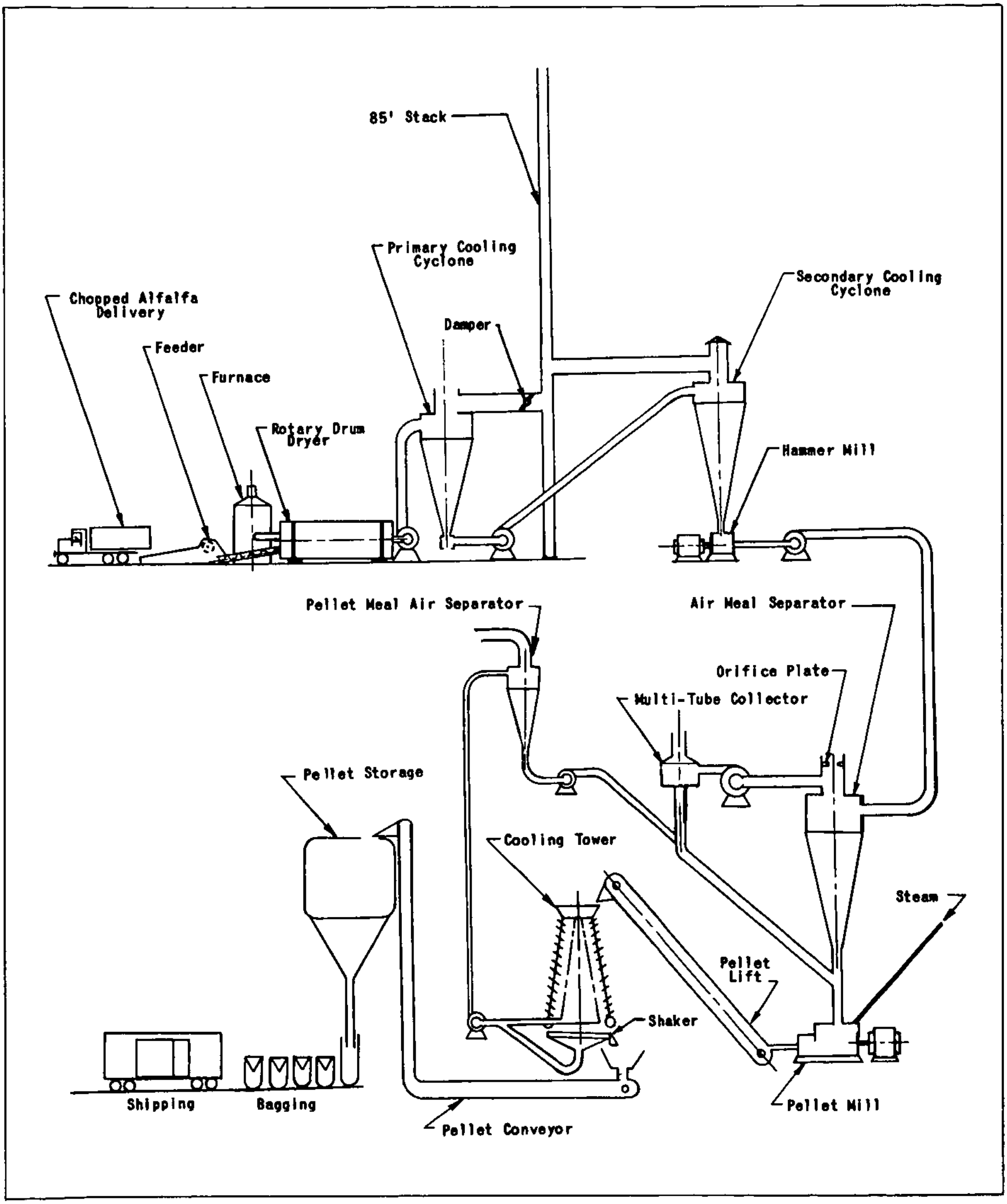


Figure 13. ALFALFA DEHYDRATING COMPANY A

TABLE 6. ALFALFA DEHYDRATING COMPANY A, KANSAS:

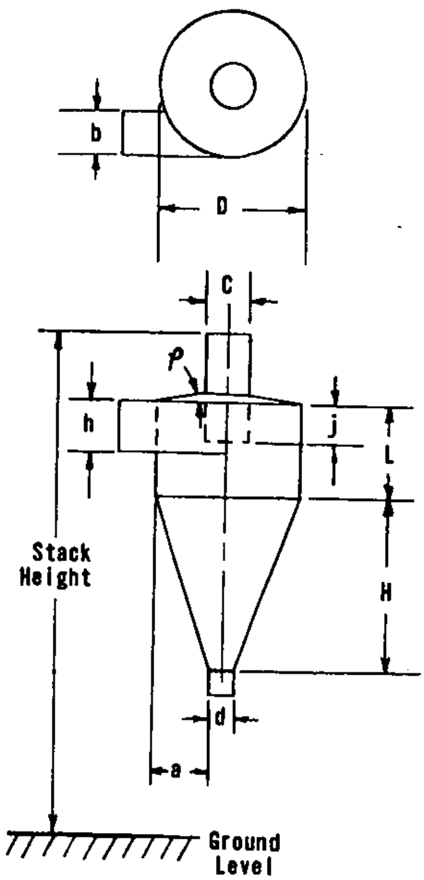
Rotary Drying Drum: Heil, 3 Pass, 1.5 Tons/Hr. Cap. (dried hay basis).

Hammer Mill: Heil, 3/64" Screen Size, 125 HP Motor, 3600 RPM.

Microclone: Dustex Corporation, Model D-4, S/N 1057, 2 Banks of twelve 2" nominal diameter tubes each.

Pelletizer: California, 2.5 Tons/Hr. Cap.

Cooling Cyclone Collectors:



DIMENSIONS

	Primary	Secondary	Air Meal	Pellet Meal	Microclone
Stack Height	25'	29'	33'	20'	34'
C	44"	30"*	30"**	28"	
D	84"	60"	60"	70"	
H	126"	128"	112"	104"	
L	42"	24"	24"	30"	
a	33"	23.5"	24"	30"	
b	24"	13.5"	9"	8"	
d	18"	13"	12"	10"	
h	24"	13.5"	9"	29"	
j	43"	***	28"	***	
ρ	0°	23°	24°	0°	

*This stack tied into a breeching which leads to an 85' stack for final atmospheric discharge.

**Orifice plate with a 10" hole 12.5" from the top and just above Microclone feeder line.

***Not measurable without disassembling the unit.

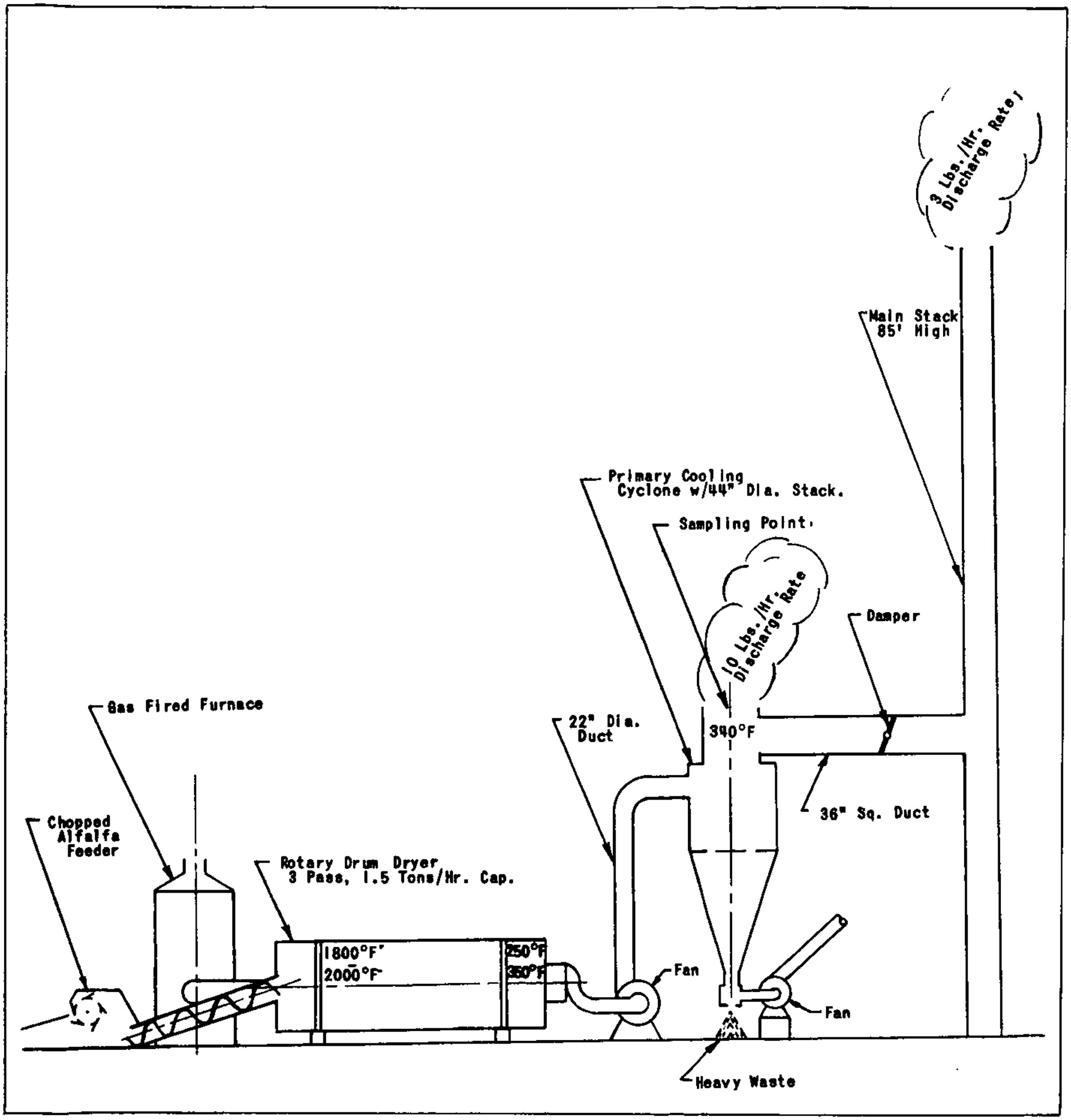


Figure 14. PRIMARY COOLING CYCLONE SAMPLING STATION,

ALFALFA DEHYDRATING COMPANY A

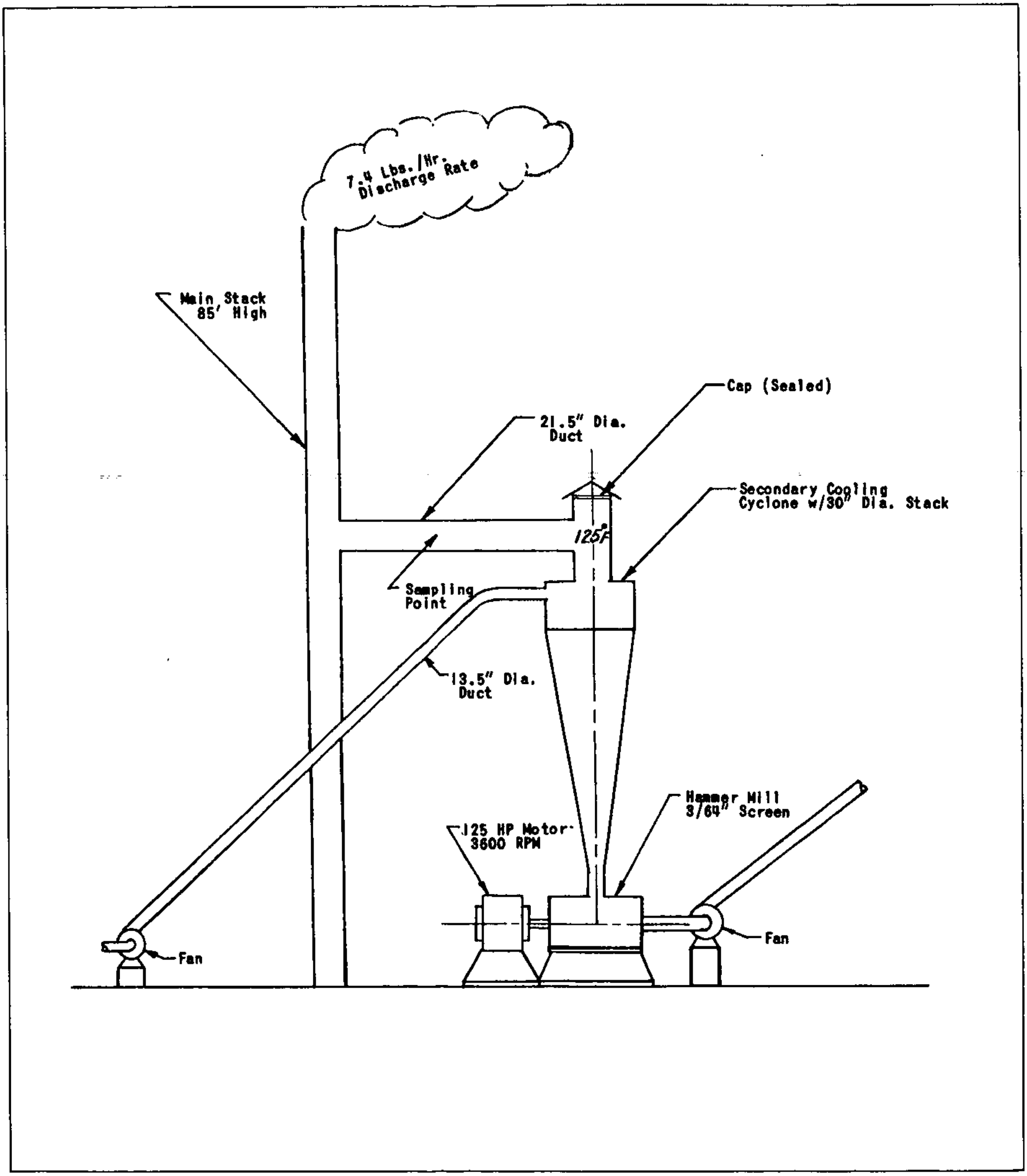


Figure 15. SECONDARY COOLING CYCLONE SAMPLING STATION, ALFALFA DEHYDRATING COMPANY A

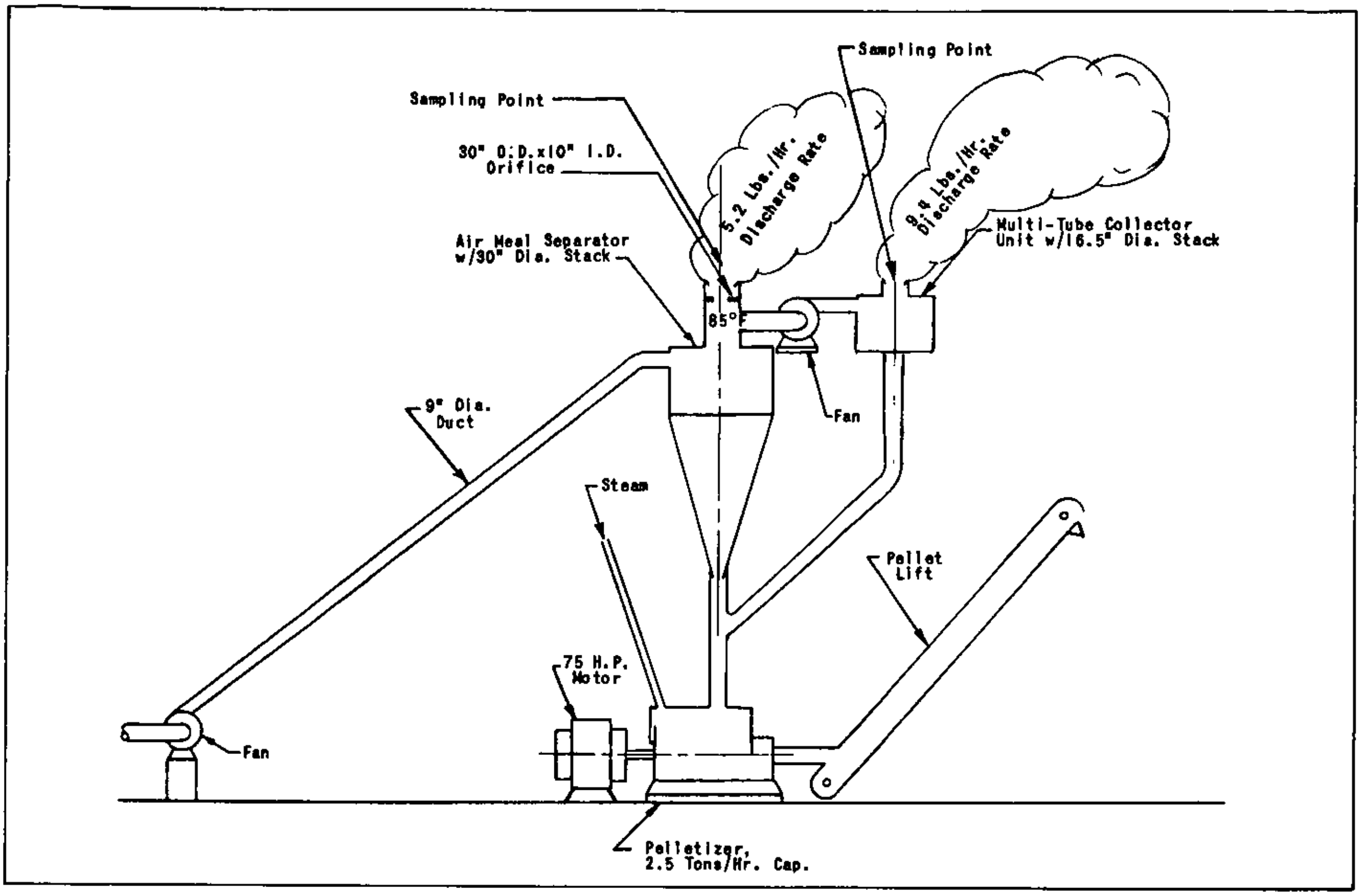


Figure 16. AIR MEAL SEPARATOR SAMPLING STATION, ALFALFA DEHYDRATING COMPANY A

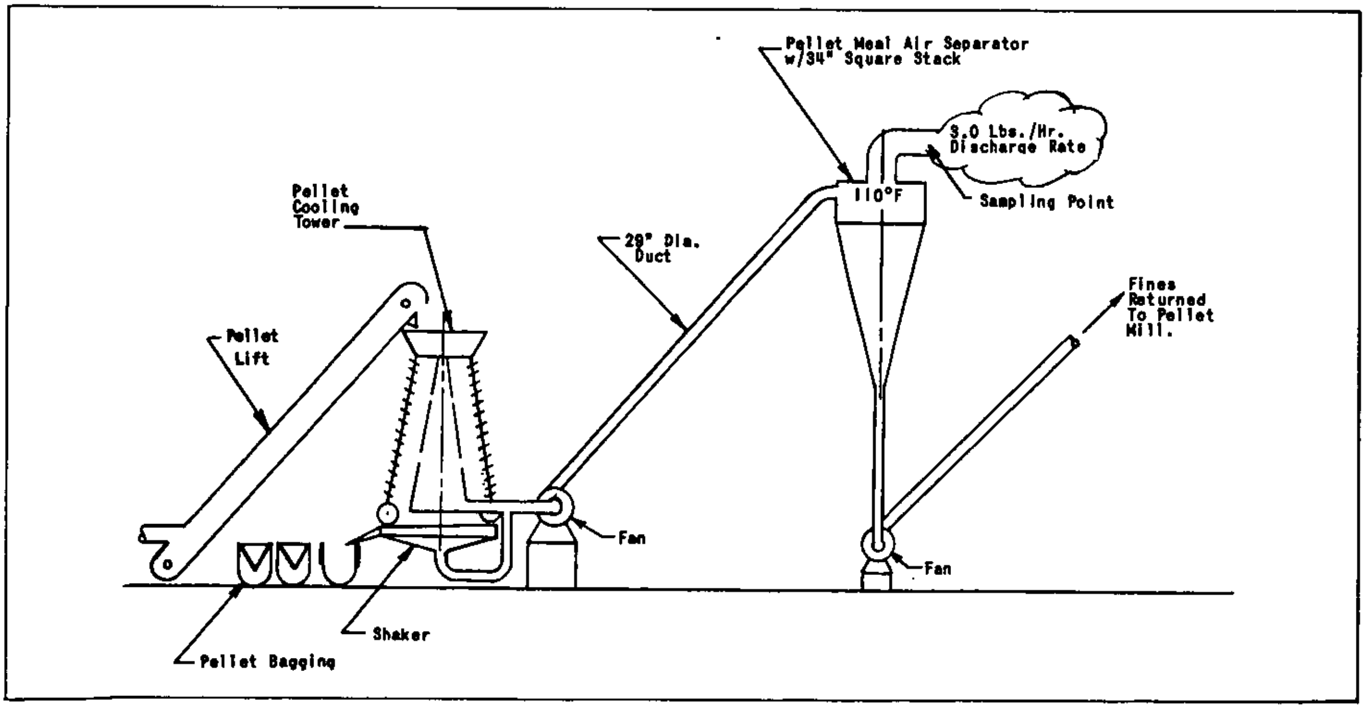


Figure 17. PELLET MEAL AIR SEPARATOR SAMPLING STATION, ALFALFA DEHYDRATING COMPANY A

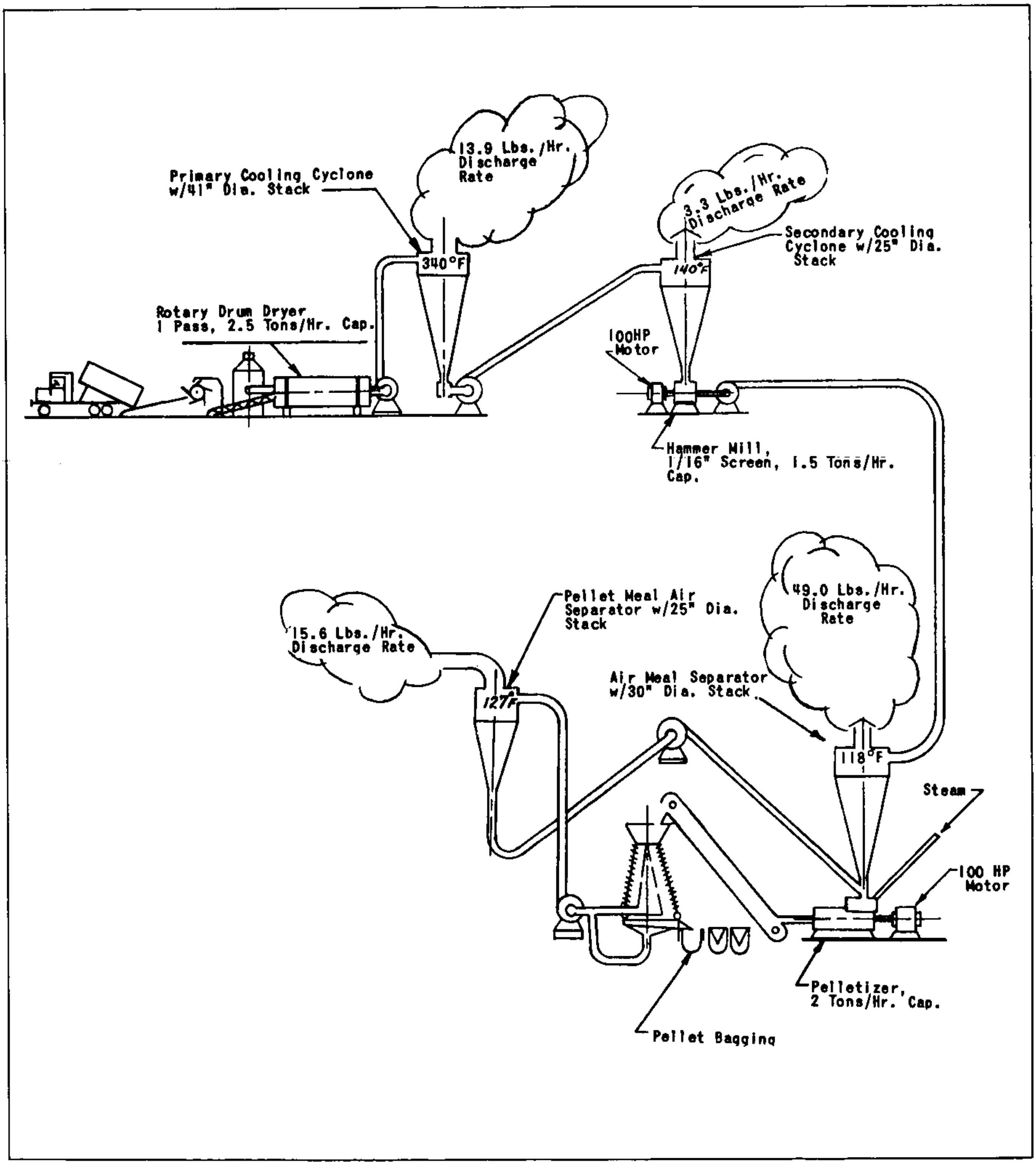
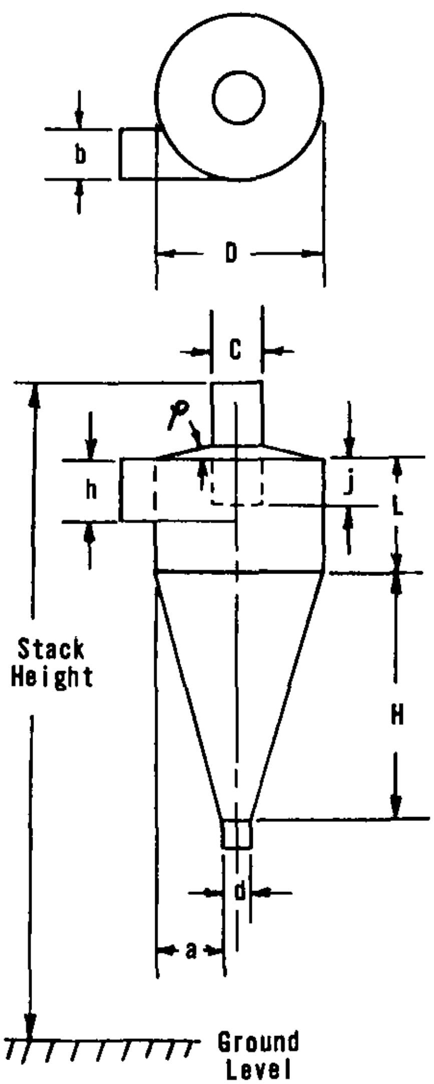


Figure 18. ALFALFA DEHYDRATING COMPANY B

TABLE 7. ALFALFA DEHYDRATING COMPANY B, KANSAS:

Rotary Drying Drum:	Howard, 1 Pass, 1.5 Tons/Hr. Cap. (dried hay basis).
Hammer Mill:	Small, 1/16" Screen Size, 1.5 Tons/Hr. Cap., 100 HP Motor, 3600 RPM.
Pelletizer:	Sprout-Waldron, 2 Tons/Hr. Cap.

Cooling Cyclone Collectors:



DIMENSIONS

	Primary	Secondary	Air Meal	Pellet Meal
Stack Height	31'	32'	36'	39'
C	40"	25"	30"	25"
D	94"	54"	53"	66"
H	141"	116"	104"	113"
L	48"	12"	14"	23"
a	38"	20.5"	22"	28"
b	20"	9"	9"	16"
d	18"	13"	9"	10"
h	48"	9"	11"	16"
j	95"	25"	16.5"	20"
ρ	20°	3°	17°	20°

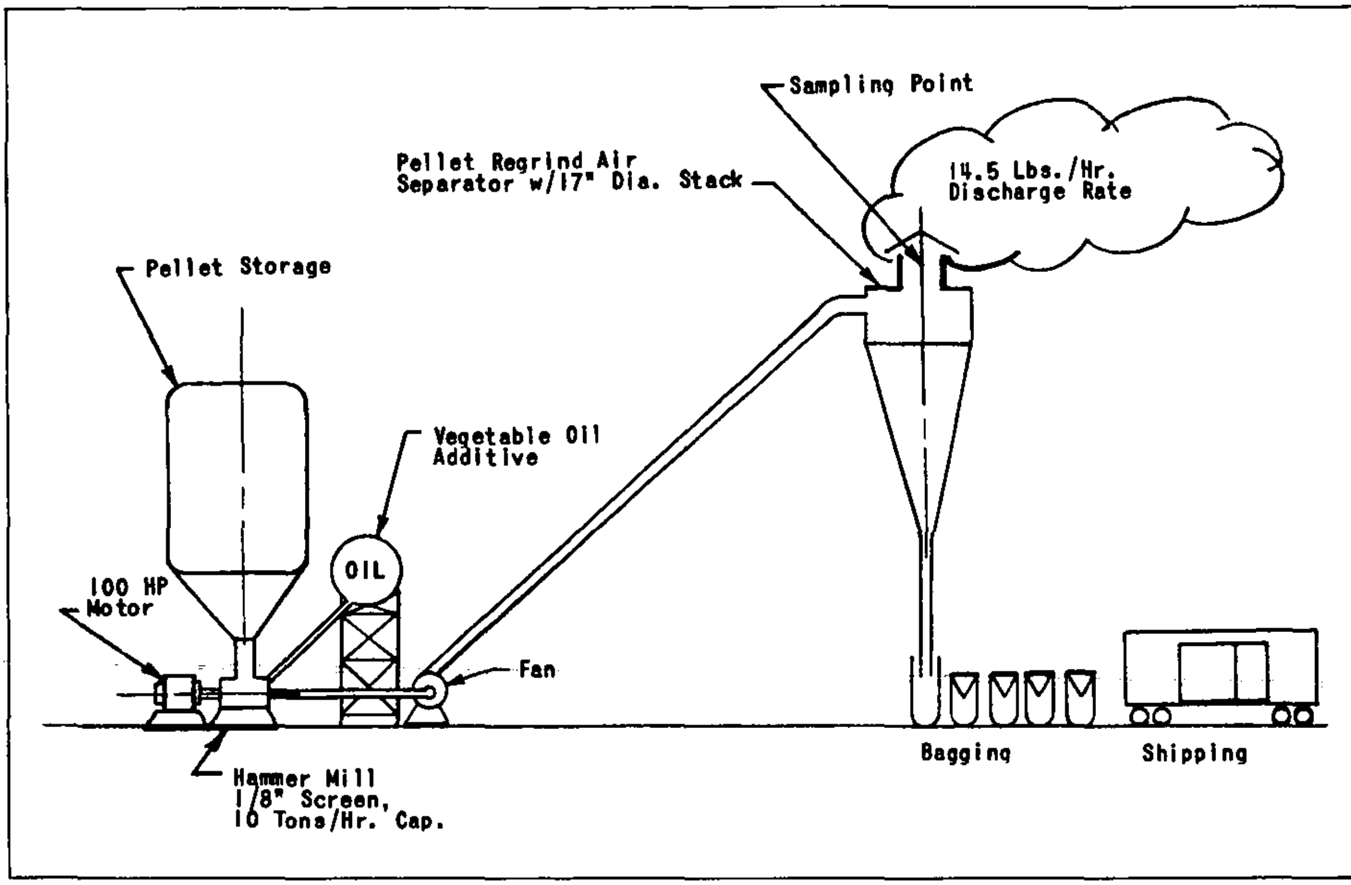


Figure 19. *PELLET REGRIND-AIR SEPARATOR SAMPLING STATION, AT ALFALFA DEHYDRATING COMPANY C*

COMPANY D:

Company D, an Ohio plant, operates two drying lines, one using a rotary drum dryer and the other using a tunnel dryer (Fig. 20 and Table 9). This plant operates twenty-four hours per day and has a maximum production rate of 5000 pounds of dry meal per hour.

To reduce the number of complaints from local townspeople regarding the dust emitted to the atmosphere, the plant management decided, in 1954, to install a bag filter to control this dust. Since most of the dust seemed to come from the cooling cyclone before the regrind mill and the two air meal separators, the discharge stacks on these cyclones were dampered and the dust drawn into the baghouse. The collected dust is blended with the meal product before the bagging operation.

The dampers in the discharge stacks are opened whenever the pressure drop across the bag filter exceeds five inches of water. Under regular plant operating conditions, a pressure drop of three to four inches of water is considered normal.

The baghouse, containing 24 bag filters and using the reverse jet principle for continuous cleaning, proved very efficient in eliminating the dust emission from the controlled cyclones. However, the first time oil was added in the dehydrating process, the bag filters plugged, the pressure drop exceeded six inches of water, and the dampers had to be opened. This eliminated secondary dust control altogether. With the reverse jets continuing to clean the bags during plant downtime, the effective operation of the bag filters is improved, although operating efficiency is not as high as that experienced prior to the use of the oil additive. It was estimated that 50 percent of the 1957 meal production schedule required the oil additive. The plant operators also find that the bags sometimes develop tears and have to be repaired or

TABLE 8. ALFALFA DEHYDRATING COMPANY C, KANSAS:

Hammer Mill: Jacobson, No. 8, 1/8" Screen Size, 10 Tons/Hr. Cap., 150 HP Motor, 3600 RPM.

Cooling Cyclone Collector:

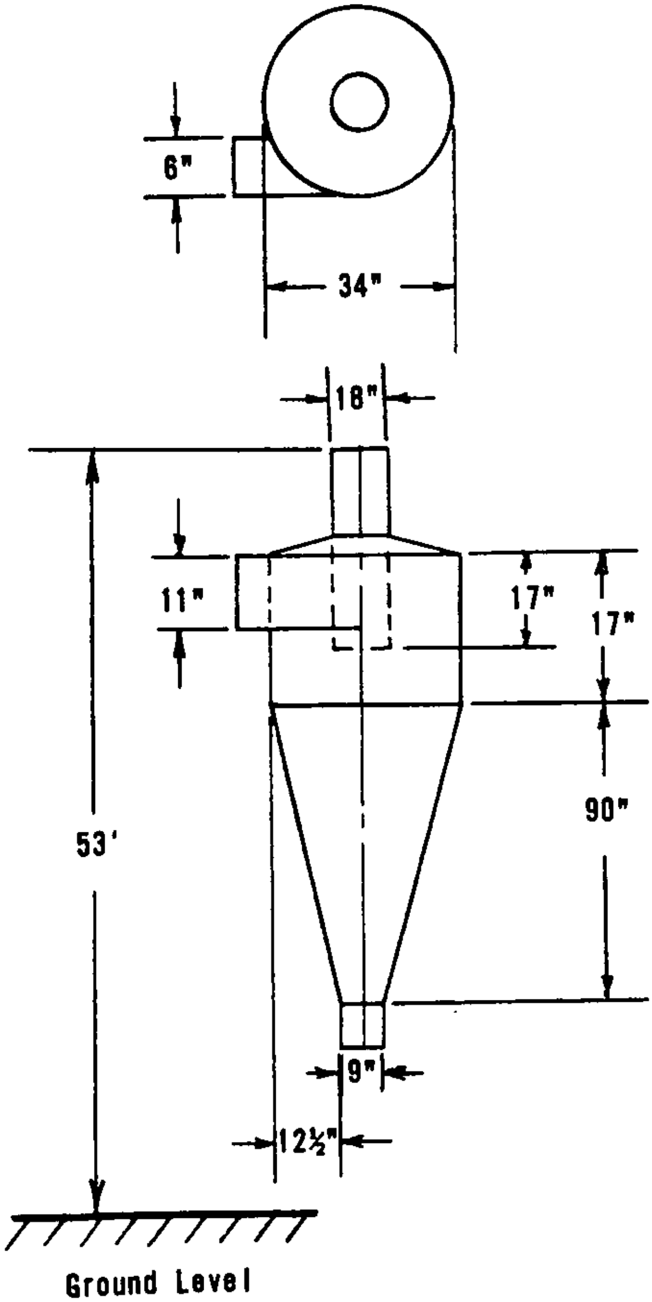


TABLE 9. ALFALFA DEHYDRATING COMPANY D, OHIO:

Rotary Drum Dryer: Heil, Model 8.25. Evap. Cap. 6000 lbs. water/hr.

Hammer Mill: Jacobson, 1/20" or 3/64" Screen Size, 125 HP Reliance Motor.

"Jay-Bee Mill", The Bossert Co., 1/4" Screen Size, 150 HP Motor.

"Jay-Bee Mill", The Bossert Co., 3/64" Screen Size, 125 HP Motor.

Air Filter: The Day Company, Minneapolis, Minn., No. 64-14 US Type "AC", 24 tubes, approx. over-all dimensions 9' x 11' x 17' high. (Housed) Cotton sateen bags 8" I. D. x 14' - 7" lg.

replaced. Experience seems to indicate a bag life of two to three years for this type of dust control equipment under average plant operating conditions.

Samples of particulate emissions were taken at the secondary cooling cyclone, at one of the air meal separators, and at the baghouse. The bag filters were housed on the roof of this plant (Fig. 12).

COMPANY E:

The flow diagram for Company E, located in Ohio, is presented in Fig. 21 and Table 10. This plant formed the dehydrated alfalfa meal into pellets by a method similar to that used in the plants of Company A, Company B, and Company C. At this plant, the pellet production rate is approximately 3500 pounds per hour around the clock.

This plant was set up in 1947, and shortly thereafter complaints about the dust emitted from this processing unit began to come to the manager. This was followed by visits from the mayor, the sheriff, and housewives.

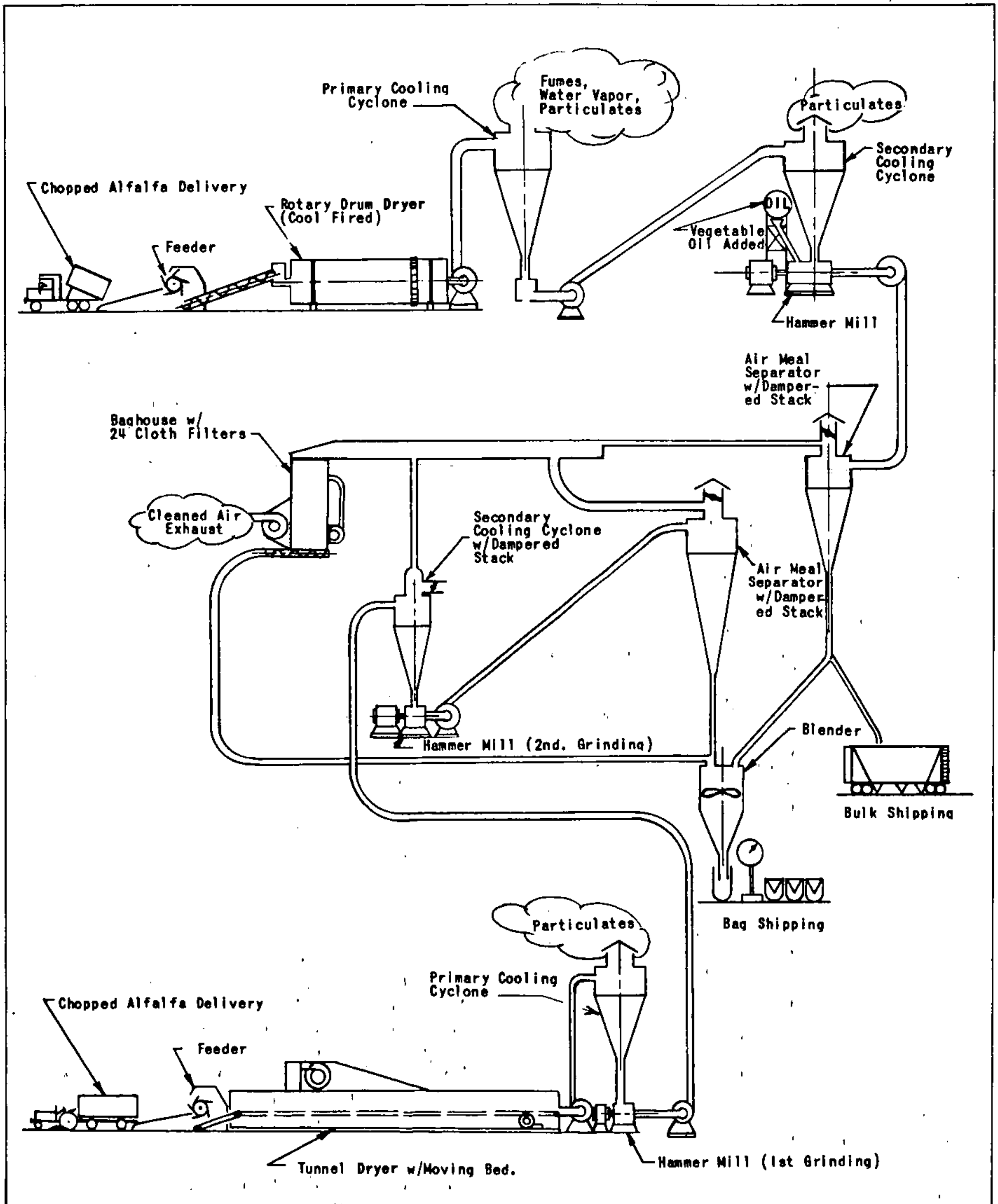


Figure 20. ALFALFA DEHYDRATING COMPANY D

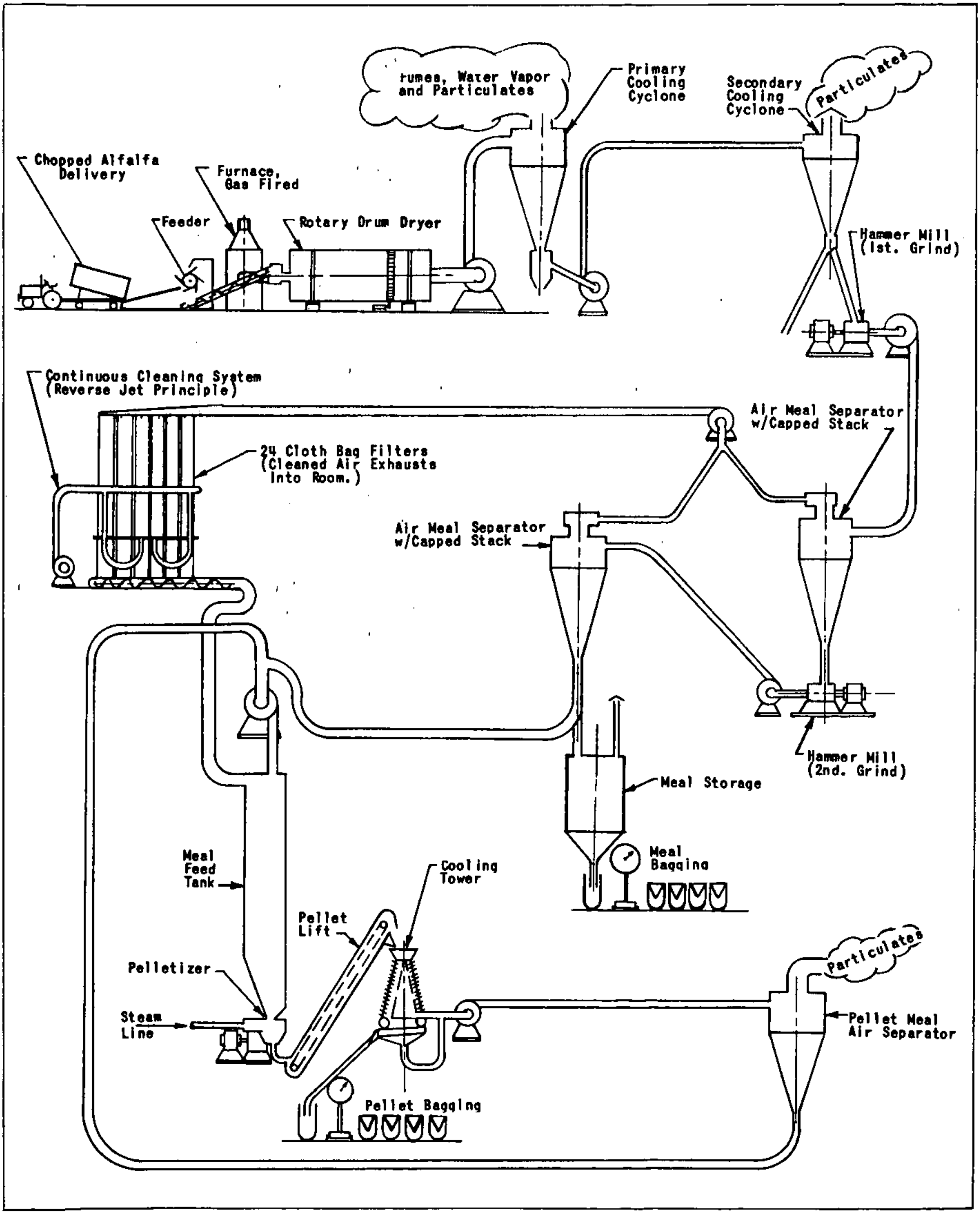


Figure 21. ALFALFA DEHYDRATING COMPANY E

TABLE 10. ALFALFA DEHYDRATING COMPANY E, OHIO:

Rotary drum dryer:	McGehee, Type P, 8 RPM, Evap. Cap. 12,000 lbs. water/hr. S/N S-38.
Hammer mill:	Jacobson, 1800 RPM, 125 HP U.S. Motor.
Pelletizer:	California, 75 HP Westinghouse Motor.
Air filter:	The Day Company, Minneapolis, Minn., No. 64 - 14 US Type "AC", S/N ACL-662, 24 tubes, approx. over-all dimensions 9' x 11' x 17' high (Unhoused) Flameproof wool felt bags 8" I.D. x 14' - 7" long.

Each requested that something be done to eliminate the dust nuisance. As a result of these complaints and frequent visits, the plant manager decided, in 1952, to have a multi-tube collection unit installed in the process line. This unit proved to be too small, and in 1953 it was replaced by a cloth filter unit. This unit collected most of the dust previously dispersed to the atmosphere, and no more complaints were received. This cloth filter unit greatly improved cleanliness and working conditions in and around the plant.

The plant manager estimated that originally from 6 to 7 percent of the product input was lost to the atmosphere as dust. This dust is now reclaimed and blended with the meal product before pelletizing. This plant does not use oil additives, and the high efficiency of the cloth filter has been maintained. The filtering unit is the same as that used at the plant of Company D, except that this equipment is unhoused inside the plant building and a different filter fabric is employed. Here, too, bag life was reported to be two to three years.

As shown in Figure 21, the air meal separators are capped and all dust discharged from these sources goes to the bag filters. The primary cooling cyclone, the secondary cooling cyclone, and the pellet meal air separator discharge directly to the atmosphere. Samples of particulate emissions were taken at the secondary cooling cyclone, the inlet duct to the baghouse, and the outlet side of the bag filter.

Personnel

The Engineering Research & Development Unit, Air Pollution Engineering Research, Public Health Service, with the assistance of Messrs. J. Lee Mayes and Raymond McClure of the Industrial Hygiene Section, Division of Sanitation, the Kansas State Board of Health, carried out the source sampling and surveys of the alfalfa dehydrating plants.

Messrs. Joseph Chrisman, Executive Vice President of the American Dehydrators Association, and Gerald W. Ferguson, Acting Assistant Regional Engineer for General Engineering Program, Region No. VI, Public Health Service, assisted the field survey team and made the necessary arrangements for sampling studies at the plants in Kansas.

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