Cigarette Manufacture

by Heinz-Christen Lorenzen

The manufacture of plain cigarettes starts with the transport of cut tobacco from the primary department to the cigarette maker. As a rule, pneumatic conveying systems are employed. So the entrance to the maker is an air-lock to separate the tobacco from the driving air stream. Out of the air-lock, the tobacco drops in portions of about 4 kilograms into the distributor (hopper). The distributor is equipped with means to:

- ☐ form a uniform tobacco flow;
- ☐ open bulks and generate single fibres;
- ☐ and to eliminate foreign parts and stems from the cut rag.

To achieve these results, the tobacco in todays makers has to go through the following procedure. Once out of the air-lock, the tobacco drops into a predistributor, which feeds small portions into a reservoir. From here a steep-angle conveyor belt armed with needles or spikes continuously feeds the tobacco into a bulking chute. At the downstream end of this chute a discharge roller armed with needles picks up the tobacco.

A level sensor in combination with a speed control of the steep-angle conveyor keeps the level in the chute constant so the pressure against the discharge roller, and consequently the amount of tobacco picked up by the needles, is uniform. The bulking chute, therefore, generates a continuous flow of tobacco.

At the next stage, a relatively fast rotating picker-roller combs the tobacco fibres out of the discharge roller onto a fast moving distributor belt. This operation leads to the desired distribution of single tobacco particles, necessary for the subsequent separation of winnowers and for the formation of a uniform tobacco rod.

The winnowers mainly consist of veins and stems of the tobacco leaf. The difference in the ratio of the particles mass to their aerodynamic resistance enables an air stream to separate the winnowers by blowing rectangularly against the moving tobacco particles.

The tobacco rod is formed by a narrow conveyor belt of about 8 to 10 millimeters width moving quickly cross ways to the direction of conveyance in the distributor, the width of which is about 800 millimeters.

To form a tobacco rod, the fibres are accelerated upwards by an air stream, which partly or completely passes the permeable rod conveyor belt. So the air stream first accelerates the fibres and than keeps them on the fast moving rod. In some machines a rotating roller supports the upward acceleration of the fibres. Hence the forming tobacco rod "hangs" on the under side of the belt, which facilitates the subsequent transfer of the rod onto the cigarette paper.

The cigarette paper is unrolled from a bobbin, which as a rule carries 7000 meters of web. On the cigarette maker the paper passes through a device which prints it with the required brand name.

The tobacco rod and the cigarette paper are simultaneously pulled through a so-called garniture section by a garniture tape. Whilst passing through the garniture, the tape and the paper are bent around the tobacco thus forming the cigarette rod. A so-called tongue ensures that the tobacco is directed into the rod-forming section. The tongue is the most essential part of a cigarette maker. Only very precise moulding and adjustment of this part gives satisfactory performance.

Just before the paper is bent completely around the tobacco, one edge of the paper web is glued. Mainly two types of glueing devices are in use:

- ■ the disk- or wheel-type paster
- ■ and the nozzle-type paster.

The disk-type paster is used for starch glue. This glue has only a short life and hence has to be prepared a short time before application. Additionally, the disk-type paster is more complicated mechanically. So today there is a tendency in favour of the nozzle-type paster. This system applies PVA-glue (PVA = polyvinyl acetate) which is supplied in an applicable form and can be stored.

Coming back to the rod forming procedure, after glueing, a seam sealer (a heated bar) sets the glue and completes the cigarette seam.

The continuous rod is cut into pieces of a desired cigarette length. Due to the fast moving rod on one side and the cutting operation taking a certain time on the other, the knife has to make a complex movement in order to generate a straight cut.

If one compares modern cigarette makers, which are capable of producing 8 000 cigarettes per minute, with machines in use before 1960, there are two essential features which caused the breakthrough to high-speed production of cigarettes. These are:

- ■ the forming of the tobacco rod by means of an air stream through a permeable belt
- ■ and the trimming of the tobacco rod.

Although the distributor is able to produce a uniform tobacco flow, present demands for low deviations in cigarette weights can only be satisfied by trimming the tobacco rod just before it is transferred into the garniture section.

The rod is therefore formed by using more tobacco than actually needed. The surplus is then cut off by a trimming device. An interesting feature of todays makers is the so-called condensed-end device. In this case the trimming device is fitted out with recesses so that small piles of tobacco are periodically formed. Synchronization with the cutting process results in condensed cigarette ends, which prevent the tobacco from falling out during the subsequent addition of a filter or during packaging.

The wish to produce uniform cigarette weight led to "Automatic Feed-Back-Control" of the cigarette making process, which is another feature of modern makers. The weight signal is generated by beta ray absorption in the tobacco rod in such a way that more or less tobacco causes less or more electrons to find their way into an ionization chamber, where they generate a lower or higher electric current. This signal is fed into a control unit which again controls the trimming device.

In addition to mean weight control, modern control equipment fulfils the following:

- ■ identification and elimination of cigarettes which are too light or too heavy;
- ■ identification and elimination of cigarettes with soft spots in the rod;
- ■ continuous display of the standard deviation of the cigarette weights;
- ■ control of the synchronization of end densening and cigarette cut;
- ■ automatic target weight shifting due to the actual standard deviation;
- ■ acquisition and display of data needed to check the machines performance and condition.

The following procedure is now the generally accepted method for the manufacture of filter cigarettes.

A filter plug twice as long as the final filter tip is put between two tobacco rods (plain cigarettes) coaxially. Subsequently, a glued piece of tipping paper is wrapped around these components. The width of the tipping paper corresponds to the length of the filter plug plus twice the width of a desired overlap for each tobacco rod. The overlap should be 4 mm at least. Finally a separating cut in the middle gives two single filter cigarettes.

The rod making machine (see manufacture of plain cigarettes) and the filter tip assembling machine are linked together and form an integrated unit. One typical feature of a tip assembler module is a great number of rotating drums equipped with grooves. Tobacco rods and filter plugs are kept in these grooves by vacuum and conveyed crossways to their axis through the machine.

As the tobacco rods coaxially leave the rod maker, one rod behind the other without a gap, the first problem to solve is to form the configuration rod-gap-rod and transform the direction of conveyance from axial to crossways.

The following procedure for high-speed production is beginning to be the generally accepted method.

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The cigarette maker delivers double-length tobacco rods to a spider-drive, so-called because of its seven leg-like structures. These "spider legs" pick up the double-length rods and transfer them to the first drum of the filter tip assembling machine. Hence the problem of changing the direction of conveyance from axial to crossways is solved very gently. The tobacco rods are cut into two pieces of equal length on a second drum, and pulled apart on a third drum so that a double-length filter plug can be placed into the gap.
As the handling of short plugs is difficult and inconvenient, the generation of double-length filter plugs starts with filter rods of four or six times the length of the final cigarette filter. These rods are fed from a hopper into a system of drums which separate, cut and arrange the rods in the required manner necessary for inserting double-length filter plugs into the gap between the tobacco rods.
The tipping paper most currently in use is imitatation cork. It is unrolled from a bobbin which usually carries 3000 meters of web. After glueing, the web is cut into lengths corresponding to the cigarette circumference plus a desired overlap to form the seam which is usually 2 millimeters. The leading edge of the glued leaf of tipping paper is pressed gently onto a surface line (generatrix) of the rods.
All parts are then transferred to a so-called rolling drum. The rods roll backwards on the surface of this drum, and in this way all parts are combined. The rolling operation is started by a so-called rolling block.
The rods are cut in half on the following drum, giving two final filter cigarettes of equal length. A turning drum transfers all cigarettes to one track all filters pointing in the same direction. Filter tip assembling machines are equipped with inspection devices as a rule, which indicate leaks, missing plugs, loose ends, rough cuts etc., and eliminate faulty cigarettes.
As ventilated cigarettes are rapidly becoming more important the manufacture of ventilated filter cigarettes is worth mentioning. Ventilated filter cigarettes are equipped with a zone of desired permeability so that a side stream of air dilutes the smoke.
The method of manufacture today still most currently in use applies preperforated tipping paper in combination with a permeable filter plug wrap.
The perforation is carried out by the paper supplier in such a way that two lanes can be seen on the tipping paper, each lane showing one or more rows of visible or invisible perforations.
The glueing device in the tip assembling machine has to be modified into a so-called skip-tip glueing unit which ensures that the perforations are kept free of glue.
The application of preperforated tipping paper excludes control of the wanted degree of ventilation and flexible shifting of targets.
To avoid this and other disadvantages, online perforation equipment is becoming increasingly popular. On-line means that the perforation is carried out on the tip assembling machine. In this field one method is especially worth mentioning. This equipment drills the vents through tipping paper and plug wrap on the finished filter cigarette by means of a laser beam at full production speed.
In addition to the description of cigarette manufacturing processes some remarks relating to trends in cigarette manufacture in general may be of interest.
When considering the development of cigarette making equipment, certain features are especially conspicuous:

- considerable increase in speed;
- the elimination of manual operations by automation;
- considerable extension of automatic control equipment and;
- automatic acquisition of data and central data processing.

The increase in production speed is characterized by a doubling in 10 years. In 1984 there will be machines in operation producing 8000 cigarettes per minute. It is worth mentioning, that in spite of this increase in speed the noise levels have decreased significantly. Whether the trend to increasing speeds will continue is more difficult to predict now than in the past, especially if unsettled economic conditions have to be taken into account, e.g. further increases in the market shares of smaller brands and changes in the employment situation.
As examples for the elimination of manual operations one might mention:

- the automatic feeding of tobacco and filter rods to the makers;
- the automatic bobbin change;
- the automatic rod breaker or;
- automatic start and stop programming, to name a few.

Automation became necessary when production speeds reached very high levels in order to relieve the operator. As production equipment will grow more and more complex, further automation will be unavoidable.
The considerable extension of automatic control equipment is mainly due to the following:

- running at high speed makes it impossible in case of emergency to stop the machine by hand in due time;
- visualization of the reasons for a breakdown or even better indication of developing trouble reduces down-time of expensive equipment;
- due to rising quality standards in spite of high speed production, automatic quality control becomes essential.

In the future, the field of automatic control will grow further. The equipment of today will be improved with regards to accuracy and reliability.

Systems to indicate developing interferences will be improved and extended. As a tool on the way, central data processing will become increasingly important. ■

Curing Flue-cured Tobacco

by W. K. Collins

The two major objectives in curing flue-cured tobacco are: (1) to provide temperature and humidity conditions which will encourage certain desirable chemical and biological changes to take place, and (2) to preserve the leaf by timely drying to retain the potential quality. Curing is more than drying the leaf. It involves chemical and physical changes which are necessary for high quality tobacco suitable for manufacture and consumer acceptance primarily of cigarette products.
The first requirement in having a good uniform cure is to start with uniformly ripe tobacco. Under normal conditions flue-cured tobacco ripens at the rate of about 2 to 4 leaves per week, thus the normal harvest rate before the use of automatic harvesters was from 2 to 4 leaves per plant per week for a period of 5 to 7 weeks. Many factors can influence the maturity and harvest rate. For example, certain diseases such as root knot nematodes or brown spot, or excessive soil moisture which causes root damage, or failure to top the plants, or heavy sucker growth can increase the maturity rate substantially.
Under extreme conditions it may be necessary to harvest 7 to 10 leaves per plant in a week to prevent some from being lost, but this is not normal ripening and usually is low quality tobacco. On the other hand, dry weather or excessive quantities of available nitrogen may reduce the maturity rate enough so that it correct level of available nitrogen is perhaps the most important because ripening is a partial nitrogen starvation process.
Proper curing is both a biological and a drying process that is controlled by ventilation for humidity regulation coupled with temperature regulation to control drying. A mature tobacco leaf as it is taken from the plant is a complex living system. It normally contains from 80 to 90 per cent water and 10 to 20 per cent solids. About 25 per cent of the solids is starch. The remaining 75 per cent is made up of numerous biochemical compounds, pigments, minerals, cell tissue, etc.
Proper curing preserves the quality of the tobacco in the barn. Poor quality green leaf placed in a barn cannot be improved; however, good tobacco can be cured poorly resulting in poor quality cured leaf.
Unfortunately, it's impossible to define a single temperature and ventilating schedule that will

becomes necessary to skip a week or more of harvesting. Also, some varieties ripen more slowly than others. Among these factors, the suit all tobacco. The moisture content, the body of the leaf, and even the difference among barns make it necessary to follow different curing schedules.

Tobacco from the lower part of the stalk should be cured differently from the leaves at the top. Tobacco harvested during a wet period should have a different curing schedule than leaves harvested during a drought. Tobacco cured in a tight barn needs a different ventilating schedule compared to that cured in an open barn. All of this means that adjustments in the temperature and ventilating schedule are required for each barn of tobacco based on three curing phases – yellowing, leaf drying or colour fixing, and stem drying.

The yellowing phase is by far the most important part of curing. During yellowing, the potential quality of the tobacco is either maintained or lowered.

The leaf drying period consists primarily of stopping the yellowing by rapidly drying the leaf. Leaf drying is accomplished by increasing ventilation and the temperature. If the cure is properly handled during the yellowing period, there should be no problems in drying the leaves without lowering the quality. On the other hand, if the moisture content of the leaf is not lowered sufficiently during the yellowing period, the higher temperature of the leaf drying phase may lower the quality considerably. High leaf moisture content with temperatures of 130 degrees F or higher can darken leaf colour and may result in scalded tobacco, especially in the thinner leaves from the lower stalk positions.

Drying the stem is the only part of curing that remains when the leaf drying period is completed. The quality of the leaf has been largely established. About the only way to lower the quality during the stem drying stage is to use excessively high temperatures or to maintain "killing out" temperatures too long. Experience has shown that extended periods of temperatures in excess of 160 degrees F will increase the amount of red colour in tobacco, especially in some varieties.

The yellowing phase is by far the most critical stage of curing flue-cured tobacco. If this phase of curing is properly managed, the remainder of the cure becomes relatively easy. The yellowing phase usually lasts for about two days starting at the time the leaf is removed from the plant.

When a leaf is harvested it is alive, and it stays alive until it is killed either by drying or by high temperature. During the yellowing period, while the leaf is alive, some very important changes take place, including both chemical and colour changes. Among the desirable chemical changes is the change of starch to sugar. When tobacco is harvested it has a high starch content and a relatively low sugar content, which is undesirable in the finished product. If the yellowing period is properly handled, though, most of the starch will change to sugar. Also, during the yellowing process, some of the sugars are oxidized or broken down and lost. If the yellowing period is extended over an excessively long period, too much sugar will break down, resulting in a loss of quality and weight.

During yellowing, it happens that the change of starch to sugar occurs at about the same rate as the colour change, so that in most cases when the leaves become yellow the change of starch to sugar is complete. When the leaf becomes yellow, then it is killed by drying or by high temperature or a combination of the two, so that no further chemical changes occur.

One of the most difficult parts of curing tobacco is controlling the moisture content of the leaf during the yellowing period. In a successful cure, enough moisture must be maintained in the leaf throughout yellowing to keep the leaf alive so that the desirable chemical and colour changes can occur. On the other hand, enough drying must occur during yellowing so that the leaf will dry without turning dark or scalding when the temperature is increased during the leaf drying period. At the end of the yellowing period the leaves should be dry enough so that they are completely wilted and limp and some of the leaf tips have become crisp.

Unfortunately, no suitable instruments are available for measuring the moisture content of leaves during curing. Determining the correct drying rate must be done by human judgment on the basis of observations and feel of the tobacco during the curing process. The tobacco must be examined as it goes in the barn to determine the degree of ripeness, the body of the leaf, and the moisture content. It may be found that the rate of drying needs to be changed as the yellowing period progresses so that the desired moisture content in the leaf is present at the end of yellowing.

The rate of drying needed during yellowing will vary tremendously, depending upon the tobacco and the weather at harvest. For example, tobacco from the first priming should be dried faster during yellowing than the tip leaves, and tobacco harvested during wet weather should be dried faster than that harvested during dry weather.

The rate of drying is primarily controlled by the air temperature and the amount of dry air that passes through the mass of tobacco. Therefore, the drying rate is regulated by controlling ventilation and temperature. Air temperature in excess of 113° F will kill the leaf, which will stop any further yellowing. The yellowing temperature, then, should not exceed about 105° F for safety reasons.

Ventilation is the major tool used to control the drying rate. If ripe leaves from the lower stalk position are harvested during a rainy period, fast yellowing can be expected. Therefore, fast drying is necessary so that the moisture content of the leaf will be low enough at the end of the yellowing period to prevent scalding. Under these conditions using a conventional type barn, less leaves should be placed on the stick, fewer sticks in the barn, and the top and bottom ventilators should be opened at the beginning of the cure and remain open most or all of the yellowing period. In bulk barns, under these conditions, it is not practical to reduce the amount of tobacco because this may cause non-uniform air circulation through the tobacco mass. However, it would be advisable to start venting bulk barns earlier than normal to achieve earlier drying.

Another problem associated with wet, thin-bodied tobacco is barn rot. This problem develops under humid, warm conditions – usually during the yellowing period. Conditions are less favourable for barn rot development if there is sufficient ventilation to at least keep free moisture from collecting on the leaf surface.

If outside racks are available, the chance of having barn rot develop can be reduced by hanging wet tobacco in the racks until the excess moisture has dried off the leaf.

Tobacco harvested during dry weather, especially up-stalk leaves, presents the reverse situation. The problem then is to keep enough moisture in the leaf so that yellowing can be completed before the leaf is killed by excessive drying. Under these conditions, place a little more tobacco in the barn and keep the vents closed during most or all of the yellowing period to reduce the drying rate. Also, irrigation can be expected to help the curability of tobacco harvested under dry conditions.

Colour of the cured leaf is one of the most important characteristics buyers use to judge the usefulness of tobacco. A good live-appearing orange or lemon colour is usually most desirable. Growers often have a full range of colours in their tobacco which are referred to as off-colour tobacco. Most of the off-coloured tobacco is caused by field production practices to include curing problems some of which will be described.

"Today" tobaccos are slick, dense, sometimes thick and leathery, and have a nondescript smutty, greyish-brown colour. Today leaves have poor grain and are very compact, dry-natured, and starchy. The cause of toadiness is not fully understood, but it has been related to variety, height of topping, and nitrogen rates. A variety first must have a tendency to produce toady tobacco. Then toadiness increases as nitrogen rates decrease and topping height increases. These two practices may be related because an increase in topping height results in an increase in plant growth which may dilute the nitrogen in the plant. Topping lower than currently done may be a way to reduce the quantity of toady tobacco produced, since toady leaves frequently come from the upper part of the plant.

Pale or brown tobacco is often related to the amount of nitrogen available during the growing season. The quantity of nitrogen needed for the production of tobacco with a desirable colour is very specific. In many cases, 10 pounds too little or too much per acre can cause the cured leaf to be off-colour.

Tobacco grown with a shortage of nitrogen will likely be pale and anaemic with poor texture and grain. This type of tobacco is usually most common when leaching rains occur and inadequate nitrogen adjustments are made. On the other hand, too much nitrogen may cause tobacco to turn brown during the curing process.

Dull, ashy-coloured leaves that have low luster and frequently are grey-brown in colour often result from magnesium-deficient or "sand drown" tobacco. These leaves are normal in size and shape, and are usually soft and thin. In the field, magnesium-deficient leaves (except for stems and veins) lose their chlorophyll

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and turn white by first fading at the tip of the lower leaves. This usually occurs after plants have reached considerable size, and most often occurs on very light sandy soils during seasons of excessive rainfall.

Fleck or spotting, which frequently gives a mildew appearance, is related to variety, weather, general growth conditions, and sometimes to air pollution. This spotting is called many names, such as tobacco fleck, weather fleck, and physiological leaf spot. Some varieties are more susceptible to fleck than others.

Almost invariably when a severe case of fleck occurs, associated with it are some undesirable cultural practices such as poor drainage, too little or too much nitrogen, or nematodes. Outbreaks of fleck frequently occur when warm air aloft traps cooler air at the ground level and air pollutants build up. When this condition exists for several days, fleck may be observed over a widespread area. Even so, it usually varies from farm to farm.

Grey lower priming tobacco with whitish stems and veins is caused by excessive quantities of chlorine from fertilizers and fumigants, irrigation water or soil accumulation. Frequently, tobacco containing excess chlorine will also have a noticeably higher moisture content, becomes soggy, and is often referred to as "wetdog" tobacco. Excess chlorine in tobacco lowers its quality and usefulness by reducing the rate of burn and desirability of smoke. About 20 to 30 pounds per acre of chlorine are necessary for best tobacco growth, and this amount will not leave more than an acceptable level of one per cent chlorine in the cured leaf.

Cherry-red tobacco continues to be a problem with some varieties, although plant breeders have made considerable progress in eliminating the genetic factor that causes tobacco to turn red. When a variety has a tendency to turn red, curing temperatures in excess of 160° F appear to encourage it to do so. Cherry-red colour is associated with relatively high quantities of nor-nicotine which gives a bitter taste to the smoke. This is why buyers usually avoid red tobacco.

Scorched tobacco is also associated with high temperatures, especially during the stem-drying period. Scorched tobacco has an abnormal aroma and an off-taste when smoked. Many growers have observed that some varieties have a tendency to scorch much easier than others. And tobacco on the bottom barn tiers is more often scorched than that higher up in the barn. To keep scorched tobacco to a minimum, keep curing temperature at or below 160° F and do not hang tobacco too close to the heating units in the barn. These suggestions are especially important with heating systems that are thermostatically controlled. A continuous excessively high temperature is much worse than one that is maintained only a short time.

Green tobacco is caused by at least three factors – immaturity, insufficient yellowing time, and excessively high temperature during yellowing. A green colour in cured tobacco is an indication to the buyer that the tobacco is of poor smoking quality. Tobacco harvested before it has reached maturity will not maintain sufficient moisture long enough for all of the green colour to be broken down. As a result, the leaf dries with a partial green colour, especially along the midrib and veins. Tobacco that is fully mature when it is harvested can be dried with some green colour if the yellowing period is cut too short.

Continue the yellowing period, with temperatures not exceeding 110° F, until all green colour is gone. If the temperature should suddenly advance to a high level during the yellowing period, the leaf may dry rather quickly. When this condition develops during the early part of the yellowing period, the dried leaf may have a deep-green or "crude-green" colour. This is very undesirable tobacco and should be discarded.

Barn scald is a condition which develops when the leaf temperature reaches or exceeds 130° F before the leaf has dried enough. The tobacco cooks in its own fluids. Barn scald results in brown, tissue tobacco with low weight and poor smoking qualities. This condition most often develops in thin-body tobacco that is spaced so close in the barn that sufficient ventilation cannot be provided, especially if the tobacco is harvested in wet weather.

If thin tobacco is harvested under these conditions, space it wider apart in the barn and provide more ventilation than normal during yellowing so leaves will be sufficiently dry before the time to advance the temperature. Barn scald may be very serious in bulk curing if racks are not filled uniformly from one end to the other. In poorly filled racks, the more tightly packed sections will not get enough ventilation or air movement to provide adequate drying. Higher temperatures then cause scald.

Sponged leaf is characterized by a motley light-brown colour and is caused by a yellowing period that is too long. When the demand was stronger for a flashy lemon colour in tobacco, sponging was more of a problem.

Barn rot is the result of bacterial or fungic action, usually starting along the midribs of leaves in the early stages of the curing process. Affected areas develop a black colour and follow irregular patterns on the leaf. These affected areas are almost worthless from the manufacturers' standpoint. This problem develops most often when tobacco is harvested wet. Wet leaves, especially those from the lower stalk position, should be spaced wider apart in the barn and should be provided with maximum ventilation until the excess moisture is driven out.

Stem runback develops when the leaf tissue is dry and moisture from the leaf midrib runs back into the dried tissue and causes it to turn black. The end result is black streaks along the midrib of the leaf. This condition develops only when stems are dried slowly. To prevent this condition, slowly advance the temperature to 160° F when the leaf tissue is almost dry. Hold temperature constant until stems are dry. ■

Curing Air-cured Tobacco

by Gerald F. Peedin

Air-cured tobacco includes Burley, Maryland, nearly all cigar types, dark air-cured, and the Virginian sun-cured types. Air-curing is also referred to as "natural" curing because environmental conditions during curing are largely determined by prevailing weather. Although some modification of humidity is usually required during air-curing, the process does not include the use of high temperatures required in the much shorter and harsher flue-cured process.

Curing is characterized by two major inter-related biological events, regardless of the specific procedures employed. One is dehydration which removes 80 – 90 per cent of the original green weight as water. The other is a series of complex biochemical changes which, in conjunction with controlled water loss, result in characteristic leaf colours indicative of desirable chemical and physical leaf properties which make a particular tobacco suitable for use in a specific consumer product.

The complex physical and chemical changes involved in air-curing begin when the tobacco is harvested and end when the midveins of leaves are dry enough to break by bending, although some enzymatic reactions occur slowly during storage and fermentation. The major visual changes of leaves are wilting, yellowing, browning, and drying. The entire process requires 30 – 60 days, depending on humidity and temperature conditions during curing.

Most air-cured tobaccos are harvested by cutting of the entire stalk near ground level when leaves in the middle stalk positions are judged to be near ripeness. Then, 4 – 6 plants, depending on their size, are placed on sticks which may remain in the field for 1 – 3 days unless rain and/or high temperatures are expected. Field wilting initiates the curing process because dehydration begins immediately, allowing the tobacco to lose about one-half of its original green weight as water over a 2 – 3 day period. This practice, although not universal among air-cured tobaccos, reduces also the amount of water which must be removed from the tobacco and consequently out of the confines of the curing barn during the remainder of the curing process. In addition, sticks are much easier to transport and hang in the barn, and more sticks can be placed in a barn when space is limited.

Green, mature tobacco contains approximately 85 per cent of its weight as water. In studies with nonwilted Maryland tobacco cured under optimum conditions, the greatest weight loss (11 per cent) occurred during the first 24 hours of curing. During the first five days of curing, the average water loss was 195 gal/A/day. During the next five days, the average water loss was 142 gal/A/day. Over the curing season, the average acre of Maryland tobacco will loose approximately 2400 gallons of water. This amount is greater for Burley tobacco which normally grows larger than the Maryland type.

Adequate and controllable ventilation is essential to remove the large amounts of water but yet maintain leaf moisture content at levels which allow the desirable chemical changes to proceed at rates required for good quality leaf. Air-cured leaves normally reach the yellow stage about 10 – 12 days after harvest, and the brown stage is reached about 6 – 8 days later. Simultaneous with moisture loss and colour change from green to yellow to brown, the chemical composition of the leaf is greatly altered. The major enzymatic reactions are the hydrolytic breakdown of large molecules such as proteins, starch and nucleic acids, and oxidative reactions that convert hydrolytic products such as amino acids and carbonhydrates to organic acids, carbon dioxide, ammonia, water and other compounds. About 15 – 20 per cent of the leaf dry weight is lost during these reactions, which usually continue until browning is complete. A more uniform leaf colour may develop during the drying phase, but few additional chemical changes occur. A portion of the leaf weight loss is due to migration of some nitrogen compounds and potassium and phosphorus from leaves to stalks.

The rates of moisture loss and chemical changes must coincide to produce good quality leaf. Three environmental factors primarily determine the success of the air-curing process: air movement, air temperature and relative humidity. A suitable temperature range is 60 – 90° F, with relative humidities of 65 – 70 per cent for Burley and 80 – 85 per cent for most other air-cured tobaccos. Under these conditions, the leaf will gradually lose its water without becoming brittle.

A low relative humidity will cause the tobacco to dry too fast, killing the leaf cells and resulting in colour fixation in the green or yellow stages. An important part of the curing process is the gradual breakdown of starch, which imparts an undesirable taste to smoke. This process is accomplished in living cells, and conditions such as rapid drying, bruising and temperature extremes which kill cells prematurely greatly reduce the quality of the cured leaves. For Burley tobacco, the danger of damage from excessive drying occurs mainly in the first 4 – 6 days of curing, before yellowing is complete, and the period of exposure required for damage decreases as temperature and humidity decrease below the optimum.

A high relative humidity will cause the tobacco to dry too slowly, resulting in darkened leaf and possibly houseburn, a disease caused by several fungi which cause destruction of the leaf-web and deterioration of veins and stalks. Affected leaves are usually dark and very thin. In severe cases, crop value is substantially reduced due to weight loss as well as quality reduction associated with the darkened leaves. This condition is most severe on leaves in the advanced stage of curing when humidity and temperature remain too high for longer than 24 – 48 hours.

With conventional curing barns, it is almost impossible to maintain optimum temperature and humidity conditions for a 24-hour period. During the first several days of curing, humidity inside a barn will approach 100 per cent at night and occasionally on damp days. Because of the need to have some control on drying rate of the leaves and to reduce the possibility of houseburn, conventional curing barns should have 35 – 50 per cent of its side area as vertical ventilators. Generally, the ventilators are opened during periods when the outside humidity is lower than that in the barn and closed when the outside humidity is usually high. The usefulness of the barn also depends on its location, size (primarily width), and exposure to prevailing winds. Generally, air-curing barns should be located on an open rise of ground where good air movement occurs, and the long side of the barn should face the prevailing winds. Barn width is important because it determines the distance air must move as it passes across the barn and also the quantity of tobacco through which the air must pass. Generally, air-curing barns do not exceed 40 feet in width. Otherwise, air movement is reduced when there is actually a need for greater air movement because of the increased amount of tobacco. In some Burley areas, fans are sometimes used to supplement natural ventilation when close stick spacing or undesirable construction or location of the barn causes poor curing in limited sections within the barn. The air is blown directly through the section of tobacco that is curing poorly but only long enough to overcome the problem. In the Maryland area, successful cures have been obtained experimentally by using large fans in confined systems to force and recirculate air directly through the tobacco. Although this technique is adaptable to conventional barns and the entire curing process may be reduced to about three weeks, it has not received wide acceptance by Maryland tobacco producers.

In the true air-curing process, artificial heat is used only to restore favorable curing conditions that are otherwise provided by nature. It is rare that suitable humidities and temperatures can be maintained solely by ventilation over the entire curing season. Supplemental heat is sometimes used to lower humidity during prolonged periods of moist weather, which retards evaporation of water from leaf surfaces. Enough heat must be supplied to warm the barn to the top, so that the moist air is removed from the barn. Houseburn can usually be prevented by maintaining the barn temperature 10 – 15° F higher than the outside air until the cured portions of the leaves are dry. Otherwise, houseburn may be enhanced rather than corrected. Regardless of humidity, supplemental heat is needed when temperatures drop below 50° F to maintain adequate curing conditions. Natural, LP, and propane gas, coke, charcoal and fuel oil are all suitable fuels when used properly and undesirable combustion products are not allowed to contaminate the tobacco.

So long as development of houseburn is prevented, strict adherence to optimum humidities and temperatures is less important in the last stage of curing. However, even after tobacco is thoroughly cured, it is still subject to darkening and further weight loss during alternating periods of high and low humidity. The deterioration is faster and more severe under conditions of high temperature.

Although bulk curing has gained wide acceptance in flue-cured production areas, this technology has not been adopted by the air-cured industry. The lack of acceptance appears to be based on real differences in leaf properties between conventional air-curing and bulk curing. Although commonly measured leaf constituents are sometimes similar for the two curing methods, certain undesirable characteristics of flavour and aroma appear to be associated with the bulk process. Further work is needed to evaluate the feasibility of curing air-cured tobaccos by the bulk process, and to study the curing conditions necessary to obtain quality leaf. ■

Manufacture of Snuff

by Alois Pöschl

Snuff manufacture is probably the most difficult form of tobacco processing and it dates back about 400 years. In contrast with other tobacco products snuff is subjected to a further process of fermentation in the factory and the formulae continue to be at all times a secret of the individual manufacturers. The methods of production are surprisingly multifarious and over 100 different tastes and varieties can be obtained.

Standard commercial-type fermented tobacco leaves together with short fibres from these, from all cultivation areas are utilized. In the main they are dark brown heavy tobaccos which are moistened with salt water or sugar sauces. This is followed by another process of fermentation, the course of which determines the quality and characteristics of the snuff. The fermentation process must be carefully supervised by observation of the temperatures and stopping at the right time. There are some types of snuff which can take several years to mature completely and the quality of which is improved, like that of good wines, by long periods of storage in moderately cool warehouses over a period of years. Not until the curing process has been subsequently completed is it possible to crush

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or pulverize the tobacco into coarse, medium or fine grain. This tobacco powder is then again moistened with additives of aromatic finished sauces and rendered durable.
There are four different technological processes in the manufacture of snuff.

The Carrot Method:

After being stripped into "carrots" the tobacco leaves are pressed together into rolls. In the course of the following years the carrots melt together until they coalesce into a firm pulp which can only be crushed or pulverized by means of powerful and sharp grinding machines. However this method of manufacture, the oldest and most time-consuming of its kind, is now obsolete.

The Paris Method:

Virginia and Kentucky tobaccos are pounded in brine (salt water) like cut tobaccos and then left to ferment for several years in moderately cool rooms after being compressed into batches of several hundredweights each. This process is followed by crushing or pulverization in pounding machines, sieving and remoistening with brine. This method produces the so-called "black varieties", such as "Paris", "Saarbrücken", etc. However, this technique too is of minor importance today and is used chiefly in the FRG and France.

The Rapid Method:

Tobacco leaves or their short fibres are pulverized on high-speed, blower-type crushers, sieved and then moistened with brine sauces. This is followed by a rapid fermentation process in hot rooms lasting from 6 to 8 weeks, more sieving and then mixing with 5 to 8 per cent of fine cooking salt and subsequently a fairly long period of maturing.
This is the most widely used method today which produces the so-called "green" snuffs, known as Kovno, "refreshment" tobacco and Danzig types, together with the modern English type of snuff tobaccos. In addition to the latter there are menthol, peppermint oil, camphor as well as aromatic additives, such as attar of roses, oil of cloves, etc. The grain size of the majority of these snuffs is very small and the grain itself is of a powdery type. The distinguishing feature of these snuffs is their high concentration of aromatics. The description "green snuffs" is based on the partial utilization of green tobacco leaves as was the custom in East Germany and Poland and which give the snuff a greenish tinge. However, the snuffs which are being produced at the present time by the rapid method in the FRG, Great Britain, Switzerland, Belgium and France have a consistently light to dark-brown and therefore natural coloration, many of them being called by the English word "snuff". There are also other types whose description or name is based on their origin, place of manufacture, taste and method of utilization or their genus.

The Schmalzler Method:

Tobacco leaves, chiefly from Brazil, are cut and moistened with sugar sauces. This is followed by fermentation at comparatively high temperatures over a period of a few months. After being dried the tobacco is carefully ground on special machines called "grinding chairs", sieved and then moistened with fine oils. In earlier times clarified butter had been utilized for this purpose on Brazil tobacco grades which since about 1830 had been produced almost wholly in Bavaria. Hence the genus term "Schmalzler" ("Schmalz" is the German word for lard or melted fat). The "Schmalzler" tobacco grade obtains its characteristic fragrance as a result of the admixture of "mangotes" or rolls imported from Brazil. These consist of Brazilian tobaccos fresh from the field, spun into ropes with the inclusion of special sugar sauces, and fermented in tanks for a fairly lengthy period together with a special sauce so that they become saturated. The ropes are then twisted tightly on stocks, pressed and sewn into fresh cowhides. The aroma is reminiscent of rum and it is impossible to obtain this scent by any other method.
The Schmalzler snuffs are a Bavarian speciality which still have many adherents today as a lot of snuff-takers prefer snuffs which do not contain menthol and which are particularly mild, in contrast with the menthol snuffs. All types of snuff have a common feature, i.e. they contain a far higher percentage of moisture and additives than any other tobacco products, in other words from 20 to almost 50 per cent of their dry weight.

Packing

In order to prevent the risk of drying up, snuff tobaccos must be carefully packed in foil bags or tight-sealing tins or plastic containers. The bags contain quantities of 20, 50 and 100 grammes and the small tins or containers 4, 5 and up to 10 grammes. Semi-automatic or fully automatic special machines are utilized to pack these snuffs. Determining the precise weight is generally effected by means of screw-fed dosing machines as in view of its moisture content snuff is one of those products which are difficult to pack.
Multi-packs for snuff must still carry revenue stamps only in Italy, Benelux and Denmark. Other wise the tobacco duty is charged according to the weight or value and collected from the manufacturer as a lump sum. However, in Great Britain and Ireland snuff has for many years been exempt from the tobacco duty.
One curious fact is that in France and Belgium packets of snuff too must carry printed warnings about health hazards, although snuff itself is considered to be a "healthier" and comparatively harmless form of tobacco pleasure. Qualified doctors have repeatedly made public statements to this effect.

Some Statistics

World production of snuff, according to the published statistics, is estimated to amount to a total of some 20 million kilos per annum. However, genuine snuff tobacco, which is inhaled through the nostrils, as used in the FRG (approx. 300 000 kg), Great Britain (approx. 200 000 kg), France and Italy each with less than 100 000 kg, as well as used also to a lesser degree in Belgium, Switzerland, East Germany, South Africa, etc., amounts to about 1 million kg per annum at the most.
The large quantities known as snus or souffi in the United States, Scandinavia and North Africa, as well as "snuff" in the United States for historical reasons, are not genuine snuff tobacco. These products are utilized solely in the mouth where they are sucked in large doses for a long time just like chewing tobacco. Consequently, not only in the way they are used but also in their composition, they differ completely from the real European snuff tobaccos for the nose and in no way are they comparable with the latter. For the most part they consist of large-grained very moist or (partly in the US) very dry tobacco products which are unsuitable for the nose.
In the FRG the production of genuine snuff tobaccos for the nose is carried out chiefly in Bavaria, and more particularly in Landshut, where about 70 per cent of German snuff manufacture is concentrated. In the United Kingdom there are some five snuff factories in Sheffield and Kendal. In France the French tobacco monopoly establishment still produces snuff at Morlaix on the Atlantic coast. Apart from the above, there are only some medium-size factories which are engaged in the production of snuff as the share of snuff on the tobacco market as a whole is less than 1 per cent. With the exception of India and Turkey, there is practically no manufacture of snuff being carried out in Eastern Europe and Asia. The situation in South America is a similar one. On the world market the quality of German and British snuff tobaccos is considered to be the best.
The world's one and only snuff museum is in the town of Grafenau in the Bavarian Forest where the visitor can obtain a comprehensive picture of the past and present history of snuff.
To sum up, it can be said that during the past twenty years the production of snuff has ceased to be in decline and that, on the contrary, it has remained steady. The main reason is probably that many more people have again begun to appreciate this tobacco product which is smokeless and therefore harmless to the environment as well as being one which does not affect the respiratory tracts. But, of course, today's production figures can never approach the enormously large output quantities of the 19th century. ■

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