

CURING TOBACCO

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Flue-Cured Tobacco Curing

Curing flue-cured tobacco should be considered both an art and a science due subtle differences between cures as a result the tobacco itself (body, stalk position, moisture content, etc.), curing facilities, and weather conditions. It is difficult to use a set curing schedule because each barn of tobacco is different. Specific curing schedule are general guidelines to be used and individual cures modified based on specific conditions.

The harvested leaves must be kept alive during the yellowing period so that desirable chemical and color changes can occur. At the same time, sufficient drying must take place so that when yellowing is completed the leaves will be thoroughly wilted. After the leaves reach the desired yellow color, temperature should be raised to kill the tissue and stop further chemical and color changes. If the leaves are killed too early by drying too fast or high temperatures, the color will remain green. After the desired color (lemon-orange) is achieved, the remainder of the cure is merely a matter of drying the leaf and stems to preserve the color.

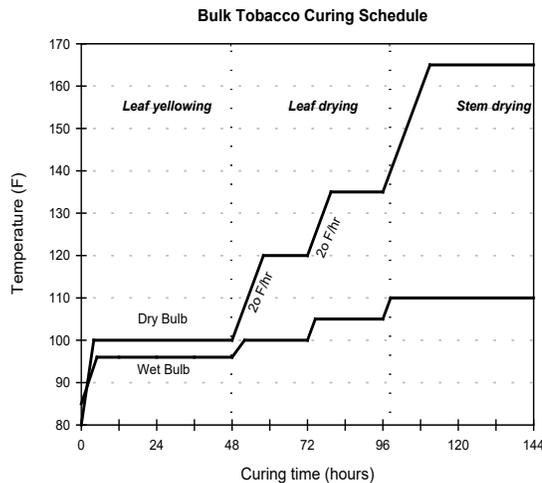
Tobacco producers may follow different temperature and humidity schedules and still obtain a satisfactory cure. The exact temperature schedule is not critical as long as it is within reasonable limits. Mr. S. N. Hawks, retired Tobacco Extension Specialist at N. C. State University developed a 'Simplified Curing Schedule' designed to reduce the complex curing procedure to its simplest terms. The three dry-bulb temperatures (100°F for yellowing, 130°F for leaf drying, and 160°F for stem drying) are well within safe ranges for each curing phase. Wet-bulb temperature for yellowing should be adjusted to fit the needs of the tobacco. The upper limits for leaf drying (105°F) and stem drying (110°F) are conservative.

The following points need to be remembered in following the Simplified Curing Schedule:

1. Remove all surface moisture from the leaves before beginning to yellow them. This may take up to 12 hours, depending on weather and tobacco conditions when the barn is filled. Lower leaves are often more difficult to yellow without developing soft rot.
2. Yellowing - Start heat at outside temperature and advance temperature 2°F per hour to 100°F. It may be necessary to open vents slightly during yellowing, but care must be taken to avoid setting green color by lowering relative humidity too much or drying too fast.

3. Maintain a dry bulb temperature of 100°F until all leaves are yellow. Provide enough ventilation so that when the leaves become yellow, those on the bottom tier will be completely wilted. Generally, a difference of 2 to 3°F between the wet- and dry-bulb reading should be maintained.
4. Leaf drying - When leaves are yellow and sufficiently wilted, the dry-bulb temperature should be advanced 2°F per hour to 130°F. Increase ventilation enough so that the wet bulb does not exceed 105°F. Toward the end of the leaf drying period it will usually be possible to reduce the amount of ventilation without exceeding 105°F on the wet bulb. A 130°F dry-bulb temperature should be maintained until all of the leaves on the lower two tiers are dry.
5. Stem drying - Dry-bulb temperature advanced 2°F per hour to 160°F and maintained until stems are dry. As long as the wet-bulb does not exceed 110°F, ventilation can be reduced. Toward the end of the cure the ventilators can be essentially closed to conserve fuel while drying stems.

A graphical representation of a bulk tobacco curing schedule provided by Drs. Boyette and Watkins of NCSU is shown on the following page. This differs only slightly from what is described above, except that there is a momentary holding of the dry bulb temperature at 120°F during leaf drying. This would provide for adequate removal of water from the tissue to avoid scalding or sweating of the tobacco.



The retrofitting of curing barns to indirect-fired heating focuses attention on heating efficiency and fuel consumption and this has only intensified with rising fuel prices. One measure of curing efficiency is calculation of pounds of cured tobacco per gallon of fuel. Although there will be varieties dependent on the sensor, the barn, and the tobacco. A reasonable value would be 10 pounds of tobacco per gallon LPG or 13 pounds per gallon of fuel oil. Higher weights of cured tobacco per gallon of fuel would indicate greater curing efficiency.

Simply increasing the amount of tobacco loaded into the barn may not necessarily result in increased curing efficiency. The uniformity of how the barn is filled has a substantial impact on air movement throughout the barn. To obtain optimum curing efficiency, barn filling rates must be compatible with the airflow capacity on the barn. With development of box loader systems and load cells to weigh tobacco, growers have been able to realize improved curing efficiency resulting from more uniformly filled barns.

Tobacco has traditionally been cured solely with the use of a dry-bulb temperature or the thermostat setting controlling the burner. A relatively few growers have made use of a wet-bulb thermometer to cure by. This is possible due to the wealth of knowledge that growers have developed for curing tobacco, experience with barns that have been used for many years, and a feel for the ripeness characteristics of their tobacco. However, the use of a wet-bulb thermometer is likely to be the single most important practice that can be used to reduce fuel consumption when curing tobacco. With older barns, some amount of added insulation and repair will reduce heat loss and most new barns have improved insulation. Use of a wet-bulb thermometer will help reduce the amount of over ventilation of the barn. Over ventilation or opening dampers wider than necessary increase the drying rate of the tobacco and the burner fires more to heat the inflow of outside air. Various wet-bulb thermometers or hygrometers (wet-bulb and dry-bulb thermometers) are available and many designs or homemade units are also available.

The dry-bulb temperature is a measure of the air temperature within the barn and is controlled by the thermostat on the burner. In contrast, the wet-bulb thermometer measures the temperature of the leaf tissue and is controlled by the amount of ventilation or the size of the damper opening. The difference between the dry-bulb and wet-bulb temperatures determines the relative humidity within the barn and therefore the amount of drying that occurs. Maintaining a high wet-bulb temperature within each stage of curing will reduce ventilation and thus increase curing efficiency. (See graph of curing schedule on previous page).

Energy Efficient Curing Practices

More than 90 percent of the energy used for the production of flue-cured tobacco is used in the curing process. The following energy efficient curing practices should be followed to help reduce the cost of curing.

1. Regulate the barn using a wet-bulb thermometer. Ventilate only enough to hold humidity down (wet-bulb temperature); the wider the vent opening, the more fuel that is consumed. Automatic curing controllers utilize the added convenience of automatically controlling the damper opening.
2. Harvest only ripe tobacco; shorter curing times mean less heat loss and more efficient curing.
3. Load racks and boxes uniformly; uniform loading with no "tight spots" assures even drying and less energy use. Uniform barn loading reduces the length of the total cure.
4. Have burner set for optimum efficiency; periodic maintenance and adjustment is required for efficient operation.
5. Stop hot air leaks; check door gaskets and structure for cracks.
6. Assure an air seal around each rack or box; small cracks between boxes or racks reduces ventilation efficiency to a large degree.
7. Add insulation; well-insulated walls, roof and floor can save 10 to 20% of fuel consumed per cure. Insulate new barn pads with 1-inch thick insulation board.

Tobacco Specific Nitrosamines

Tobacco specific nitrosamines (TSNAs) are a principle group of carcinogens present in tobacco. Formation of these compounds is by two different pathways. In burley tobacco and fire-cured tobacco, TSNA are produced by naturally occurring microorganisms present on the leaves during curing. They feed upon natural compounds found in the tobacco leaf and produce TSNAs. Although curing conditions may be manipulated to modify TSNA levels, the curing season has a substantial input on TSNA levels found in stalk cut tobaccos. The higher temperatures and accelerated drying of the leaf greatly reduces the activity of microorganisms responsible for TSNA formation. However, the pathway for TSNA formation in flue-cured tobacco primarily involves nitrous oxides (NO_x), produced as a by-product of combustion of LP or fuel oil, with specific alkaloids present in the tobacco. The use of heat exchangers or indirect-fired heating of curing barns has eliminated the introduction of NO_x into the curing air space. However, heat exchangers must be tested periodically to ensure their physical integrity and repaired if a leak is detected.

Barn Testing. Although NO_x is the actual concern with a leaking heat exchanger, carbon dioxide (CO₂) will also be present in the curing air space. Carbon dioxide is measured because it is present in much higher amounts than NO_x and measuring devices for CO₂ are much cheaper and portable than those for NO_x. The procedure involves measuring the ambient CO₂ level (typically 350 to 500 ppm) in the barn with the burner off and then recording the increase in CO₂ above ambient in the barn after the burner runs for a sufficient time. Dampers are to be closed and the barn cannot contain green tobacco.

Interpreting CO₂ Meter Test Results:

- No increase in CO₂ above the ambient indicates that the entire system is intact at the time of testing.
- An increase in CO₂ less than 100 ppm indicates the present of a minimal leak somewhere in the furnace system.
- An increase in CO₂ between 100 and 200 ppm warrants further inspection of the furnace since a crack may be forming in the heat exchanger or a gap may be present in the exhaust stack.
- A doubling of the ambient CO₂ level indicates that a crack in the heat exchanger is likely.

Removal and examination of a heat exchanger for a crack can be a difficult procedure. High temperature (2500°F) caulking is available for minor repairs. Fortunately, the source of many leaks has been the exhaust stack. Any gap between the flue pipe and the heat exchanger or opening in the stack pipe may potentially allow exhaust gases to enter the curing chamber of the barn.

Although the use of indirect-fired curing removes NO_x from the curing chamber, it is critically important to remember that microbial production of TSNA's may occur in flue-cured tobacco. It is important to remove any oxidized or barn rotted leaves from tobacco before baling and do not bale tobacco with excessive moisture or compression. Each of these factors will impact the TSNA level of tobacco.

