ASPECTS OF
TOBACCO PROCESSING

COMPOSITE INFORMATION FROM PHILIP MORRIS U.S.A. ASSEMBLED BY THE TOBACCO TECHNOLOGY GROUP. AUGUST 1984.

2059485314

Page

2059485317

Page

2059485318

Page

2059485320

2059485321

2059485322

INDEX OF FIGURES

2059485323

INDEX OF FIGURES

2059485324

INDEX OF FIGURES

INDEX OF FIGURES

1. Tobacco Processing

1.1 Background

The first tobacco processing techniques developed were based on the principle "tobacco is alive", and the aim was to retain this "life" in the cigarette itself by means of gentle handling and as little interference as possible. Playing the role of "guardian angels" were experienced tobacco craftsmen, under whose control highly individual standards of quality were aimed for. Cost factors were frequently treated as matters of secondary importance.

Perhaps this description is a little exaggerated, but it does show how "experience" can exert a strangle hold on the requirements of processing technology. Occasionally, this still forms a basis for disdain and mistrust of new techniques.

This phase was very quickly brought to an end by a series of various factors which have led to today's level of technology.

- Rising demand made a more extensive mechanization of all operations essential

- Rising personnel costs gave further incentives for mechanizing particular stages, and accelerated the introduction of new techniques.

- Faster cigarette makers demanded higher uniformity of the tobacco used and motivated the development of continuously operating metering equipment to monitor particular properties such as moisture content.

Taken all round, these developments created a basis for looking at primary processing from a technological view point, seeing the individual stages not isolated but rather as a series of feedbacks and linkups, thereby moving towards optimum efficiency of all interconnected stages.

Tobacco men have been replaced by tobacco dryer operators; a new generation in the work force and the gradual retirement of the old tobacco man, who, from experience, could from the "feel" of the tobacco coming off the dryer know what adjustments had to be made.

It is presently felt that these new operators know the control systems and process technologies, but are slowly losing the feel of handling tobacco.

There is certainly no way back to manual and subjective control of the primary process, even more and more sophisticated control instruments may be used in the future (such as continuous filling power measuring devices, for example). On the other hand, the operators must be able to recognize eventual wrong tobacco treatments and not rely solely on instrument displays. They should notice such things as unusual high or low moisture content at different processing points or an uneven carpet coming off the Burley dryer.

1.2 Tobacco Quality

When speaking about the "quality" of tobacco, it must be realized, that there is no real objective measure of it. Generally, tobacco quality is not a single thing, but a range of overall effects which can be blended to produce a finished product which is more appealing to the smoker than any one of individual components alone. The fact that the smoker does not want the tobacco as such but rather its smoke, makes the problem of defining quality of leaf tobacco more complex.

a. Judgement of Quality

Judgement of tobacco quality is made in different ways: by buyers, technologists, chemists and, finally, by smokers. Buyers have learned from years of experience to judge the leaf quality in terms of choice: fine, good, fair, etc.; according to leaf color, texture, size, aroma, etc.; and as evaluated by appearance, feel or touch and smell. Technologists have learned to judge the leaf in the same manner as buyers in addition to its suitability--including smoking qualities--for specific purposes in manufacture. They have learned how to mix the different grades and types of different "qualities," to obtain the "blend". Chemists have learned to associate amounts and proportions of organic and inorganic constituents with different grade groupings of various blends. The final judgement of quality is determined by the smoker. He must find in the cigarette smoke the agreeable taste, aroma, strength, etc., that satisfies his smoking pleasure.

2059485329

Quality of the leaf includes the various elements or properties that make the leaf suitable for manufacture. Therefore the commercial value, or quality, of any single grade of tobacco leaf depends fundamentally on:

- The specific purpose for which this grade will be used in manufacture
- Standards of quality, which differ from country to country

b. Elements of Quality

There are a wide range of factors contributing to quality, some are more important than others.

- Leaf size and shape

  Leaf size is important in Oriental tobaccos; it is usually connected with aroma and overall quality.

- Leaf veination

  "Vein Islet" number was used as a measure for leaf veination. The midrib is about 20-25% of the leaf by weight; it is higher in thin leaves of large area.

- Thickness

  Though thickness of the leaf may be examined with fair accuracy by the use of calipers, still there is no satisfactory means of measuring, because of the irregular surface caused by the uneven contraction of leaf tissues in the curing process.

2059485330

- Density, body

The term "body" in the case of cigarette tobacco, refers to the content of soft semi-fluid constituents which contribute to the weight of the leaf without influencing its thickness or density. A leaf is said to be deficient in body when it is dry with a chaffy nature. A heavy-bodied leaf, unless very dry, will develop a stained oily appearance when compressed between the fingers, and is relatively soft, slick and rich in "oil".

The term "structure" is frequently used to indicate the arrangement and density of leaf cells. Close-textured leaf has an apparently denser texture of the leaf tissue, that is, more compactly arranged leaf cells with smaller intercellular air spaces.

The term "texture" is the summation of physical characteristics as determined by the sense of touch and is frequently used to indicate apparent density of structure which may refer to graininess.

- Elasticity

This is the ability of the leaf--when sufficiently moist--to undergo stretching without breaking or tearing. It is also the resistance against compression, for such tobacco, after being compressed during cutting and it will expand immediately, thus giving more filling power.

2059485331

- Gum

As the leaves grow and mature in the field, their surface becomes coated with a sticky, gummy secretion composed of ethereal oils, resins and waxes which originate in the glandular hairs. Volume of aroma, but not necessarily quality, is conditioned by the amount of these gummy resinous materials on the aged and fermented leaf. With the Oriental tobaccos, this gum, particularly resins, is of primary importance.

- Color

Although color in itself has little to do with the actual quality in tobacco, its use in judging quality is very important because color is correlated with other characteristics which cannot be seen by simple inspection.

- Aroma

Freshly cured tobacco does not possess aroma, having merely a rather flat unpleasant odor. In the subsequent fermentation or aging an agreeable fruit-like aroma develops which varies in quality and strength with the type of tobacco, conditions of aging or fermentation, soil, climatic conditions during the growing season, and the position of leaf on the stalk.

- Taste

The taste quality of each tobacco grade is of great practical importance. Almost all the groups of constituents in the composition of tobacco leaf have the property of being reflected in one way or another in the taste quality of its smoke.

Carbohydrates, volatile oils, resins and tars are components which have a positive influence on tobacco quality. Protein, albumins, pectic substances and organic acids have a negative influence. However, the increasing of the carbohydrate content does not always improve the quality, but quality improves only when a high carbohydrate content is accompanied by the harmonious action of other tobacco components.

1.3 Homogenous and Consistent Product

Once the consumer has been accustomed to a certain cigarette brand, he expects to find again the same visual and taste impression with each purchase, and that from one day to the other, from one month to the other.

But tobacco offers great variations. According to the position of the leaf on the stalk, even in each single leaf, the proportion of the chemical constituents differ. For example, the rate of nicotin varies to a large extent. These differences can also be considerable from one crop to the other.

Despite these variations two main problems must be faced:

1. Homogeneity

   Each gram of cut filler taken from one blend should be as identical as possible to another gram from the same blend.

2. Consistency

   The identity of a blend should be assured all the time, or at least it should be avoided that these mentioned variations effect the taste drastically.

Blending

From one bale to another, from one crop to another, one must expect to find, under the same situation, perceptible differences of quality, from which 2 simple rules come to reduce the variations of the product:

1. Rule: The blend formula must comprise a large number of different types, and each type different crops and qualities.

It is clear, that when one blends small fractions of different types of tobacco, the less one individual type will influence and the more chance it will have to compensate one for the other. In principle, one can say, that one source or one quality must not occur for more than 5% of the blend. It is also standard in the U.S.A. that blends are made up of at least 3 different crops.

2059485334

2. Rule: The different grades or lots a blend is made from must maintain the determined quality level; after one certain grade from a certain year has run out, a succeeding grade has to be chosen carefully to maintain the average quality.

This choice becomes incumbent on a responsible expert. The determination of indices of quality by chemical analysis constitutes an aide and method of efficient control.

1.4 Primary Plant

The basic principle of handling tobacco is, that it must be handled as gently as possible at every stage of the processing. Every point where the tobacco is touched, whether by the pins of a cylinder or by the doffer of a silo results in breakage, i.e., an increase in small particles. Great attention must be paid to details in the conveyor design and drop points; wide, slow-moving belt conveyors with drag pans can help to ensure a higher quality product and, thus, minimize airborne dust and leakage of tobacco. The breakage occurring on drop points can effectively be reduced by shortening the dropping heights. In general, the equipment should be designed to give easy access for cleaning under it.

Whenever new equipment is to be installed, it must be considered whether the new equipment should have a higher capacity than presently required; greater flexibility and frequently better moisture performance (when run at mid-range capacity) is the result.

a. Arrangement of the Plant

The following points summarize the most important factors involved in the selection and arrangement of a primary plant and in grouping it to one single process:

- In contrast to cigarette production, where total output equals the sum of the outputs of a number of individual machines, the total amount of tobacco being subjected to primary processing is passed, as a rule, along one line only. We can therefore speak of cigarette manufacture as a parallel process carried out by a large number of similar machines, whereas primary processing is a series process carried out by a line of dissimilar units. All influencing factors in primary processing, whether positive or negative, will therefore affect the whole amount of tobacco being treated.

- All primary processing stages can be controlled better if the throughput, i.e., weight of tobacco per unit of time, is kept constant. There is in any case a range of other parameters such as toughness, hygroscopic behavior, chemical properties etc. which can only be varied under careful control.

The hogshead storage prior to conditioning should be arranged so as to allow blend lines to be stored together. This applies, of course, only if adequate storage space exist to facilitate storing at random and proper removal, i.e., as long as other hogsheads need not to be moved in order to get the required ones.

Figure 1 depicts a simplified flow diagram of a Primary with a Burley-line.

b. Humidity and Temperature

In the modern primary, humidity and temperature control during processing are vital for reasons other than the maintenance of mere comfort conditions. Constant and uniform humidity and temperature during processing must be maintained because:

- if the tobacco during processing is too dry, excess loss in the form of "fines" and dust occurs resulting in an economic loss;

- if the tobacco is too dry, a loss in filling power occurs as the tobacco is broken up resulting in a product that yields fewer cigarettes per unit weight of tobacco;

- if the tobacco is too moist during cigarette manufacture, the cigarettes will mold in the package thus giving an "off-taste" to the cigarettes; and

- in too moist a condition during cigarette manufacture will cause erratic operation of making machines thus increasing maintenance and shut-down time. The acceptable range of tobacco moisture for cigarette making operations is fairly narrow--about 11.5 to 13.0%.

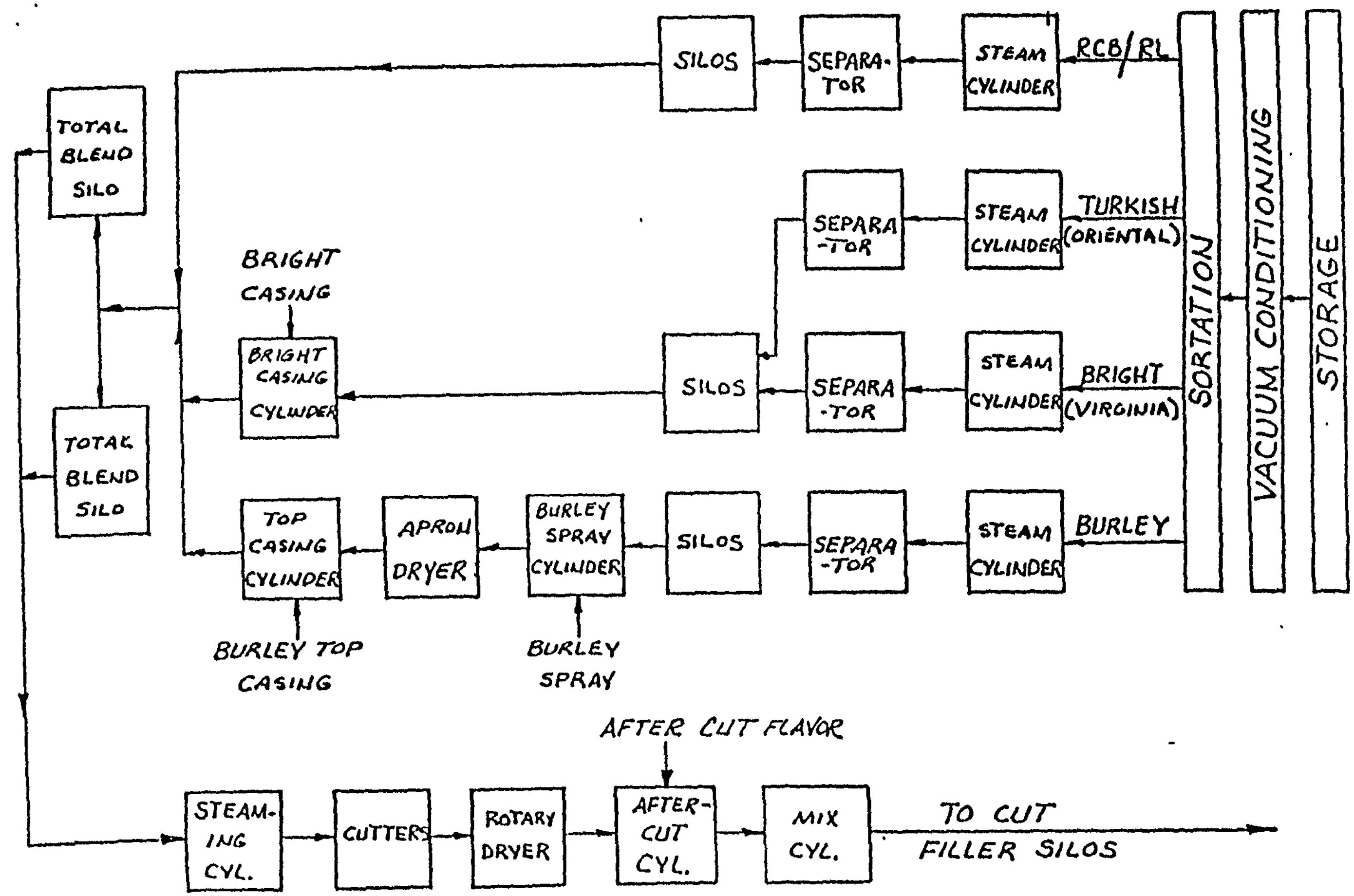


FIGURE 1: SIMPLIFIED FLOW DIAGRAM - PRIMARY

Goal:

The temperature in the processing area should be 75°F $\pm$ 3° with a relative humidity of 62% $\pm$ 3%.

In an extremely dry climate, moisture can be easily added to the air. Removing moisture in a wet climate is much more difficult and costly.

Many primaries in Philip Morris are so constructed that very little environmental control is present; this is, of course, not necessarily the proper method, however, the economic cost must be considered. Air conditioned primaries are still the exception.

Generally, hot weather doesn't represent a problem: Stagnant air can be prevented by simple ventilators changing the air. Care should be taken that no fan is blowing directly onto the product.

c. Prohibited Materials

Several materials have been determined not to be used in Philip Morris tobacco operations. This concerns all kind of equipment, such as conveyors, pumps, cylinders, pipes, etc., that might come in contact with tobacco directly or indirectly.

These materials are classified in 2 categories. These lists are not complete and do not constitute any endorsement or approval of any materials.

Category A

These materials can not be used under any circumstances:

2-Acetylaminofluorene
Alpha-naphthylamine
4-Aminodiphenyl
Asbestos
Benzidine
Beta-naphthylamine
Beta-propionlactone
Bis(chloromethyl) ether
Cadmium and cadmium salts
Chromium and chromium salts
3,3'-Dichlorobenzidene
Ethyleneimine
Lead and lead salts
Mercury and mercury salts
Methyl-chloromethyl ether
4,4'-Methylene bis(2-chloroaniline)
Nickel and nickel salts
4-Nitrobiphenyl
N-nitrosodimethylamine
Polycyclic aromatic hydrocarbons
Teflon (polytetrafluoroethylene)

Category B

These materials can be used where the possibility of contamination of tobacco products is minimal. However, these materials are not recommended for use.

Acrylonitrile-Butadiene-Styrene Rubbers (ABS)
Methyl Silicone
Silicone Rubber
Neoprene
Fiberglass
Polyformaldehyde
Rayon
Polyurethane Rubbers
Polyvinyl Acetate
Polyvinyl Chloride
Polyvinyl Floride
Halogenated Hydrocarbons
Nylon (Varies - some are acceptable)
Buna-N
Viton

If there is any question whether a material is acceptable or unacceptable, please make inquiries to Research and Development in Richmond, VA. If a sample is sent to R&D please include: the name of the material, the materials intended use, the compounds the material is made of, and any other information that can be obtained from the manufacturer or vendor.

1.5 Material Balance

Besides controlling the quality of the product (cut filler), the "efficiency" of each primary must be monitored; the high cost of tobacco compels the industry to track down each tobacco loss. While the primary "yield" informs about how much of the incoming tobacco is actually used in cigarettes, the material balance identifies where losses occur, where the problems are. It provides detailed information regarding

- tobacco utilization
- generation of by-products
- tobacco quality
- processing equipment

A tobacco material balance consists basically of 3 parts

(1) Tobacco usage, yield, and by-product are itemized by production location on a bone dry (0%) moisture basis.

(2) A quality profile of the operation is made in regard to moisture, sieve, and cylinder volume at key locations in the process and after drying, stem line vs. filler.

(3) A listing of equipment type and process parameters should also be included. This information can be used to compare the merit and deficiencies of certain types of equipment.

A material balance is usually done on request. 2-3 outside people need 1-1½ weeks to do it. However, it is more desirable to document the by-products continuously instead of conducting a material balance at one time.

a. Equipment Tobacco Losses

A study done by engineering shows at which points in primary losses occur. These data are based over a 1 month period, and the losses are total, i.e., they are gone once and for all and are not used for making reconstituted tobacco.

Description	Loss* Factors, %
Preblend Steam Cylinder	
Bright	0.112
Burley	0.119
Turkish	0.124
RL	0.104
RCB	0.131
Separators	
Bright	0.168
Burley	0.165
Turkish	0.167
RL	0.157
RCB	0.175
Burley Spray Cylinder	0.055
Burley Top Casing Cylinder	0.04
Bright (Virginia) Casing Cylinder	0.01
Aftercut Dryers	0.377
Aftercut Flavor Cylinders	0.16

* Loss = Total Input For Equipment x Loss Factor/100

b. Material Balance Test Procedure

(1) Receiving

Clearly identify the method in which tobacco is received, i.e., bales, boxes, hogsheads, etc.

In addition, what weight system is used to account for tobacco usage?

- Ticket versus actual scale weights

- What procedure ensures accountability for tobacco usage and blend integrity?

- Whenever possible, moisture checks of 10% of the hogsheads, bales, etc., by type of tobacco should be made to facilitate an accurate beginning weight and to show average deviation from ticket weights.

An entire day's tobacco processing is recommended for a test sample. This eliminates needless clean-ups and by-product collection between blends and provides an accurate representation of routine production and brand mix.

(2) Conditioning

The type of conditioner should be noted and conditioning cycles for each tobacco or stem type.

Before and after conditioning moisture data is required on the same hogsheads as tested before conditioning and a moisture gain figure determined by tobacco type. Thief samples are preferred whenever possible.

(3) Strip Blending and Casing

Note the blending and casing methods used and type of equipment and conditions used in each stage of the process.

- Type of blending; consecutive or continuous

- Type and specifications of all equipment

- Method of casing application and monitoring

- Are blending silos used?

- What are the actual casing gains versus theoretical solids gains? i.e., weight gain versus calculated solids

- Do moisture and temperature sampling to provide a profile of each step in the process. Are these parameters acceptable with normal variations?

(4) Cutting/Drying

Note all equipment specifications in the area and again produce a moisture and temperature profile.

Determine the sieve size and cylinder volume profile of the product before and after drying at an equilibrated moisture where sample conditioning equipment is available.

Example: Cylinder Volume (cc/10 grams)

(a)	Filler Before Drying	80% x 36 CV =	28.8 CV
(b)	Stem Before Drying	20% x 40 CV =	+ 8.0 CV
	Calculated Composite Cylinder Volume		-36.8 CV
	Actual Test After Drying		+37.8 CV

100 x 1 cc/10g / 36.8 cc/10g = 2.7% increase

2059485344

A similar calculation and testing should be done for tobacco sieve size in regard to long, medium, short, small, and fine fraction changes.

Note the top flavor (after cut) metering methods, usage, and theoretical casing solids.

Acquire as much detail as possible about cutting flow rates, dryer operations and parameters (air flow, temperature, moisture change, residence time in the dryer, the number of heater coils, steam pressure, etc.).

(5) Cut Filler Storage and Primary Yield

Note the method of storing cut filler and weight/moisture control of the product.

The total weight and moisture average of the day's production will be required.

The total input tobacco weights and finished cut filler weights should be compared on a bone dry (0% moisture) basis and a yield figure determined.

Example:

- Input tobacco and stem 1,000 kg @ 0% moisture
- Cut filler output 1,010 kg @ 0% moisture

% yield = 1,010 / 1,000 kg = 1.01%

2059485345

(6) By-Products and Waste/Primary

For the day's production all by-products and waste should be weighed by separate location in the process and moisture sampled (2 each).

Each weight is calculated to a bone dry (0% moisture) and itemized as a percentage of the input tobacco weight.

Example:

Tobacco Input	1022 kg @ 0% moisture
Cutter Dust	2 kg @ 0% moisture
Pneumatic Dust	4 kg @ 0% moisture
Scrap Tobacco from Casing Cylinders	6 kg @ 0% moisture

By-Product % of Total Output

Cutter Dust	2 / 1022	0.2%
Pnuematic Dust	4 / 1022	0.4%
Casing Scrap	6 / 1022	0.6%
Total	12 / 1022	1.2%

2059485346

Standard Primary Waste Report

Location	Actual Weight	% Moisture (O.V.)	Correction Factor (1-OV)	Bone Dry Weight	% of Input
Cutter Dust					
Pneumatic Dust					
Casing Scrap					
ETC.					
Total					

Total Tobacco Input to Primary = ___________kg.

2059485347

2. Raw Tobacco Reception

2.1 Quality Goals

Once the tobacco is unloaded on the receiving dock, it is usually stored in the receiving area by type or grade.

Important points to be noted:

a. The tobacco has to be free of contamination and infestation, i.e., especially mold, oil spots, strange colors, abnormal stems, foreign material and beetles. This can be achieved by visual inspection of each package before and after the dismantling.

   - Clean dismantling and batch assembling area
   - Careful separation of packaging materials and tobacco
   - Use of technical means which avoid contamination

b. Each bale, hogshead or container must be identified properly, i.e., grade, batch number, blend and processing line should be posted. If this identification is computerized, manual identification should still be possible. Identification must be guaranteed for each bale from the reception area to the feeder/line.

c. A meaningful yield determination and a correct blend composition require a precise control of the incoming tobacco weight. The tobacco moisture (O.V.) should also be known.

The yield should be found by tobacco variety (grade) and batch (lot) to confirm the amount of tobacco received.

2.2 Tobacco Density

The apparent density and the density distribution of tobacco in hogsheads, bales and cases is important, because:

- The more tobacco which can be put in a package, the lower the storage cost per unit weight

- If the tobacco at the bottom of the package or around the sides is too loosely packed, undue breakage of the packing can result

- Low density areas around the outer edges are conducive to mold and beetle penetration

- High density areas in the interior can result in "cold spots" during thermo-vacuum treatment

These effects make it highly desirable to have a minimum variation in density within a package.

Generally: The density (lbs/ft^3) of Bright tobacco is higher than of Burley.

Average density: 18-22 lbs/ft^3

It has been experienced, that cold spots appeared at a density of 25 lbs/ft^3 or higher. These cold pads were often found in the center of the cases towards the bottom and were 10 to 12 inches in diameter and 2 to 3 inches thick on average.

2059485349

Container Filling

To free the densely packed tobacco hogsheads or bales, the tobacco orientation should be vertical when it is conditioned in the vacuum-chamber. This, of course, can be done only if containers are used (see 3.3). Furthermore, free space is needed in the container to enable expansion and opening of the tobacco due to the absorption of heat and moisture.

2.3 Tobacco Moisture

The moisture content of the incoming tobacco should be known, both to

- make a yield determination possible
- guarantee a correct blend composition (see 2.5)

However, this is not under the control of the primary management. Serious quality problems don't occur usually, if the moisture is below 14%. But above that, the danger of molding, fermentation, etc., exist. Specifically, the oriental and homogenized tobaccos are more susceptable to these dangers due to their hygroscopic character.

a. Importance of Moisture on Tobacco

Moisture is added and subtracted from the blend many times during processing to achieve different goals, like

- to control fragility
- to increase filling power
- to distribute casing better on tobacco

2059485350

Moisture content has many other influences, not only on tobacco during various steps in the manufacturing process, but on the properties of the finished cigarette as well. Its control and measurement (see 8.3) is, therefore, exceedingly important.

Before one can fully appreciate the effect of moisture on process variables and the instruments developed for measurement and control, it is necessary to understand the effect of moisture on some of the properties of the tobacco itself.

b. Equilibrium Moisture

The equilibrium moisture content of a tobacco is an inherent characteristic of that particular tobacco and is determined largely by its chemical makeup. The equilibrium moisture content is, however, dependent on the relative humidity and temperature of the environment. A typical set of equilibrium moisture curves for a Bright tobacco blend at various humidities and temperatures is shown in Figure 2.

Such a curve can be helpful in determining the moisture content that a tobacco will attain when left in a room at a given relative humidity and temperature.

c. Influence of Moisture and Physical Properties

The sensitivity of filling power to changes in moisture content has been mentioned. Virtually, as little as a 1% change in moisture can cause as much as a 4% change in filling power; as filling power decreases moisture increases.

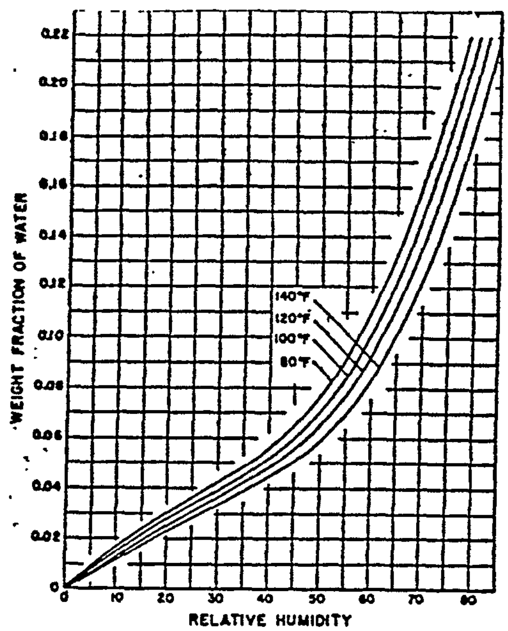


FIGURE 2: EQUILIBRIUM MOISTURE CONTENT OF A BLENDED BRIGHT STRIP AS A FUNCTION OF RELATIVE HUMIDITY AND TEMPERATURE

The fragility of tobacco decreases with increase in moisture, i.e., the elastic limit increases with the moisture content. It should also be noted, that swelling of the leaf occurs at higher moisture contents, and this is at least partly responsible for better distribution of casing materials in tobacco which has been preordered.

Furthermore, thermal and electrical properties of tobacco are also extremely sensitive to moisture contents.

d. Means to Change Moisture

Moisture is controlled during the processing of tobacco by the following means: (1) Moisturization, i.e., the direct application of water in liquid form

(2) Humidification, i.e., the control of the ambient relative humidity of the air

(3) Drying, i.e., the vaporization of water from the tobacco through the application of heat.

2.4 Inspection - Foreign Material Control

It is absolutely necessary that:

- no beetles
- no damaged tobacco
- no foreign material

enters the finished product.

a. Beetles

If the incoming tobacco is heated properly in the vacuum chamber, a complete bug kill is guaranteed (see 3.1). If a bug wall divides the area before and after the vacuum chamber, attention should be paid to the necessity, to keep the discharge door closed while loading and the front door closed while unloading. Thus, no living bugs can reach the clean area after the chamber. Furthermore, all areas in which tobacco is stored or treated must be maintained as clean as possible. Organic waste of any origin must not be allowed to accumulate. All such material must be kept in airtight containers or burned.

b. Damaged Tobacco

After stripping, the hogsheads and bales must be inspected for damages such as water damage, carbonizing, mold, etc. The portion damaged is cut away and inspected by a representative of the Leaf Department or another responsible person and disposition is made. That amount which is damaged is discarded and the weight for the discarded grade is recorded.

c. Foreign Material

Should tobacco received be visually contaminated by a foreign substance (for instance, oil) it must be held out of storage and not conditioned until being checked thoroughly. Any foreign matter visible in each unit of tobacco (i.e., wood, paper, etc.) is picked out of the tobacco. Every incidence of product contamination must be taken very seriously and should be investigated.

2.5 Weighing A Blend

In Philip Morris U.S.A. the bright and burley portion for each single blend are taken from a DBC-burley or a DBC-bright supply. "DBC" stands for "Designed Blend Components". A DBC-line is usually made up of entire package units (hogsheads or bales) so that weighing out of each grade is unnecessary.

However, in case each single grade is weighed per total blend, we face an important point to be considered. As a rule, blend sheets showing the required amount of the different tobacco types, are based on 12% moisture content. Frequently the moisture of the incoming strips varies quite a bit, often a constant but different moisture content can be observed.

This may change the composition of a blend, thus even changing delivery and taste of the cigarettes. Therefore, adjustments of the blend formula could be necessary, if a trend shows a higher or lower moisture of a special grade or lot.

$$\text{Adjusted Weight [lbs]} = \frac{\text{Formula Weight} \times 1 - \dfrac{\text{Formula Moisture(\%)}}{100}}{1 - \dfrac{\text{Actual Moisture(\%)}}{100}} \text{ [lbs]}$$

<u>Example</u>

(1)	Blend Sheet:	Grade X:	1000 lbs at 12%
		Y:	500 lbs at 12%
		Z:	100 lbs at 12%
			1600 lbs
(2)	Real Situation:	Grade X:	1000 lbs at 8%
		Y:	500 lbs at 12%
		Z:	100 lbs at 15%
(3)	Adjusted Blend Sheet:	Grade X:	956.5 lbs $= \dfrac{1000 \times 0.88}{0.92}$
		Y:	500 lbs
		Z:	103.5 lbs
			1560 lbs

3. Pre Conditioning (Vacuum Chambers)

The first treatment of the incoming tobacco consists of humidification of the entire package, i.e., hogshead or bale. This has been done by using vacuum chambers, in which steam is injected after a vacuum has been pulled. This is a batch process and from 1 to 12 hogsheads are usually treated in these chambers at a time.

Recently the interest in continuous conditioning machines (T.O.P. and Dickinson) has increased; in this process the tobacco packages are placed on a belt and doffers break them up under steam, a vacuum is not needed. Only the Dickinson machine uses a probe under slight vacuum.

It is too early to state whether any of these designs will eventually replace the vacuum chambers, but testing on T.O.P. and Dickinson indicate that these are not viable alternatives to vacuum conditioning.

3.1 Purpose Of The Vacuum Conditioner

Quality goals: This process shall render the tobacco flexible and easy to handle in the feeders. Furthermore, the vacuum treatment is one of the protective elements against all stages of insect infestation. These goals can be controlled by:

- Visual inspection of tobacco behavior in the feeder
- Quantity of pads and tobacco clumps after the feeder
- Cold/wet spots, which are a sign of a not optimized conditioning process.

Three main purposes of the vacuum treatment:

(1) To produce a bug kill.

The tobacco beetle's life development takes it through 4 stages: Adult, pupa, larva and egg with the larva being the hardest to kill. A high enough temperature for the proper time is how beetles are killed, vacuum alone does not produce the beetle's death. The tobacco moth can survive severe cold climates where the tobacco bettle is no problem; however, the moth is easily controlled by vacuum conditioning.

Figure 3 shows the temperature, absolute pressure and exposure needed to kill all stages.

Rule of thumb: $\boxed{\text{3 min at 55°C/130°F}}$

(2) Increase the moisture and heat content.

When the tobacco is placed into the vacuum chamber, it contains approximately 10-15% (Canadian bright, oriental, etc.) moisture, varying with the seasons of the year and the kind of tobacco. By putting heat in tobacco by condensing water vapor, it is made more hygroscopic, i.e., it accepts water better.

The increase of moisture will be in the range of 2-5%, depending on these major factors:

(a) Incoming temperature of the tobacco (summer approximately 2.5% moisture gain, winter approximately 4.5%)
(Q = M Cp (Tobacco Temperature In - Tobacco Temperature Out)

2059485357

The adjustments of the blend sheet can be made:

- on a weekly basis; random moisture samples of each grade/type are taken during the week and serve as "actual moisture"
- before a grade/lot is used; after a new grade/lot has arrived in the warehouse, random moisture samples from the whole lot determine the "actual moisture".

2059485358

Table 1.—Percent mortality of 3 stages of the tobacco moth after exposure to steam vapor flowing at 1 pound per hour in vacuum

Temperature, absolute pressure, and exposure	Eggs	Larvae	Pupae
120° F, 3.5-4 in. Hg			
1 minute		3	3
2 minutes		33	3
3 minutes		85	35
4 minutes		98	83
5 minutes	36	100	100
7.5 minutes	83		
10 minutes	89		
15 minutes	99		
17.5 minutes	100		
122° F, 3.6-4.1 in. Hg			
2 minutes		20	15
3 minutes	50	90	55
3.5 minutes		100	98
4 minutes	88		100
5 minutes	93		
6 minutes	94		
7 minutes	100		
125° F, 4.0-4.5 in. Hg			
1 minute	38	80	63
2 minutes	38	100	100
3 minutes	96		
3.5 minutes	100		
127° F, 4.2-4.7 in. Hg			
1 minute	86	83	73
1.5 minutes	100	100	100
130° F, 4.6-5.1 in. Hg			
1 minute	100	100	100

FIGURE 3: TOBACCO, NEW YORK, VOL. 12, NO. 12, PP. 30-32, 1966.

Where: Q = Heat

M = Mass (WT) of Tobacco

Cp = Specific Heat of Tobacco At Various Moistures

(b) Quality of the product: If we don't use a leaf that has enough texture or body to obtain moisture, we can't produce an internal moisture that will stay with the product

(c) The packing moisture must not be so low (approximately 8%) that the ability of the tobacco cells to obtain moisture has been changed, i.e., the value of Cp becomes very low.

(d) The quality of the steam (to be saturated and free of non-condensible gasses)

(e) Density of the product

Rule of thumb:

$$\boxed{\text{Moisture Increase \%} = \frac{\text{Temperature increase in chamber}}{20}} \ [°F]$$

For example: Incoming tobacco temperature: 50°F

Outcoming tobacco temperature: 150°F

(150°F - 50°F) ÷ 20 = 5% Moisture gain

This rule assumes a Cp value of 0.5 BTU/lb/°F, or a very good grade of Bright tobacco at 12% moisture. The Cp of Burley and low grades of Bright will always be lower under the same conditions.

(3) Consistency

The conditioner can produce a high level of repeatability on a bug kill, heat penetration and internal moisture. The moisture gained from the vacuum chamber is of an internal leaf moisture as opposed to the conditioning cylinder external wetting.

3.2 How Does It Work?

a. Physics Principle

Boyle's law of gases states: "The temperature remaining constant, the pressure of a gas varies inversely as the volume."

Expressed in another form: If the volume of a gas increases, its absolute presssure decreases, and vice versa.

Therefore, if a cubic foot of air at atmospheric pressure (762.0mm Hg/30" Hg Absolute) is placed in a container and the pressure is reduced to 381.0mm Hg/15" Hg Absolute, the absolute pressure is halved and the volume of the gas is doubled if the container is flexible such as a balloon. If the absolute pressure is further reduced to 50.8mm Hg/2" Hg Absolute, then it becomes 1/15th of atmospheric pressure; therefore, the volume of the gas is increased 15 times and now occupies 15 cubic feet. Volume of air:

Cubic Feet	Vacuum	Absolute Pressure	No. of Expansions
1	0" Hg	30" Hg	--
15	28" Hg	2" Hg	15
30	29" Hg	1" Hg	30
300	29.90" Hg	0.1" Hg	300

It is interesting to note, that in going from 0" Hg vacuum to 29.0" Hg vacuum the volume of air has expanded 30 times, and the expansion taking place from 29" Hg to 29.5" Hg is an additional 10 times.

2059485361

Vapor Pressure

The boiling point or boiling temperature of a liquid varies with its vapor pressure, that means, the greater the pressure on the liquid, the higher its boiling point will be. A pressure cap on an automobile radiator is a good example of preventing overheated water from boiling.

Example: An open vessel of water at sea level will boil at 100°C/212°F. If this vessel were placed on a very high mountain, it would boil at a lower temperature, because the air pressure on the liquid is lower. At 10,000 feet level it would boil at 90.2°C/194°F.

Latent Heat

In dealing with heat it is necessary to have some unit of measurement:

- In the USA the accepted standard unit is a BTU (British Thermal Unit): That is the amount of heat required to raise one pound of water 1°F

- In the metric system: A gram-calorie ("cal") is defined as the amount of heat required to raise one gram of water 1°C. A gram of water is very small, so 1000 calories or 1.0 kcal is most commonly used in calculations.

- 1 BTU = 0.252 kcal

In order to boil water into steam, sufficient heat must be added to the water to supply what is known as the "latent heat of vaporization".

The converse of this is to condense steam, the removal of latent heat from the steam is required in order to convert it into water. (Approximately 1100 BTU per pound of steam to obtain one pound of water at the boiling point.)

b. Description Of The Process:

The tobacco bales or hogsheads are placed in the vacuum chamber that is connected to the suction of a vacuum pumping system. In the case of a probe system, a probe is driven into each bale or hogshead after the chamber has been loaded. The probe slots must be below the top of the tobacco mass. There are at least two stages to draw the vacuum because it is not possible with only one stage.

At first the vacuum pump draws a vacuum up to 27.5"-28" Hg vacuum in the chamber and in the condenser. The condenser maintains at least this level throughout the cycle. When the steam ejector or vacuum pump has drawn this 28" Hg vacuum and removed the bulk of air, the booster steam ejector begins to work to reach the needed 29.7" Hg vacuum (0.2 in Hg Absolute). Water in the tobacco boils to produce very large quantities of water vapor to remove residual air in the chamber and tobacco.

When the chamber is evacuated, so are the probe tubes (if existing). Then saturated steam and sometimes hot water (micromist) is injected. During the steaming vacuum is drawn through the probes to remove gases pushed ahead of the steam that enters the tobacco from the chamber.

After having reached a certain temperature there is a short holding time (1-4 minutes) while the steam is penetrating the tobacco. Vacuum and steaming is repeated as necessary to complete penetration.

At the end of the cycle, the chamber is vented to atmosphere.

c. Main Parts

Probes:

Their function is to let heat and moisture penetrate quicker into the center of a bale and thus cut down the cycle time by up to 40%.

They also create an internal flow of the steam through the tobacco into the higher vacuum of the probe.

On the other hand, the probes make the whole vacuum process more complicated; more valves, instruments and equipment are needed. This sums up to more than $10,000 for each probe.

Furthermore, each probe represents an additional leak possibility. The alignment of the probes is critical. Experts claim that with the container/holes system instead of probes, only a little more time is required to achieve a conditioning level that is as good as the probe system. This depends a great deal on how large the bales are, how tightly they are packed, and how they are oriented, i.e., with tobacco laminations in a vertical plane.

<u>Booster</u> (first stage jet):

Because the current types of vacuum pumps do not have the capability of pulling a sufficiently high vacuum, a booster is needed to achieve the required 29.7" Hg vacuum.

Steam jets function by the venturi principle wherein steam at a high speed (at over 100 psi, can be low as 80 psi) passes through the diffuser throat at sonic speeds, and pulls the air and vapor from the chamber with it (see Figure 6).

<u>Condenser</u>:

Since we have the booster in our system, we have to condense the steam it uses to reduce its specific volume. Therefore, a condenser is connected with the discharge end of the booster to handle the steam from the jet and also provide the 28" Hg vacuum to enable the jet to function. This steam from the booster has to pass through a water curtain produced in the top of the condenser by a splash plate (see Figure 7) and the water supply entering into the top of the condenser. This water curtain will collapse (condense) the steam. Air and non-condensible gases will be drawn to the vacuum pump or final stage steam jets and vented to the atmosphere.

<u>Cooling Tower</u>:

The water that has condensed the steam and circulated to the

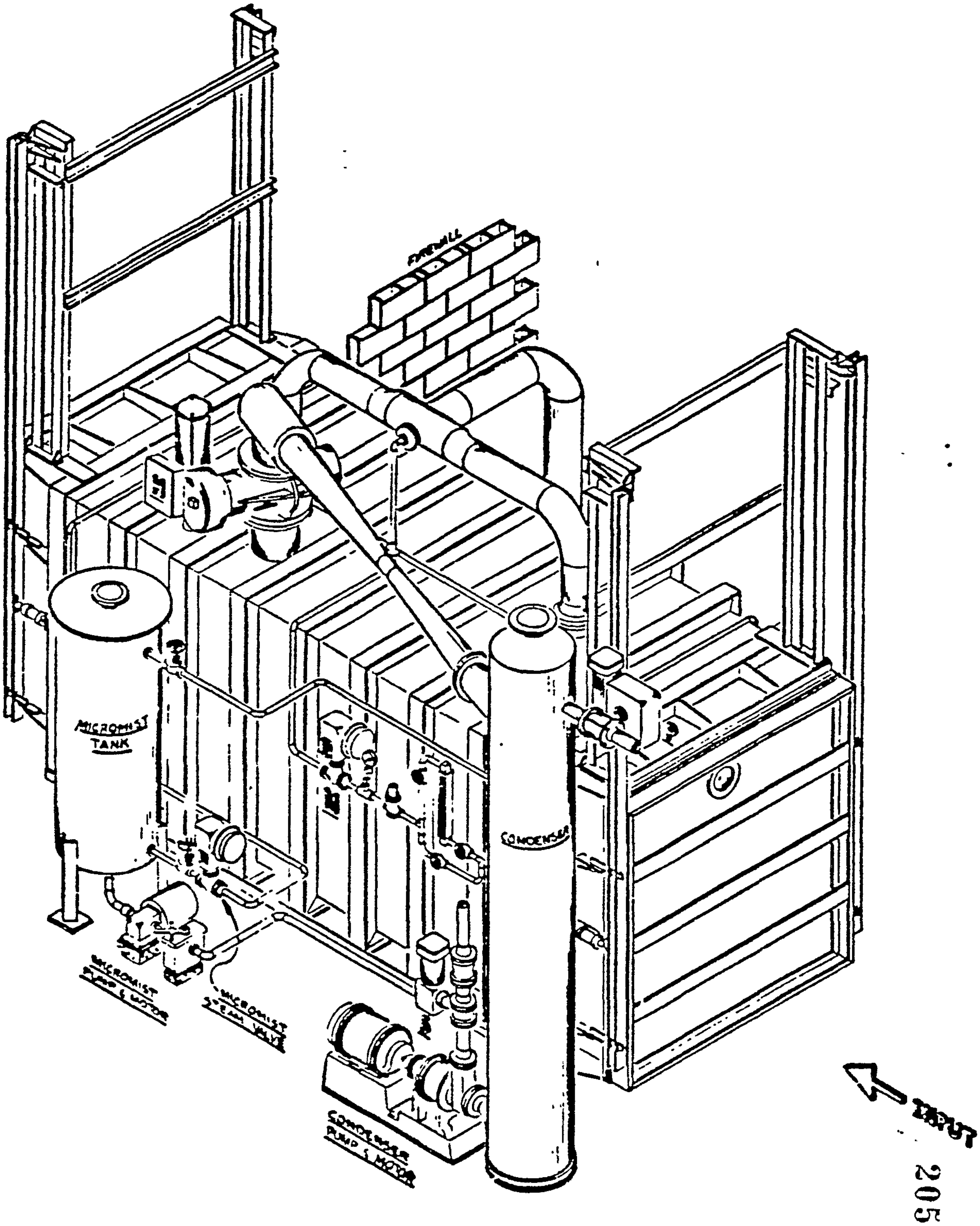


FIGURE 4: PM-DESIGNED VACUUM-SYSTEM WITHOUT PROBES, INPUT VIEW

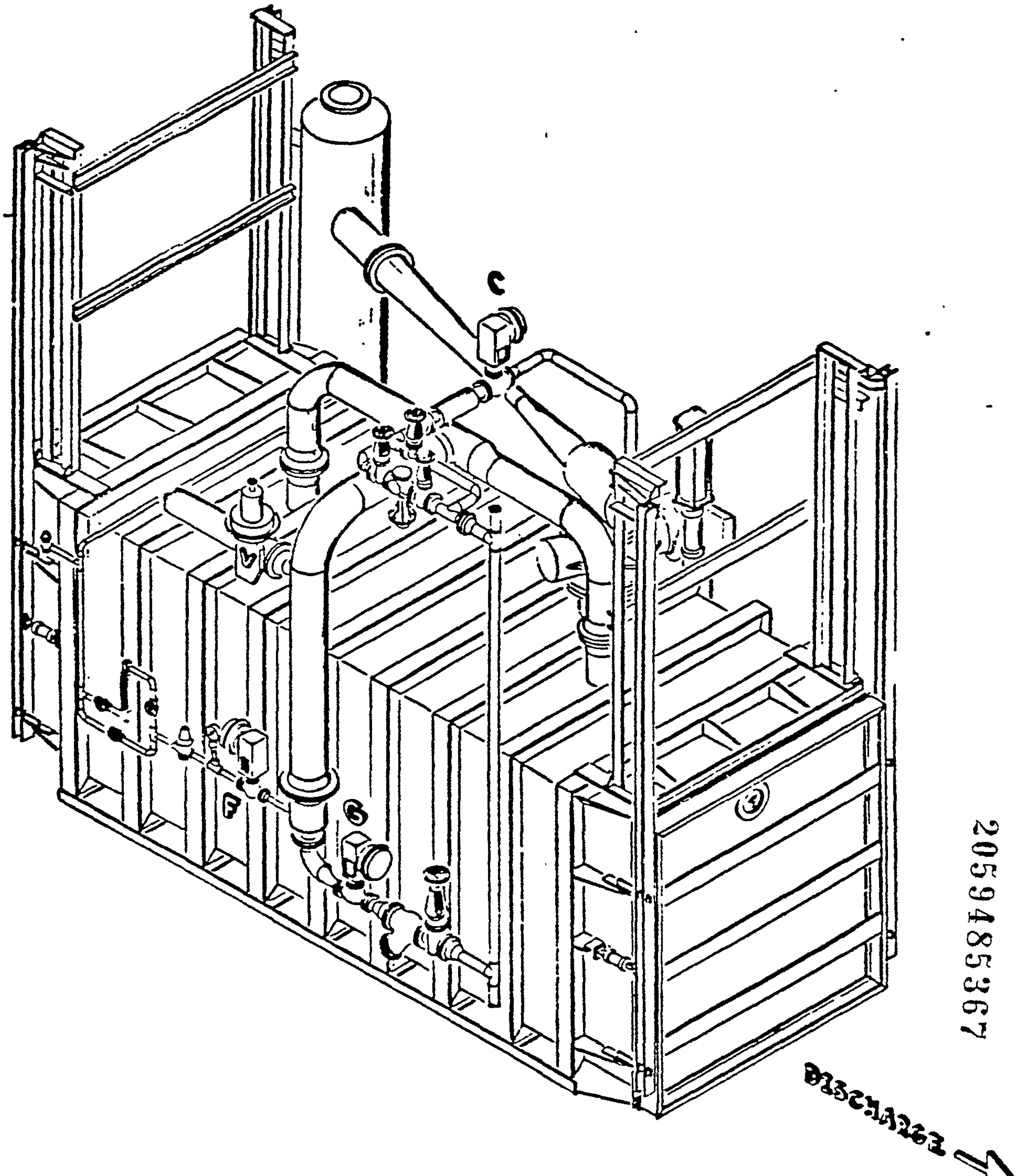


FIGURE 5: PM-DESIGNED VACUUM SYSTEM WITHOUT PROBES, DISCHARGE VIEW

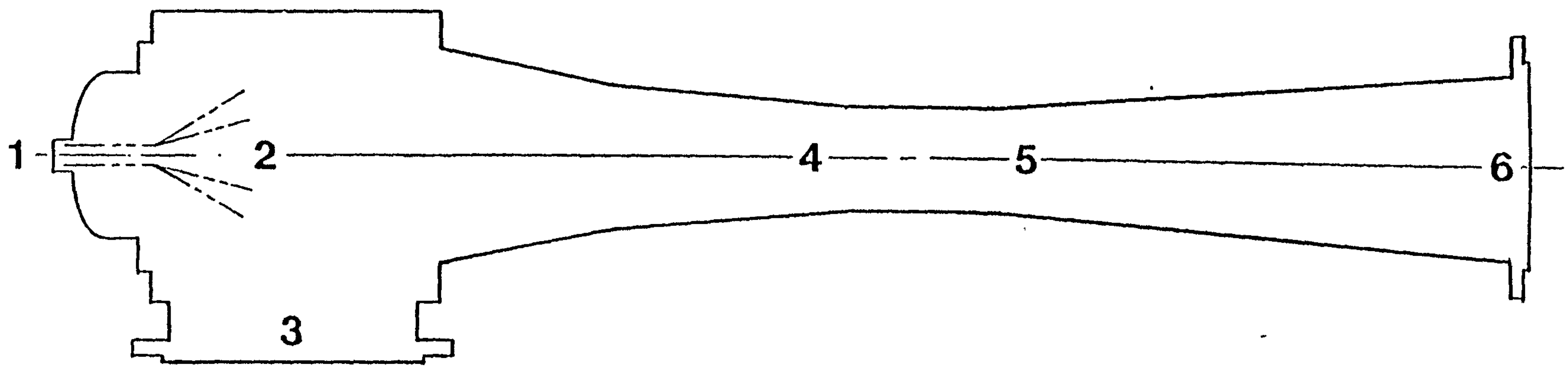


FIGURE 6: EJECTOR PRESSURE SCHEMATIC

Note: Guardite's Hi Vac-Probe PAC was sued out of existence by Johh Mohr in a U.K. appeal case in 1967. AMF World Tobacco Group is no longer in existence, so neither is the Guardite, in any form.

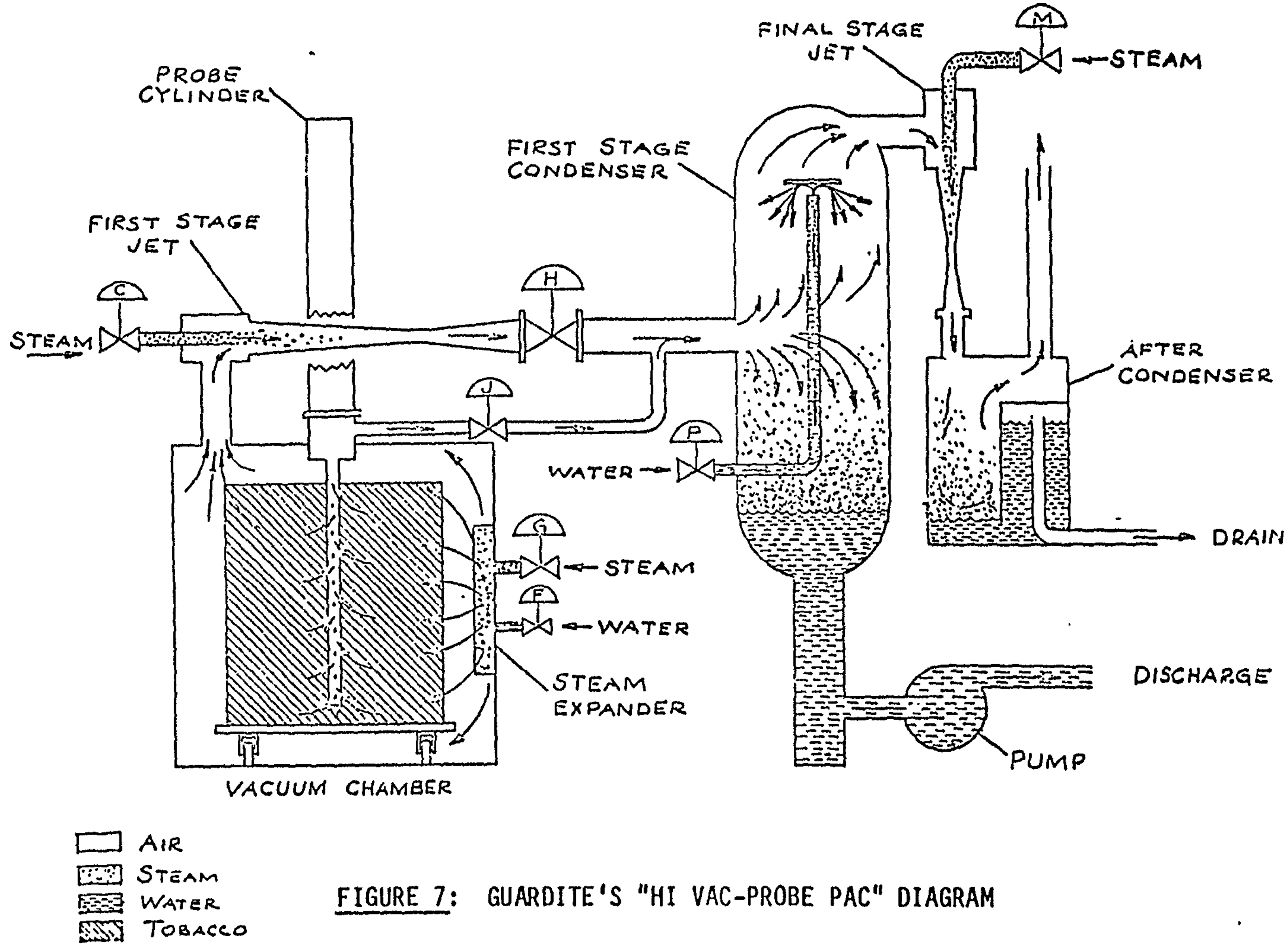


FIGURE 7: GUARDITE'S "HI VAC-PROBE PAC" DIAGRAM

cooling tower on the roof must be cooled, so it can be recirculated back to the condenser. The water inside the condenser will gain approximately 10°F while the jet is running.

<u>Note</u>: If the water supply entering the condenser were too hot and raised the temperature over 38°C/100°F in the condenser, the booster would not work. Reason: The water in the condenser boils and produces so much vapor (specific volume) that the downstream jets or vacuum pump is overwhelmed. The condenser pressure rises as a result and the booster becomes detuned (backfires) and will no longer pump.

<u>Vacuum Pump</u>:

It pulls the vacuum in the chamber and condenser to a level that the booster will operate. It has a water ring to seal the tips of the rotor blades so it will be able to trap air in between the rotor blades until the air is discharged out of the side ports of the pump. Although no "piston" is involved, some call this a water piston pump.

The water used in the seal water system is recirculated back into the pump, provided the temperature is not too high. Maximum temperature: 32°C/90°F. If necessary, it is cooled by city water or a chilled water heat exchange. The ideal seal water temperature into the pump is 60°F.

Desuperheater:

Mixes micromist water into the steam: Water is metered by a special plug lying in a ring on the circumference of an orifice that is varying due to the steam velocity raising the plug.

When the steaming cycle starts, the heated deaerated micromist water is mixed with the steam to remove approximately 111°C/200°F degrees of superheat from the steam. Remaining superheat is removed by water spray nozzles inside the chamber where the final steam expansion takes place.

Micromist Tank:

It contains water which is sparged with steam for heating and to drive out (vent to atmosphere) non-condensable gases, such as air, oxygen and carbon dioxide. The gases are vented from the tank to the atmosphere as they are replaced with water vapor. The heated water is recirculated through a spray nozzle to a splash plate to hasten release of the gases.

Wet Bulb Bath:

A sensitive temperature element is covered with a wetted wick lying in a water bath and indirectly measures the chamber conditions (see Figure 8). It is convenient that wet bulb temperature is the same as saturated steam temperature in a closed container. (This indication does not hold true when the chamber door is open, or when a vacuum is drawn on an empty chamber.)

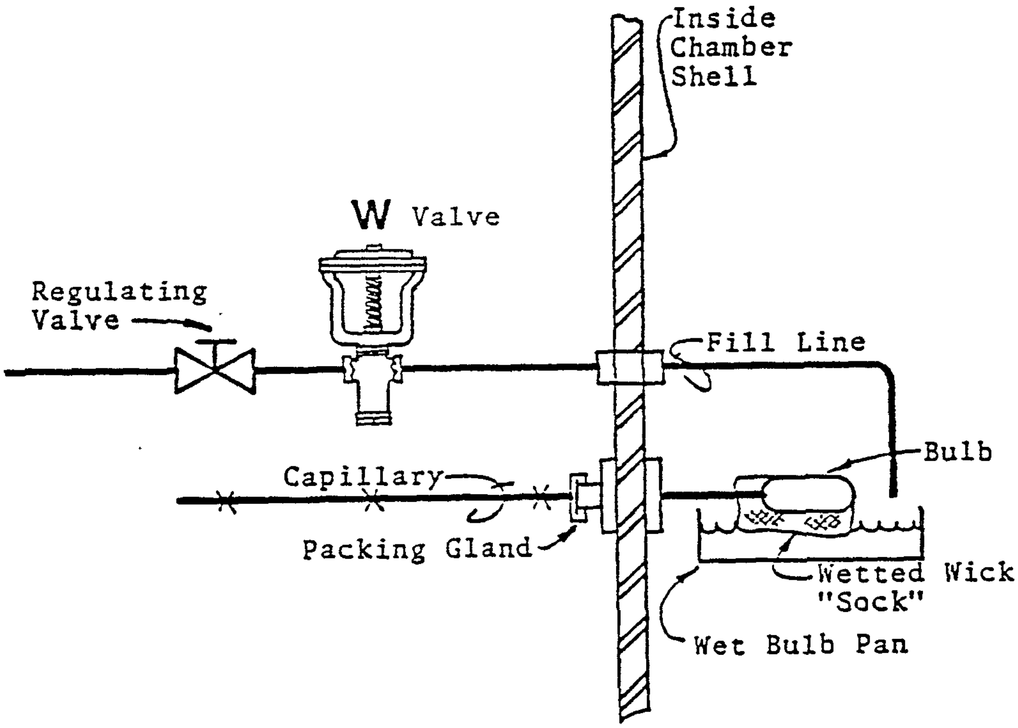


FIGURE 8: WET BULB BATH SCHEMATIC

2059485372

3.3 Handling The Tobacco

Generally, the vacuum chamber is designed to accommodate the existing layout of the plant. That applies to

- Size of the chamber
- Size of vacuum pumping system
- Loading/unloading system used
- The way the doors are set up
- The way the drainage of the chamber is designed
- Availability and relative costs of boiler fuels and electricity
- Government restrictions (fuel rationing, etc.)

The individual needs of each location must be evaluated on its own special circumstances.

In the following, different solutions for the above mentioned items are pointed out.

a. Loading/Unloading

(1) Automatic Conveyor System

The tobacco is placed in aluminum containers which are moved automatically into and out of the vacuum chamber and on to the feeders. A computer controls the operating sequence. Such a system is realized only in the most modern primaries. When working with automatic conveyor systems, tobacco should not be allowed to fall onto the floor or out of the conveyor system. Therefore, transport in or on some type of retainer should be used.

In Figure 9, such a container is shown, usually made from aluminum or stainless steel.

It is essential that holes be drilled into the container to allow the steam to get into the bale, and the water to drain from the container. These holes are especially needed near the corners.

Because air is heavier than water vapor (molecular weight 29 vs. 18), the air will settle in the bottom of an unvented container causing uneven moisture distribution and eventually cold tobacco.

Diameter of the holes - on the sides: 1/2" - 3/4"
- on the bottom: 1/4"
Spacings on approximately 12" centers.

If needed, hooks can also be welded on the container.

(2) Roller Conveyors

Driven rolls move the bales, hogsheads or container. A shaft going into the chamber is needed to drive the

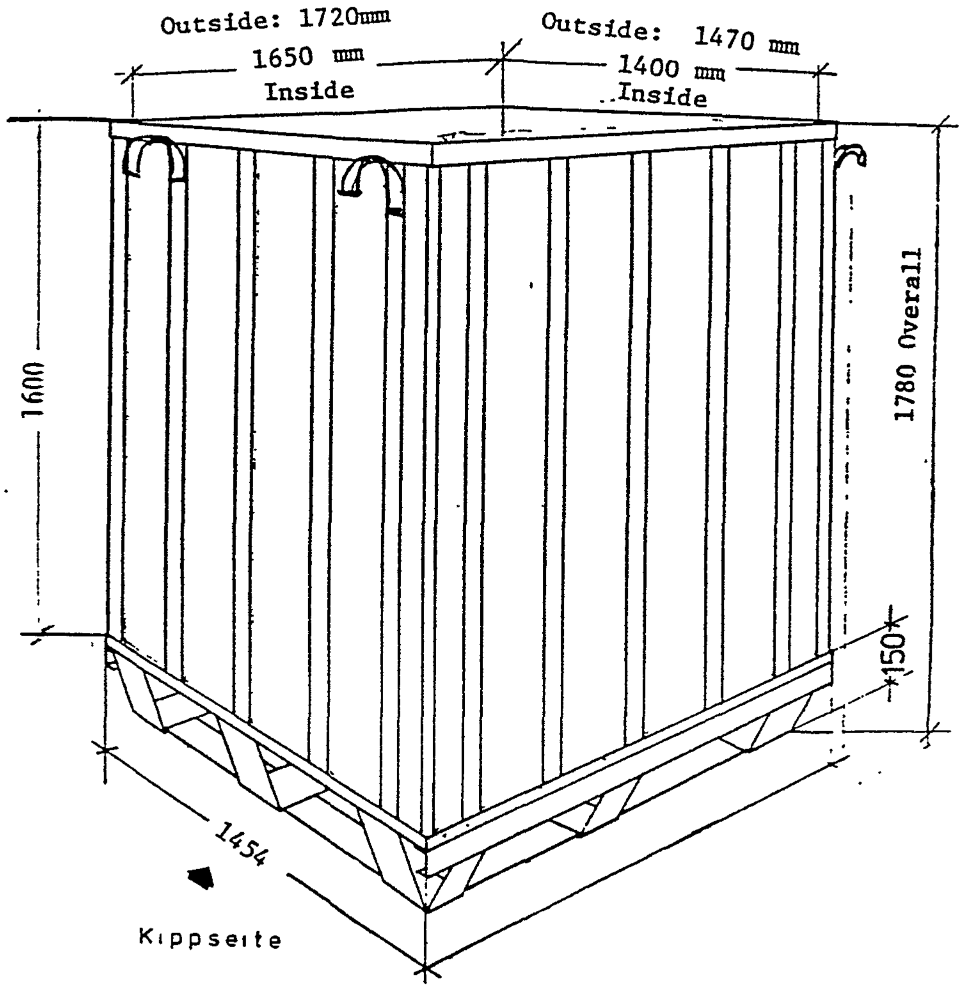


FIGURE 9: ALUMINUM CONTAINER (NO HOLES)

rollers in the chamber. The through-hole represents a possible leak of the vacuum when the seal is not properly maintained. Roller bearings do not do well inside vacuum conditioners, as steam interferes with their lubrication.

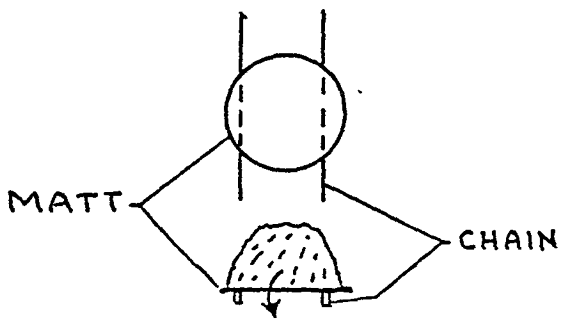
This system is used if there is a roller conveyor already installed in the plant.

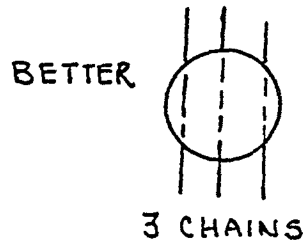
2059485375

(3) Chain-type Conveyor

Driven chains move the tobacco packages. This system also requires a drive shaft into the chamber.

If hogsheads are moved, 3 chains are recommended to prevent the mats from drooping.





(4) Pusher Bar System

A pusher bar with a little "pawl" (or "dog") pushes all hogsheads or mats into the chamber. The mats roll on idle-rollers, a drive shaft into the chamber is not needed. This is a simple, cheap, and reliable conveyor system, and does not require a high chamber like conveyors do.

(5) Lift-and-Lay System

The hogsheads are loaded into the vacuum chamber by means of a conveyor system consisting of a pneumatic lifting and sliding device. The hogsheads are handled very gently. Three indexing conveyor systems have been installed in the Louisville plant.

(6) Dollies

Each hogshead is placed on a single dolly, which usually has 4 or 6 wheels. The hogsheads can easily be pulled or pushed by hand, forklift or a pusherbar. This is a relatively cheap, easy and flexible system. In locations where space is a consideration, dollies can be a good solution because by moving these by hand, no spacious conveyor system is needed.

Note: The bigger the wheels, the easier the dollies roll and turn, the easier they can be handled. Also, steel wheels are easier to deal with than rubber covered casters.

b. Doors

(1) Sliding Doors

Depending upon available space, the doors can be lifted up or move to one side or the other for opening. On lifting doors, a counter-weight is used for safety and to minimize the energy required for opening. Vertical sliding doors are powered open or closed by an air cylinder. Doors that open to the side are usually manually controlled.

(2) Hinged Swinging Doors

These doors are manually closed and a hand wheel is used to lock them. They open around the side that is hinged so that space is needed for the swing of the door.

Ramps and bridges span the jump between the chamber and the outside floor level. (There is always either a gap or a difference between the chamber and factory floor.)

(3) <u>"Shiff and Stern"</u>

This name represents the Austrian manufacturer. The door is hinged on the top and swings over the chamber. This has the disadvantage of limiting the location of equipment on top of the chamber, as well as floor layouts for condenser, pumps, etc. Vacuum chambers are relocated fairly often due to primary expansion programs.

c. <u>Pit</u>

Wherever it's possible, a pit underneath the chamber should be built for

- having the chamber and primary floor at same level
- collecting the drainage water coming out the chamber after the conditioning cycle
- providing working space in case a replacement of the drain header gasket or the drain header itself is necessary. Or, to replace chamber bottoms after many years of service.
- providing working space to empty drain header basket

Ideally, the pit is about 4-6 feet deep.

In the case where a bug wall is between the loading and discharge sides of the chamber, it is important to also seal the pit, i.e., to continue the room dividing wall into the pit. Small 20 mesh screen wire may be used to seal small openings.

3.4 Operating Set Points

As mentioned in 3.1, moisture increase inside the vacuum chamber will be in the range of 2-5%, depending on different factors.

a. Initial Evacuation:

The wet bulb temperature of the first evacuation must be lower than the temperature of the incoming tobacco, i.e., it is important to get below the vapor pressure point to boil off the water.

For instance, it is important only in the winter to go as low as 0°C/32°F and only if the tobacco comes into the chamber close to the freezing point of water. In the summer we can increase the initial evacuation set point, thus reducing cycle time and saving energy. In the tropics, it may never be necessary to evacuate below 50-60°F.

b. Intermediate Steaming Point:

It has been shown, that

- Tobacco with a temperature of 71°C/160°F and above is chemically changing (discoloring, etc.), if it remains over 2 hours at this temperature.

- The vacuum chamber doesn't work efficiently with regard to moisturizing the tobacco, if the temperature is much below 71°C/160°F. Furthermore, the lower the temperature, the more time is needed for a complete bug kill. Oriental tobacco is an exception - 145°F being the recommended initial steaming temperature.

However, tests have shown that the average tobacco temperature never reaches the temperature of the steaming set point (see Figure 10). At the most, the temperature of the final steaming set point can be obtained, and only after the end cycle, after venting.

c. Reevacuation

Highly compressed tobacco contains approximately 2/3 air by volume. After the first evacuation and steaming, there is still a lot of air left in the bale. Therefore, the chamber is reevacuated (and steamed) up to 4 times. The reevacuation set point is about 43°C/110°F, because

- by going lower it overcools the center of the tobacco
- the booster comes on at 2" Hg automatically; for energy and time reasons operating the booster seems inappropriate for "reevacuation" vacuums. The condenser collapsing steam will draw the necessary vacuum without the booster's help. The condenser temperature should be 85°F or lower.

d. Final Steaming

As Figure 10 shows, the tobacco temperature eventually rises up to the final steaming temperature. To guarantee a bug kill and to prevent the tobacco from becoming exothermic,* a temperature of about 57°C/135°F is recommended. Temperatures above 145°F will cause the tobacco to become exothermic and will begin to darken from the heat build-up, if allowed to sit for any length of time in the bale or hogshead compressed state form.

*"Exothermic" means generates its own heat.

e. Holding Time

The tobacco needs to follow the temperature of the wet bulb to guarantee heat transfer into the tobacco.

Recommended holding time: 3 minutes.

f. Ramping Time (Optional Special Electronic Control Systems Only)

This is the time span in which the wet bulb temperature rises from initial evacuation set point to the initial steaming set point. In order to get to the desired steaming set point and not to "overshoot" it, computerized ramping makes the steam valve open and close several times.

Recommended ramping time: 6 minutes, or as long as 12 minutes on old systems having small steam piping. High steam velocity in small piping causes superheated steam and water that wets tobacco.

2059485381

Note: The majority of vacuum conditioning systems use 12" circular charts.

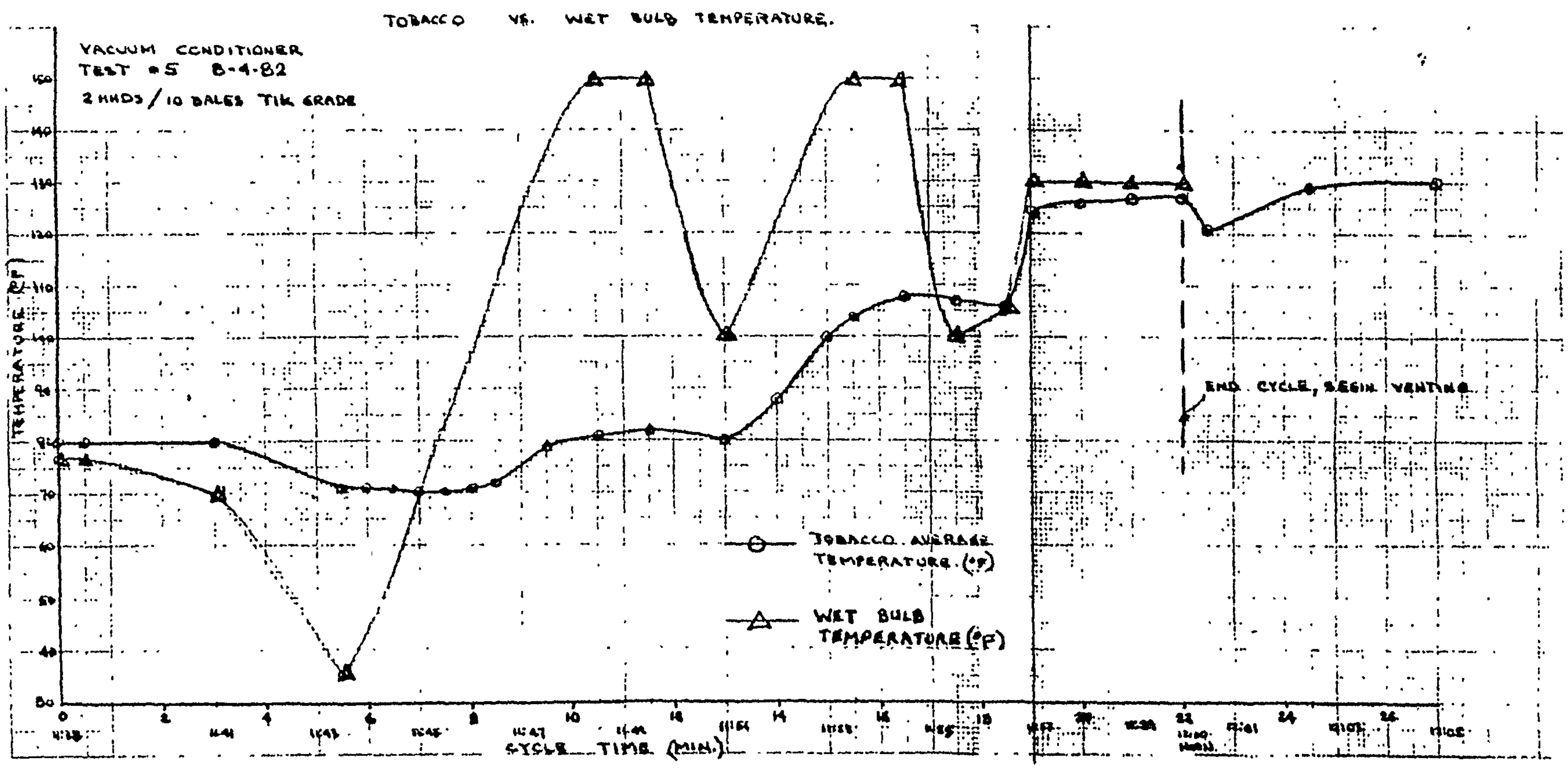
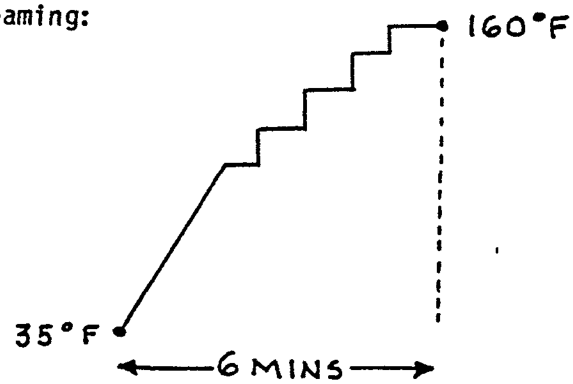


FIGURE 10

Steaming:



g. Process Water

This is the micromist water injected into the steam going into the desuperheater and chamber.

Rule of thumb: 3/4 - 1 gpm per 1000 lbs tobacco

h. Cycles

The number of cycles needed depends on probes or no probes, on the tightness of the chamber, on the tobacco density and the tobacco quality. For instance, lower grades are more tightly packed and need generally more cycles.

Increasing the number of cycles (all other factors being constant) means:
- more even distributed moisture
- more consistent temperature
- better bug kill
- better cigarette maker operation

2059485383

3.5 Cold Spots/Holding Test

Cold spots in the tobacco bale coming out of the vacuum chamber mean steam has not penetrated the area in question.

Cold spots can be caused by:

- initial evacuation setpoint too high
- non-condensible gasses in the boiler steam
- too high density (try more vacuum/steaming steps)

  The bulk of tobacco in hogsheads has a density in the range of 18-22 lbs/ft^3. It has been experienced, that high density tobacco, i.e., more than 25 lbs/ft^3, is prone to have cold pads.

- too low steam pressure (booster jet not pumping)
- possible vacuum leak; air hasn't been pulled out of the chamber or tobacco, thus the steam couldn't penetrate the whole bale.

Leak Testing

The chamber and system (!) should be leak tested every month. The system should be tight enough to hold the leakage rate down to 0.5" Hg per hour. Greater leakage will deteriorate the quality of conditioning. Spot checks of individual control valve tightness should be made continuously. Sonic leak detectors are inexpensive and very helpful in locating leaks.

Holding Test:

After closing the vent valve and drain valve, a vacuum down to 50°F is pulled. Then the chamber isolation valve is closed manually. The mercury reading will rise for the first 1/2 hour because chamber metal heat will cause the water in the chamber to evaporate until equilibrium is reached. Therefore, the actual holding test should start one or two hours after isolating the chamber. The minimum holding time should be 2 hours, recommended are 10 hours. A chart of a typical holding test is shown in Figure 11. Caution: Never open the valve to the test mercury manometer while allowing steaming into the chamber. Water will condense into the manometer mercury column.

Leak Detection:

When air passes through an orifice, the turbulence generates high frequency sounds. With an ultrasonic leak detector "gun" the leakage spots can be detected easily. Most severe leaks can be heard without aids when the factory is quiet. "Feel" carefully for heat downstream from the various steam control valves.

Manufacturer: UE-Systems, N.Y.; price about $1,000.

3.6 Maintenance

a. Cooling Water/Condenser System

Daily: - Check flow through the mechanical seal on the condenser discharge pump, if any. All condenser water pumps do not have a sealing water feature.

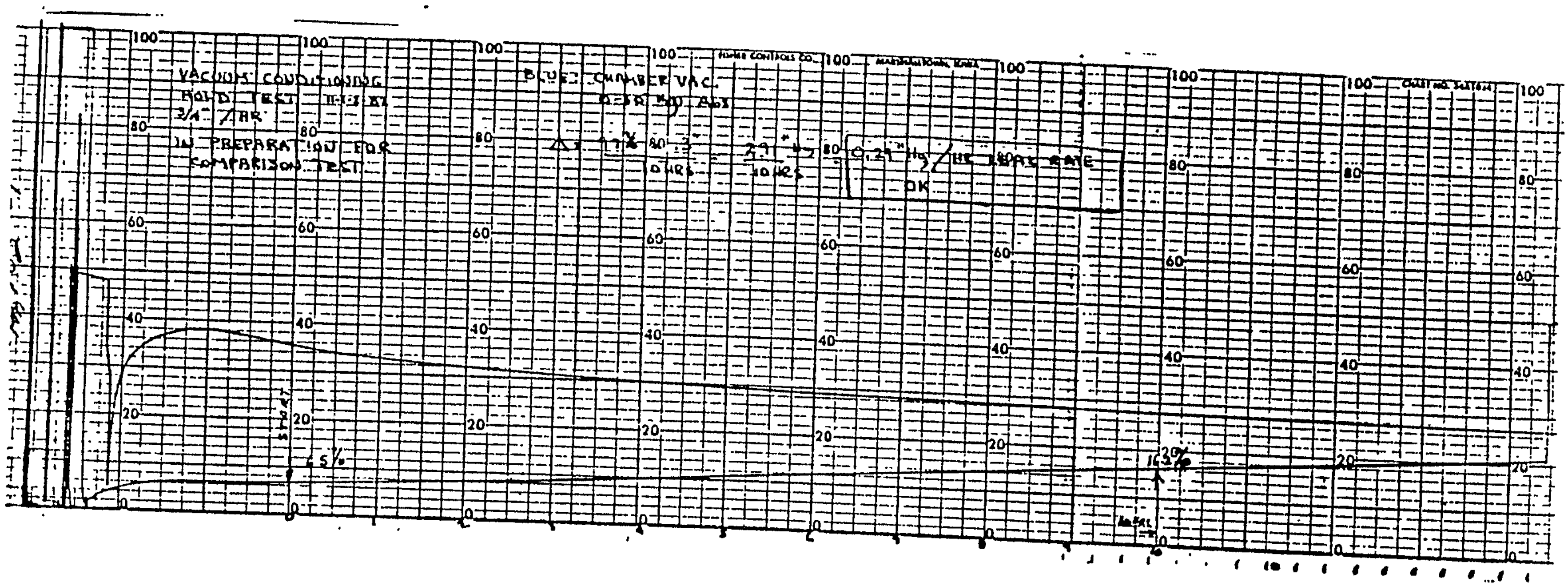


FIGURE 11 - HOLDING TEST

- Observe water level in condenser. If the high water cutoff switch is shutting off the water flow anytime during the cycle, check the level control system and see if the is water foaming.

- In case of pneumatic level transmitters (PLT): Drain the compensating line that runs from the top of the condenser to the transmitter.

- Drain the condenser water.

Weekly: - If a water treatment program is not utilized, clean the cooling tower and flush the lines.

Monthly: - Check chamber, condenser, booster and piping for leakage

Every 3 months:

- Grease condenser pump and couplings, and probe drive mechanism, if any.

- Replace probe receiver O-rings, if any.

- Grease drive motors

- Grease cooling tower drive motor and fan bearings

Shutdown periods:

- Clean the cooling tower and flush the lines

- Wash down inside of condenser

- Replace or clean condenser sight glass

- In case of PLT: Remove housing flange on the high water switch and wash out

- Check bearings on pumps for excessive noise

- Check calibration of wet bulb temperature and condenser water level transmitters.

b. Evacuation System

Daily:

- Wash down chamber, inside of doors and door gasket
- Visually check for steam, water and large air leaks
- Check the wet bulb wick
- Check the wet bulb pan for water before first cycle

Weekly:

- Check the door gaskets for damage or joint separation
- Blow down the air filters on the chamber, in the main control panel and on the air pressure reducing valves
- Remove the wet bulb wick, clean and replace

Monthly:

- Check drain O-ring valve liner for damage - visual inspection with valve in line (most chambers have no drain with O-rings for sealing. Others have pinch-type lined valves).
- Check steam reducing station output pressure

2059485388

(100-110 psi). A pressure gauge should be installed in the booster steam chest to insure that the pressure during operating matches the booster nameplate valve.

c. <u>Steaming System</u>

Daily: - Blow down all steam strainers and trap lines

- Adjust operating set points as required for process

- Adjust steaming hand valve as required for steaming time. The chamber should steam for at least 6 minutes total during intermediate steaming (counting 3 minutes time on TR2). Total steaming time should be 6 + 3 minutes.

Weekly: - Switch Hayward strainer (on the micromist system) and clean baskets

Monthly: - Remove spray nozzle tips, clean and reinstall

Every 3 months:

- If applicable: Remove spray nozzles at steam entry flanges, clean and reinstall.

d. <u>Auxiliary Equipment</u>

Monthly: - Check operation of bleed valves on door solenoids for proper speed

- Check limit switch adjustments

Every 3 Months:

- Lubricate door chains

- Grease door bridge pillow block bearings

2059485390

4. Blending and Conditioning

Process Description:

Conditioned strips exit the vacuum conditioners at 14 to 16% O.V. The conditioned packages (hogsheads, bales, cases) are transported to the feeders to begin the strip opening operation. Separate lines are used for Burley, Bright, Oriental and Reconstituted tobacco to enter the processing area.

Figure 12 illustrates the general processing steps for strip opening.

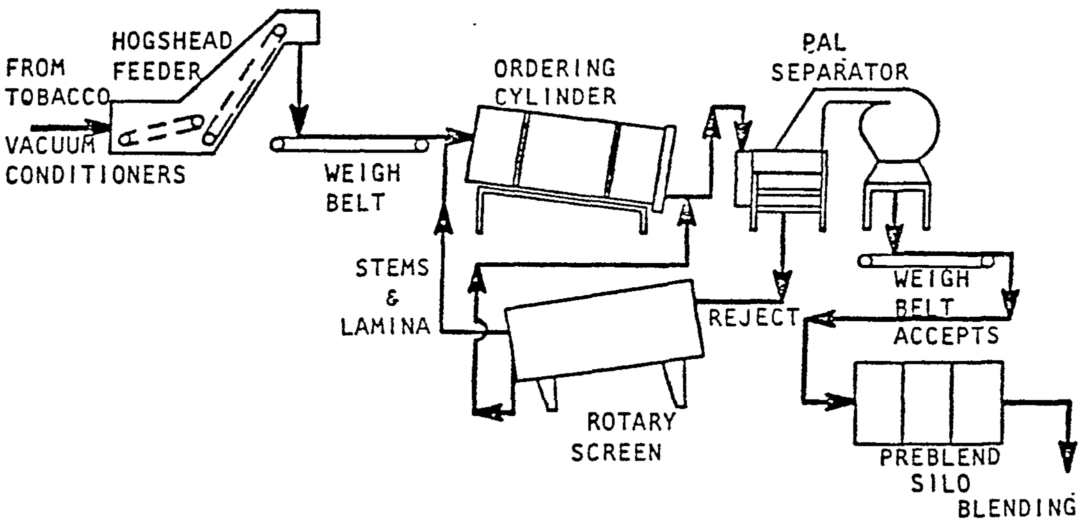


FIGURE 12: STRIP OPENING FLOW DIAGRAM AT MANUFACTURING CENTER

4.1 Quality Goals

The goal to be achieved in the strip opening process is

- To produce a constant flow of tobacco. A constant flow through the whole primary process will always help to achieve product

2059485391

uniformity, a high throughput, and better equipment utilization. A smooth flow can be controlled best by visual inspection. Instrument readings and diagrams give a long-term general view of feeder/weigh belt performance.

- To open the leaf, to fluff it up.

  It is a very subjective job to control whether the leaves are opened enough or not. This requires much experience. However, a great "free" surface of the leaves is essential for the following processes. Hand checks of the leaves by experienced people can always be helpful for fine tuning of factors like changing cylinder RPM with type of tobacco, steam pressure, position and type of nozzles, additional water, etc.

- To increase the moisture.

  The amount of increase depends on the type of tobacco and the following processing steps.

- To break up pads in the tobacco flow.

  Oriental tobacco is prone to padding. The pads are defined as wads of tobacco, with three or more leaves sticking together. If separators are used to get pads and tobacco packs out of the tobacco flow, the air flow settings should be adjusted according to type of tobacco and throughput.

2059485392

4.2 Strip Blending

The vacuum chamber conditioning leaves the tobacco pliable and loose enough to be fed to the processing system. Several feeders feed strip into the process.

A weigh belt located at the feeder discharge controls the tobacco rate by varying the feeder speed. Based on the cigarette blends run at the facility, the amount of silo storage space and the hours of operation for the primary, a rate is determined for operating each strip opening line.

a. Feeder

The feeder incline angle is about 50 degrees. The inclined belt speed is usually between 30 to 50 feet/minute.

Pins: Although some experts consider pins as a generally degradating means of tobacco handling, pins can't be avoided at feeders; with plates instead of pins, the same consistent flow wouldn't be possible. Average pin length for strip handling: 3-4". A slow running incline belt with long pins would result in least tobacco degradation.

Carrier-rails: The pins are welded onto carrier-rails which are screwed on to the belt. The carrier-rails should have some height to carry small tobacco particles, and they should be extended below the side walls to ensure that tobacco is conveyed across the full belt width.

Belts: Endless belts have usually a longer service life.

Caution: Belt materials must not contain PVC.

Bottom-covering: The bottom-covering of the incline belt should be easily removable for maintenance purposes. Furthermore, a plexiglas window in the covering rendors possible to spot excessive dust accumulation.

It is important to have an appropriate tobacco-roll or pile on the pull up (bottom) belt, out of which the pins of the incline belt drag the tobacco. If this pile is too small, a thinner bed with feed-holes and thus uneven carpet will result. An inconsistent flow can also be caused by a too big tobacco-roll, because the incline belt overfeeds and the doffer kicks back too much leaving blank spots in the carpet, and degrades the tobacco.

Size: Although the feeder manufacturers have adapted the modular system and Philip Morris usually buys feeders from the shelf, feeders are still individually tailored to suit the respective flow-rate and product type.

The feeder width can be calculated from the following formula:

$$\text{Feeder Belt Width (ft)} = \frac{\text{Tobacco Flow}\ \frac{\text{lb}}{\text{hr}}}{\text{Bulk Density}\ \frac{\text{lb}}{\text{cf}} \times 60\ \frac{\text{min}}{\text{hr}} \times \text{Carpet Depth ft} \times \text{Incline Speed}\ \frac{\text{ft}}{\text{min}}}$$

Carpet depth is usually 2 to 3 inches for design.

The following table gives the bulk density information for different strip in the preblend feeders.

Strip Type	Density LB/CU. FT.	% OV Of Sample
Bright	4.4	14.7
Burley	2.9	14.5
Turkish	5.6	17.2
RL	2.5	14.3
RCB	4.3	16.2

b. Weigh Belt

Weigh belts continuously register the momentary throughput and convert the mechanical indication into proportional voltage values, which are used to control the feeder. At the same time, the weight of tobacco is integrated and summarized.

Most weigh belts on the market have a strain gauge: The pressure applied onto the belt is more or less directly coupled with the strain gauge, i.e., the readings can be influenced to a certain extent by vibrations which always occur in a production environment.

On the other hand, the THAYER weigh belts utilize a series of blue steel flexure plates to transmit gravimetric loads from the belt vertically through levers. As the strips pass over the conveyor scale, the instantaneous belt speed and belt loading values are measured and their signals combined and integrated. Further processing of the combined signals produces a current signal proportional to the rate of material flow. The belt loading is determined by a weight transducer which produces a DC voltage output with an amplitude proportional to load.

Calibration: The Thayer weigh belt needs little maintenance, but it should be re-zeroed every day, and re-spaned every week.

Because of the given even flow and relatively consistent depth, moisture meters are usually placed over weigh belts.

Size: Thayer weigh belts are available from 500 lbs/hr up to 30,000 lbs/hr. The respective bulk densities for each tobacco type have to be considered.

c. Throughput Control

There is an optimum load range for every weigh belt. If this value is exceeded, the metering device built up on this basis will become less accurate. Since the tobacco more or less tends to form lumps, it is sensible to install a device for metering the tobacco volume in front of the device, metering the tobacco flow. Because a feeder, from its way of construction, is a device for metering the volume and because the accuracy of the volume is dependent on the tobacco level in front of the incline belt of the feeder, the solution for metering already loosened strips could read as follows:

- Control the tobacco level in front of the incline belt to a constant level by means of an electric eye, which regulates the bottom belt.

- Choose a separate drive (D.C. motor) for the incline belt and for the weight belt and control their belt speed so that the tobacco flow discharged is constant.

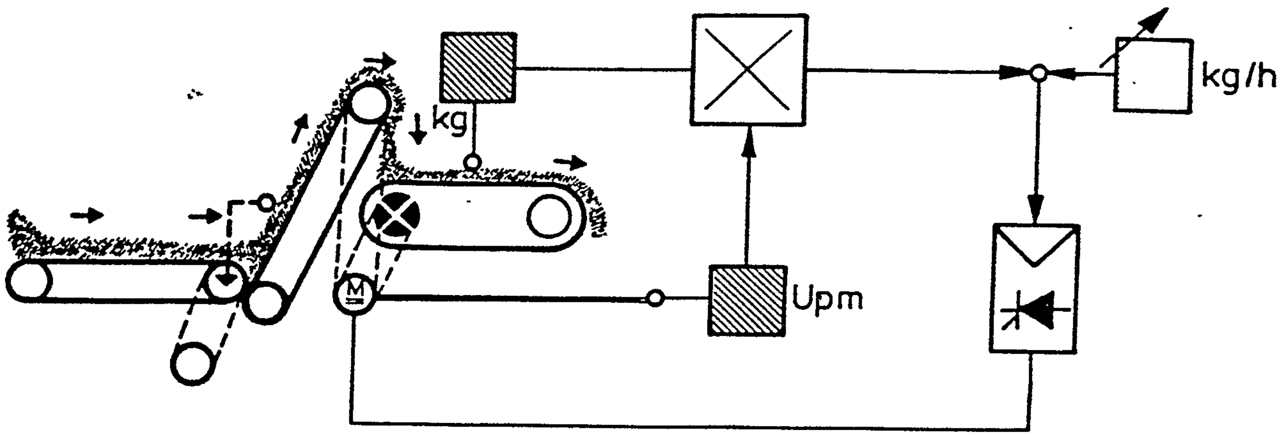


FIGURE 13: METERING OF TOBACCO ALREADY LOOSENED (COMBINED DRIVE FOR WEIGH BELT AND INCLINE BELT)

d. Pre-Blending Box

In some cases, a pre-blending box prior to the total blend silo can be necessary. This box

- can increase the flow rate to the bright casing cylinder by storing the flow for a certain time
- ensures that even the smallest blend components are spread in complete layers in the total blend silo
- doses the flow to the bright casing cylinder instead of just a feeder.

Construction and Operation

The pre-blend box consists of a box with base conveyor and attached feeder. Feeding is carried out by a trolley which moves to and fro. The belt on the trolley always runs towards the feeder and spreads the tobacco in thin layers onto the bottom belt.

2059485397

The discharge time of the bottom conveyor in the box and the duration of the travelling conveyor of the total blend silo are brought into relation so that every component results in complete layers.

4.3 Pad Removal/Separators

a. Process

Ordered strip is passed through a separator to open leaves and to remove pads and stems from the strips. Frequently, 2 or 3 separators are placed parallel to handle the total line throughput. Light material which is accepted is conveyed to the preblend silo (if applicable). In a Bright or Burley line, the heavies are dropped from the separator and conveyed to a screen to separate pads from stem. Other plants use shaker screens. The pads that pass over the screen are returned to the ordering cylinder to be opened. The smaller material that passes through the screen is recycled to the separator. Since there are no stems in reconstituted sheet, the separator in this line does not have screens on the heavies recycle stream.

Problem: Because some heavy pads and other heavy material such as wood are not loosened up by recycling them, they continue to be recycled. The only way to get them out of the process is that the dropping belt of the separator is reversed after a line is finished.

b. Separation Goals

- The strips should flow in the air and not strike the wall. The heavies or pads might hit the wall but not the lamina.

- The tobacco should tumble in the separator, thereby giving stems the chance of separating from larger pieces of lamina; frequently stems are embraced in curled lamina and tumbling in the chamber can improve the separation.

- To keep the moisture in the leaf, the tobacco temperature is decreased relatively quickly in the separator to approximately 90°F.

- It is important to get all pads to drop out and perhaps therefore some good product too, rather than having some pads in the process.

c. Separator Models

There is a variety of separator manufacturers, however, the CARDWELL PAL, AMF LES and the Philip Morris separator are used in many Philip Morris primaries. Figure 14 shows the Cardwell separator principle.

The following table contains typical design and operating rates for a 36" Cardwell PAL separator.

Tobacco Rates for 36" Cardwell PAL Separator

Strip Type	Maximum Rate LB/Hr	Optimal Operating Rate LB/HR
Bright	7500	6000
Burley	5700	4500
Turkish	8000	6500
RL/RCB	5500	4500

2059485399

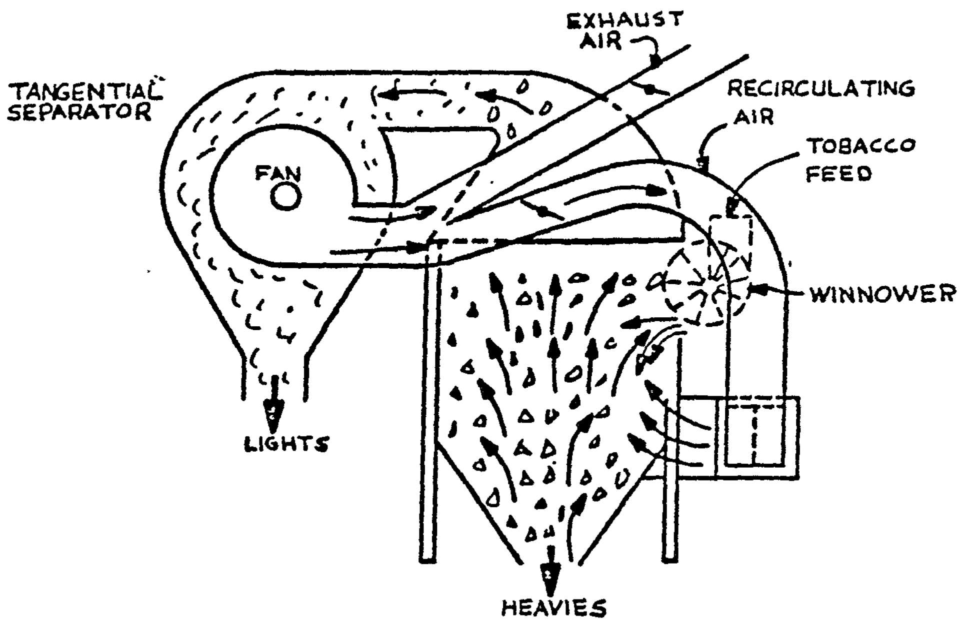


FIGURE 14: CARDWELL PAL SEPARATOR

These rates were determined from Philip Morris' experience with different types of strip for these separators.

Loading

It is crucial for optimal operation of a separator, that

- it is loaded at a consistent flow
- it receives the correct amount of tobacco

As Figure 15 shows, the separator efficiency decreases sharply with the loading rate. Separator efficiency is defined here as

$$\frac{\text{real removal of undesired pieces}}{\text{theoretical removal of all undesired pieces}}$$

and it is a measurement of how "good" a separator works.

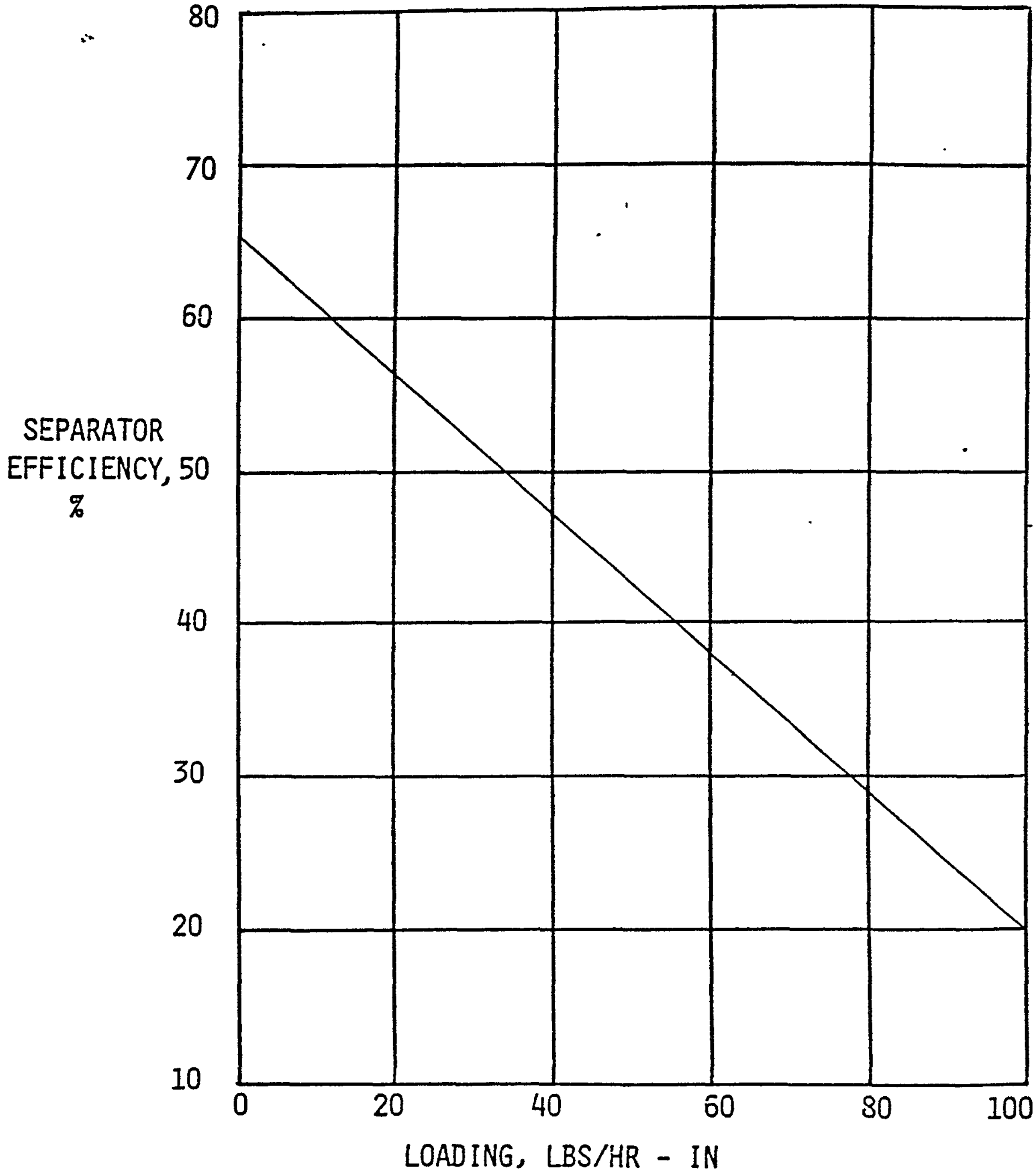


FIGURE 15: SEPARATOR EFFICIENCY VS. LOADING

2059485401

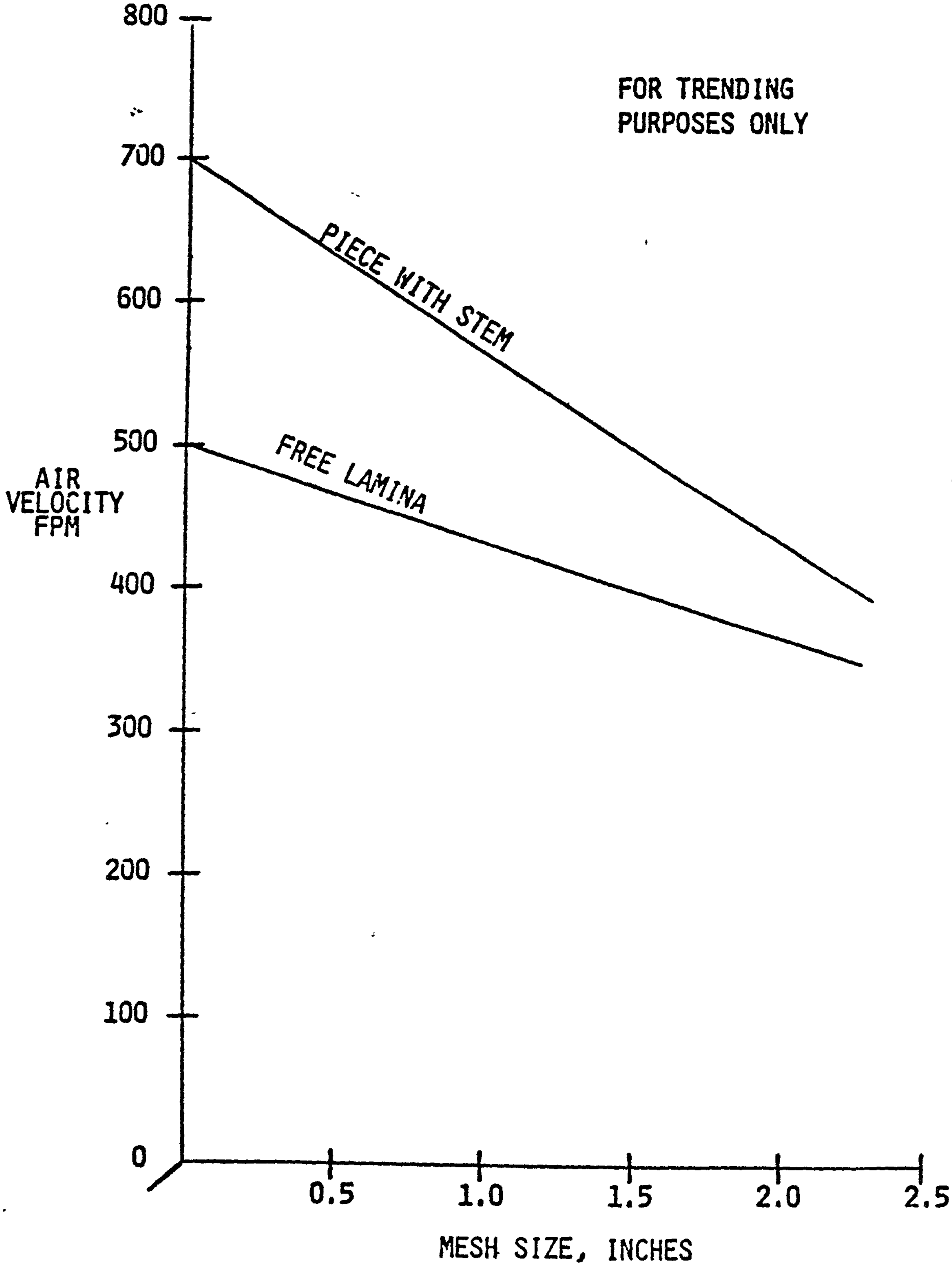


FIGURE 16: FLUIDIZATION VELOCITY VS PIECE SIZE

d. Air Distribution

The air flow in the separation chamber should be as even as possible. The manufacturer's specifications usually give information about the air distribution in an empty chamber. The air flow must be set while checking the difference in the tobacco that is carried by the air and the tobacco that is dropped out. For every different type and grade of tobacco, a different air setting will be required. From day to day a slight change in the air velocity might be needed, this is usually caused by a change in air humidity or temperature.

As Figure 16 shows, the air velocity required to fluidize a small piece of lamina is greater than the velocity required to fluidize a large piece. This holds only, if the density of both pieces is the same.

Furthermore, as the piece size increases, it is harder to use air to discriminate between a piece containing stem versus a piece without stem.

Adjustment: The air flow settings are usually determined from subjective judgements of minimizing the amount of pads in the accept stream and the amount of free lamina in the reject stream.

Air Legs

Air legs can generally be used for small volumes (maximum 2500 lbs/hr) to bring out the heavies in a tobacco flow. To improve the separation efficiency 2 or more air legs are arranged in a row, the second and further air legs serving as a backup.

4.4 Conditioning by Cylinders

The first processing step in opening strip is raising the moisture to about 17 to 21% OV. This is accomplished with an ordering cylinder.

a. Function

Through steam/water mixing jets and sometimes additional steam spray pipes at the cylinder inlet, all of the moisture applied is a mixture of steam and water, to which the tobacco is subjected right at the beginning of its stay in the cylinder.

Steam condenses on the surface of tobacco transferring the heat from the steam to the tobacco. This heat transfer leaves hot water behind which soaks into the leaf and raises the moisture level.

The recirculation air loop is optional for the cylinder and has been removed from cylinders at some locations. Tobacco has a dwell time in a cylinder of about 2 minutes. During this time the tobacco is raised, dropped, and mixed by four rows of pins, usually placed in a spiral pattern the length of the cylinder.

For some types of tobacco which are difficult to moisten (with resinous surface), additional heating of the drum wall can help to obtain a further increase in tobacco temperature. Figure 17 contains a schematic of an ordering cylinder.

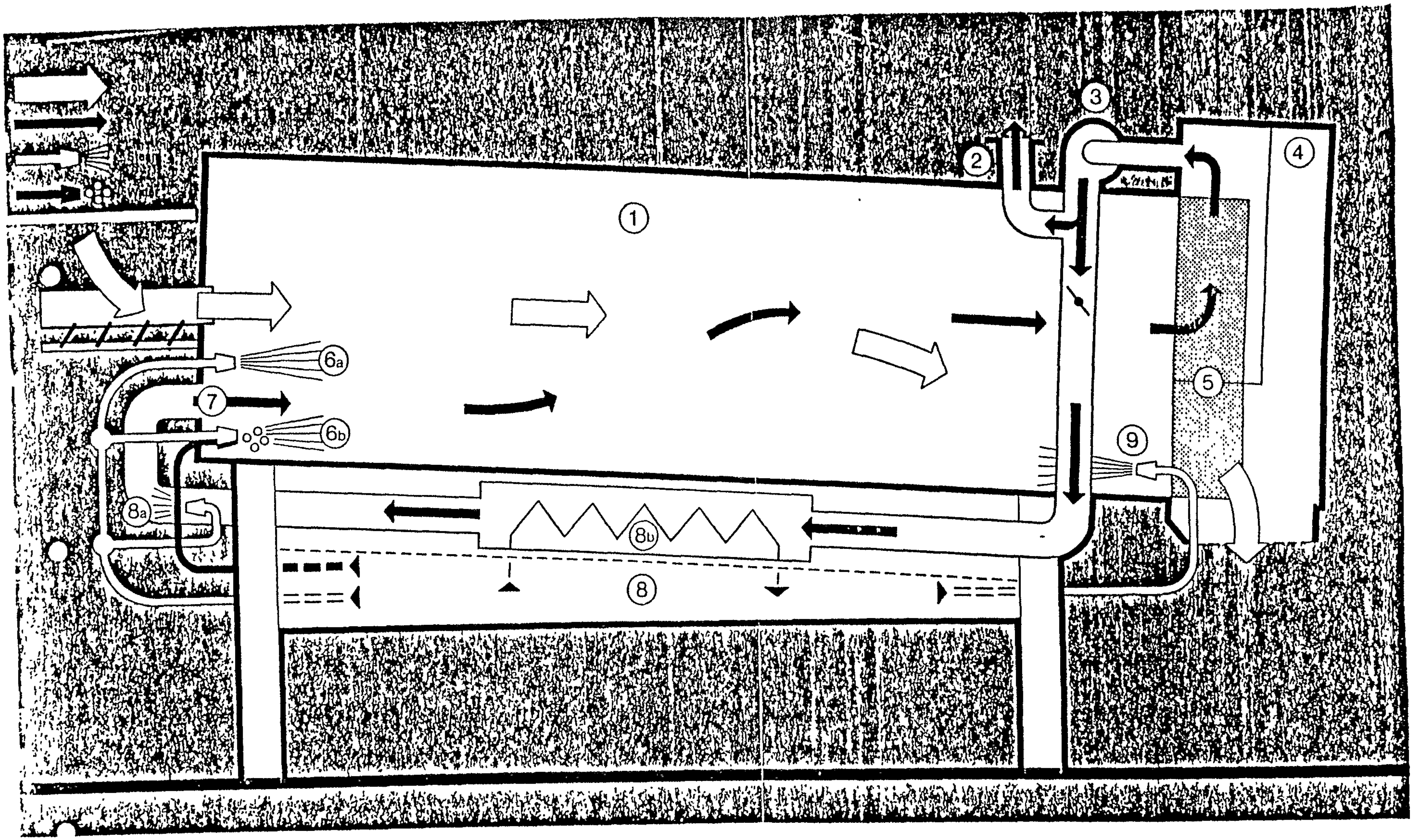


FIGURE 17: SCHEMATIC OF AN ORDERING CYLINDER (HAUNI WH)

The following table shows average bulk densities of strip exiting the pre-blend ordering cylinder.

Strip Type	Density LB/CU. FT.	% OV Of Sample
Bright	4.0	19.0
Burley	3.5	24.0
Turkish	6.4	17.4
RL	3.0	18.8
RCB	4.6	18.4

b. Tobacco Moisture and Automatic Control

With every conditioning cylinder, the control of final moisture is dependent on the following parameters:

1. Dispersion of tobacco mass flow at drum inlet

2. Dispersion of volumetric flow of water addition

To reduce the dispersion of the final humidity, the following measures are appropriate, according to the desired results:

1. Dosing of the volumetric flow of water

2. Dosing of the mass flow of tobacco

3. Control of water addition by an installed moisture meter

Figure 18 shows how a conditioning drum could be controlled: The metering pump for water spraying is controlled by a moisture meter installed in front of the cylinder.

In case water is injected at both inlet and discharge end, the system can be controlled as follows:

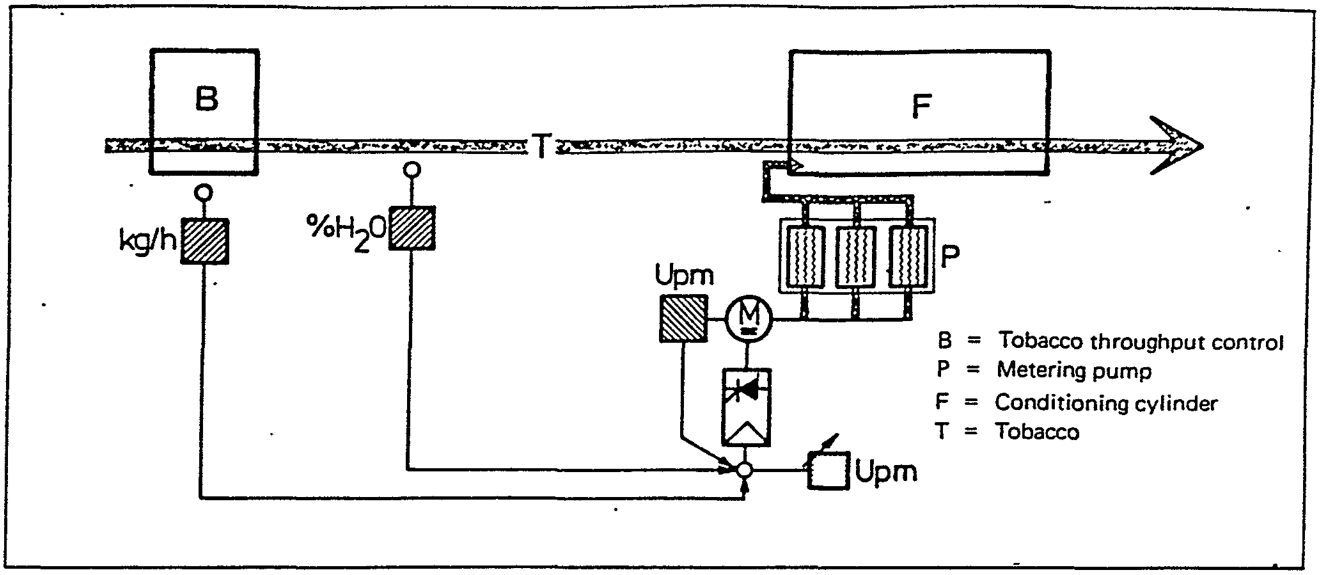


FIGURE 18: CONTROL OF A CONDITIONING CYLINDER

- At the entrance end the amount of water is set manually (approximately 0-0.3 gpm)
- The addition of water at the exit end is dosed by a moisture meter downstream the drum

Steam can be controlled by the air temperature measured in the hood at the exit. Sometimes a determined "ratio" can be adjusted at the control panel, i.e., the relation of injected steam between inlet and discharge end. This ratio also influences the retention time of the tobacco in the drum.

c. Sizing Rotary Cylinders

Sizing of cylinders has been based on rules of thumb and experience. The following are three different ways of how a rotary cylinder can be sized:

(1) Figure 19 and 20 show how drum diameter and length can be roughly estimated: The diameter is given as a function of the tobacco mass flow, the length as a function of type of tobacco.

(2) Cube root procedure:

If the optimum feed rate of an existing cylinder is known, and the new cylinder is to be used for the same purpose, the length and diameter of the new cylinder dimensions can be determined using the following formula:

$$D_2 = D_1 \sqrt[3]{\frac{FR_2}{FR_1}}$$

$$L_1 = KD_1$$

$$L_2 = KD_2$$

Where: FR_1 = Optimum feed rate of existing cylinder [lb/hr]

FR_2 = Desired feed rate of new cylinder [lb/hr]

D_1 = Diameter of existing cylinder [ft]

D_2 = Diameter of new cylinder [ft]

L_1 = Length of existing cylinder [ft]

L_2 = Length of new cylinder [ft]

K = Ratio of length/diameter

2059485408

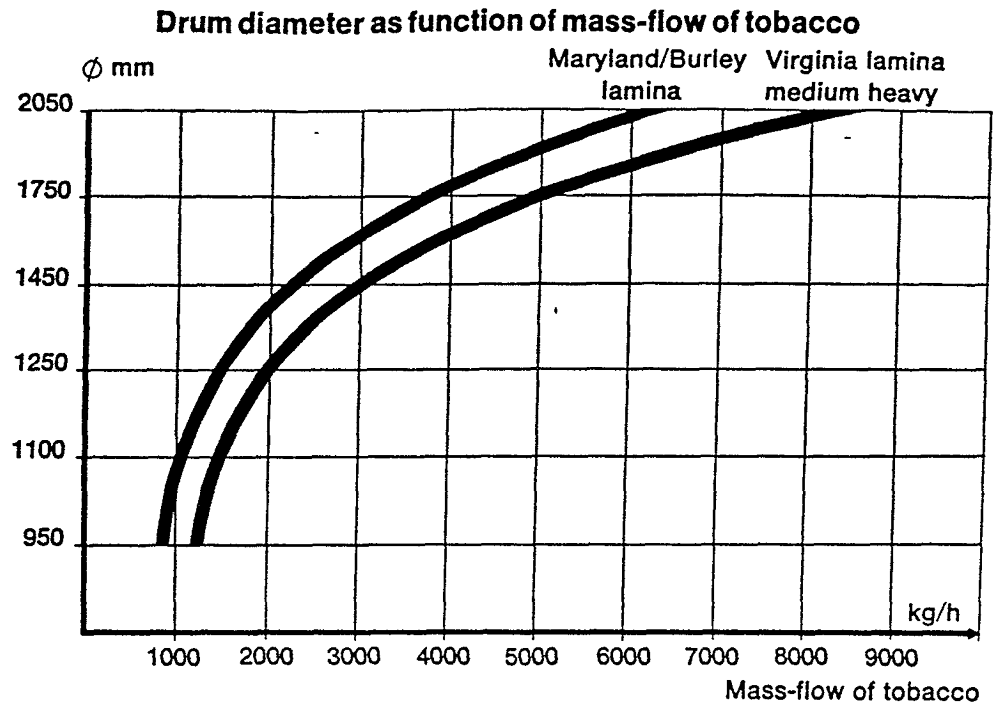


FIGURE 19: DRUM DIAMETER AS FUNCTION OF MASS FLOW TOBACCO (HAUNI)

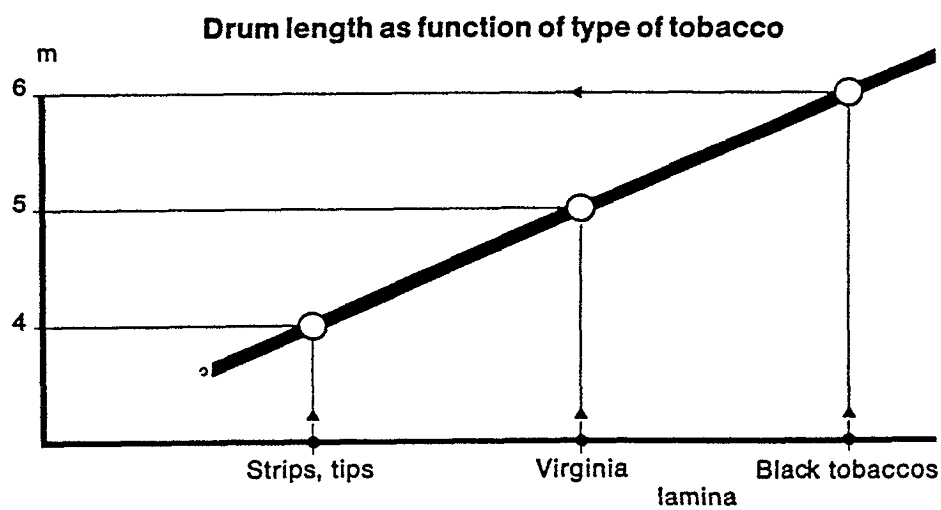


FIGURE 20: DRUM LENGTH AS FUNCTION OF TYPE OF TOBACCO (HAUNI)

2059485409

Example:

An existing 2' x 8' ordering cylinder processes bright strip (4.2 lb/ft^3) at an optimum feed rate of 150 lb/hr. It is desired to increase feed rate to 10,000 lb/hr. What size cylinder would be required?

1. Maintain the same L/D ratio of 4/1.

2. Maintain the same residence time.

3. $D_2 = D_1 \sqrt[3]{\frac{10000}{750}} = D_1(2.37) = 2(2.37)$

   $D_2 = 4.74$ ft.

   $L_2 = 4D_2 = 4(4.74) = 19$ ft.

4. Choose a 5' x 19' cylinder. A diameter of 5' was selected; however, a fractional diameter such as 4' 9" could have been selected.

5. Slope is 1" per foot, which is industry standard.

6. Choose flights using section 4.4 d. The new cylinder will be 5' diameter so three staggered pin flights should be used with a pin radial height of 6".

(3) Vendor's Procedure:

Another method, used and considered conservative by vendors of drums, is to assume a residence time and calculate the volumetric holdup (see 4.4 d.) using the product density. The volume of the cylinder is sized so that the holdup is less than or equal to one-third of the volume of the cylinder.

- Given: material properties, process, feed rate
- Cylinder slope be 4°-6°, or 0.84-1.26 inches per foot
- Residence time is assumed based on experience
- Volumetric holdup is calculated - this is 33 1/3% of the volume of the cylinder so the volume of the cylinder can be calculated.
- Using the volume of the cylinder, vendor selects a cylinder diameter based on experience, but also using an L/D ratio of 4 as a guideline.

  Note: Diameter can be calculated directly knowing the volume of the cylinder and using an L/D ratio of 4 by this formula:

$$V = \frac{\pi D^2 L}{4} = \frac{\pi D^2 (4D)}{4} = \pi D^3$$

Where: V = Volume of cylinder [ft^3]

D = Diameter of cylinder [ft]

L = Length of cylinder [ft]

- Cylinder length is then selected to satisfy the volume of the cylinder.
- Select flights using Section 4.4 d.

Example:

1. Material is bright strip with 4.2 lb/ft^3 bulk density

2. The process is ordering.

3. Cylinder slope will be 1" per foot.

4. Desired feed rate is 10,000 lb/hr.

5. A two-minute residence time is assumed based on experience.

6. Volumetric holdup = $\frac{(10000\ lb/hr)(2\ min.)}{(60\ min/hr)\ (4.2\ lb/ft.^3)}$ = 79.4 $ft.^3$

   Minimum volume of cylinder = $\frac{79.4}{33\ 1/3\%}$ = 238.1 $ft.^3$

7. Diameter = $\sqrt[3]{\frac{238.1}{\pi}}$ = 4.2 ft., use 4 ft.

8. Length = $\frac{(238.1)(4)}{(4)^2}$ = 18.9 ft., use 19 ft.

9. Use three staggered pin flights; pins should be 6" long and spaced 8" apart.

d. Cylinder Parameters

Flights

Flights are necessary to give the tobacco a forward motion in the drum: When material is dropped a distance equal to the drum diameter, it is advanced an amount equal to the diameter multiplied by the slope of the drum.

from Griffin & Company gives comes the following rule of thumb: With a cylinder slope of one inch per foot, tobacco will move forward 3-4" per revolution, regardless of cylinder diameter. Generally, pin flights are used for strips. They are staggered to aid in opening of the tobacco. The infeed end can have a 2 feet section of curved solid flight and the discharge end can have a 2 feet straight section of solid flight with the solid sections being the same radial height as the pins.

Possible flight arrangments:

Cylinder Diameter (ft)	Pin Radial Height (in)*	# Staggered Flights
2	3	3
3	4	3
4-5	6	3
6-7	8	3
8	8	4

*Note: If solid flights are desired, use the same radial height as for pins.

Some primary people are skeptical of pins. Generally, pins tend to tear up the lamina. However, whole leaves or large pieces of strip may get clumped in the drum like a rope without pins. In some locations pins have been replaced by curved flutes running through the whole cylinder or by rounded baffles.

Residence Time

The average time of passage of tobacco through a cylinder is about 2 minutes. Residence time is effected by cylinder length, diameter, slope and rpm. It can be calculated by dividing the equilibrium holdup in the cylinder by the feed rate. It can also be determined by measuring the time of passage of strips of paper (one vendor reports he uses a one dollar bill).

Holdup

H = FT

Where: H = Holdup [lb]

F = Feed Rate [lbs/hr]

T = Average Residence Time [hr]

It is widely acknowledged, that the holdup should not exceed 35% of the volume of the cylinder.

Experimentation indicated, that

- Holdup decreases with increasing rpm
- Holdup increases with increasing feed rate
- Holdup increases with decreasing slope
- Holdup increases with longer flights

Cascading

That is the showering of tobacco from the cylinder flights as the cylinder rotates. With clockwise rotation, cascading should begin at about 9:00 o'clock and end at about 11:00 o'clock with the majority occurring at about 10:00 o'clock.

- tobacco should land at the bottom center at about 5:00-7:00 o'clock.

RPM

The industry standard is 18 rpm, minimum 10-12 rpm, maximum probably about 25 rpm. RPM should be such that optimal cascading is achieved.

L/D Ratio

Length/diameter ratio; industry standard 4 to 1.

Insulation

Experiments show, that up to 175-200 BTU's are lost per sq. ft. per hour if cylinders are not insulated. The temperature inside the drum was 175°F, outside 60°F, and the drum surface temperature was 85°F.

These heat losses vary with ambient temperature, however, they can be minimized by insulating drum, hood, doors and recirculating air ducts. Whether insulation is economical must be determined from case to case.

Nozzles

External mix nozzles are used to spray the steam and water mixture. The cylinder is equipped with guns carrying 1 to 4 nozzles at each end of the cylinder. More important than the number of nozzles is their arrangement: The steam/water mist shouldn't hit the cylinder walls and the atomization should be as fine as possible.

5. Burley Casing and Drying

5.1 Purpose of Burley Treatment

Since Burley contains little natural sugar, the purpose of the special Burley treatment, i.e., Burley spray addition, is to apply a solution of sugar and other flavorings so the Burley will blend well with the other tobacco components. In applying the Burley spray the moisture content of the Burley is raised to about 35% OV and, thus, the Burley must be dried back down to near the cutting moisture before it receives a final casing in the total blend area.

The drying back also gives the Burley its own particular fragrance and taste; air temperatures above 212°F/100°C are required to achieve this. Quality goals in the Burley treatment:

- uniform application of the casing
- adhesion of the casing on the strips, i.e., solids of the casing must cling to the tobacco
- even drying back to around cutting moisture

5.2 Burley Spray

a. Process Description

A sketch of a typical Burley spray system is shown in Figure 21. DBC Burley at a moisture content of 19 to 20% OV exits the preblend silo across a flow controlling weigh belt so that a constant flow of Burley is achieved. The moisture of the Burley is measured by a moisture meter and this

2059485417

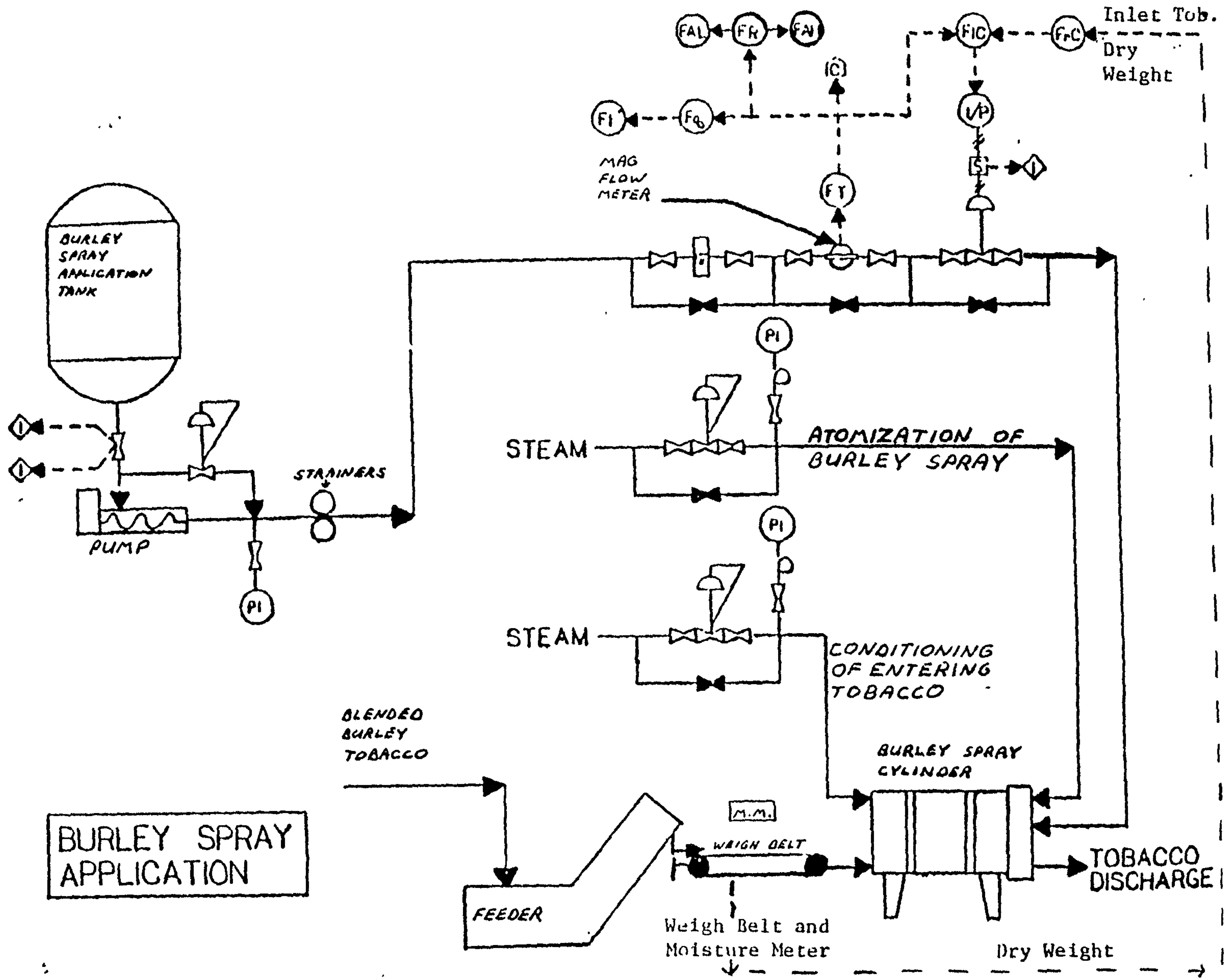


FIGURE 21: BURLEY SPRAY APPLICATION

2059485418

moisture signal is combined with the weight signal from the weigh belt to achieve a dry weight signal. (This can be done by a local dry weight computer or in a central process control computer.) This dry weight tobacco signal is the basis for the Burley spray application. From the blend formula the gallons of Burley spray per 1000 lbs of dry weight Burley is determined. This can be entered as a ratio in the process computer and this ratio times the dry weight signal produces the set point for controlling the Burley spray application.

b. Spray Application

The Burley spray has been mixed in a flavor room, pumped to an application tank, and maintained at its 180°F application temperature. The spray is applied using a progressive cavity pump such as Moyno. Flow is measured using a magnetic flow meter, and the flow is varied by either changing the pump speed (new method) or by modulating a control valve (old method). The spray is atomized using about 60 psig steam. Steam is also applied through a nozzle at the tobacco entrance end of the cylinder to heat the Burley so it is more receptive to the Burley spray.

It can become difficult to achieve a uniform application if the size of the casing cylinder is too small (for sizing a rotary cylinder see section 4.4.c.). Two values, the amount of tobacco in the cylinder at any time expressed as a percentage of the total cylinder volume and the residence time for the tobacco in the cylinder have to be determined and compared to predetermined target values.

Targe values (based on M/C data):

- 12.8% full
- 1.4 min residençe time

c. Spray Nozzles

Several different types of nozzles have been used for spraying the Burley. The most commonly used nozzle is the Spraying Systems Co. external mix Model 1/4J set-up E45 nozzle assembly.

A typical nozzle installation is shown in Figure 22. High capacity external mix SCHLICK nozzles (Model 854/0) have also been tested and produced good results. These nozzles have the advantage of being mounted in the hoods at either end of the cylinder and do not extend into the area of the falling tobacco. These nozzles will also spray a higher density casing than most other nozzles.

The Burley spray liquid is somewhat viscous and contains a rather high concentration of undissolved particles. It is necessary to pass the spray through strainers before the nozzles to prevent them from plugging. The spray piping from the application tank to the cylinder must be heat traced to maintain the desired 180°F application temperature. The weight of the dry solids in the Burley spray is equal to more

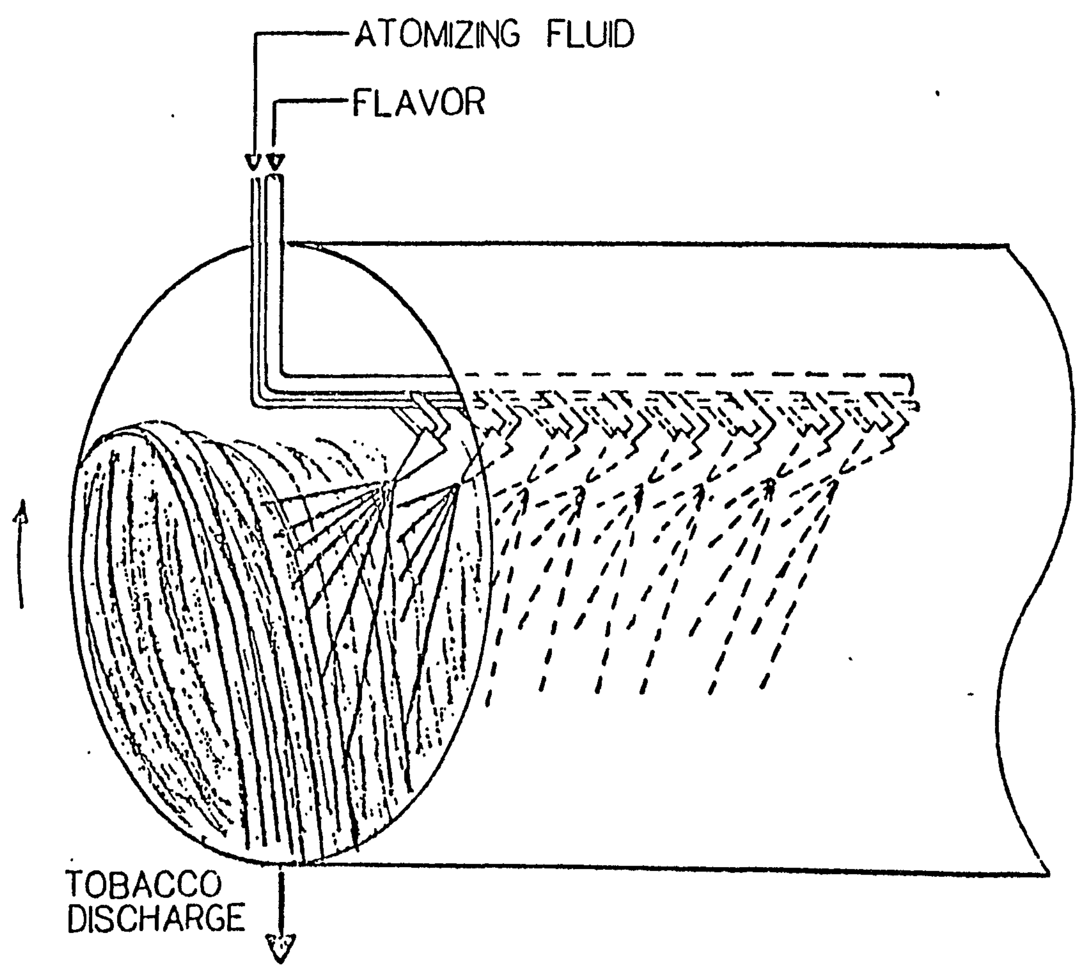


FIGURE 22: TYPICAL NOZZLE ARRANGEMENT

than 20% of the weight of the dry tobacco entering the cylinder. If the CTB (class tobacco on Burley) process is implemented, this weight gain from the Burley spray will be even greater. This process involves the mixing of class tobacco with the Burley spray and spraying this even more viscous, more solid laden liquid on the Burley.

d. Potential Burley Spray Problems

(1) Frequently inconsistencies in the spray and long cooking times for preparing spray batches can be noticed.

To solve these problems

- larger cook tank mixers
- manual temperature control valves for the steam flow to the cookers
- a sufficient steam supply
- temperature indicator in the tank can be helpful

(2) One problem with Burley spray is the production of extremely wet balls of Burley. These balls result from some tobacco adhering to the cylinder walls and remaining in the cylinder until sopping wet and then falling off. They are also produced by tobacco hanging up on the nozzle assembly that extends into the cylinder. Some of our European affiliates such as PM-Munich have successfully solved this problem by using hood mounted nozzles

and a cylinder wiper system.. Although similar nozzles have been tested with some success by Philip Morris U.S.A., the wiper system design failed possibly because of longer cylinder lengths and different pin arrangements.

5.3 Burley Dryers

Several alternative dryers could be used for Burley instead of single pass apron dryers.

a. Fluidized Bed Dryer

Principle: A fluidized bed is a layer of granular or fibrous material through which air steams upwards at a speed, lifting the particles slightly but not carrying them away.

This condition equals that of a layer of bubbling liquid, the reason why this layer is also called fluidized bed. Transmission of heat and substance (i.e. water) is very intensive at this condition and intermixing is carried out continously.

Small zones with increased air speeds and slightly pulsating air currents are additionally produced, so that the tobacco, which can not be classed as pourable material, forms a stable fluidized bed. The tobacco fibres are not damaged since they are carried on a cushion of air.

Continuous conveyance of tobacco is achieved because the fluidized bed trough is the conveying means of a vibratory conveyor.