CURING TOBACCO

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Flue-cured Tobacco Curing

Curing flue-cured tobacco should be considered a complex procedure because of the differences in types of tobacco (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.

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, the 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. S.N. Hawks, retired Extension tobacco specialist at North Carolina State University (NCSU), 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:

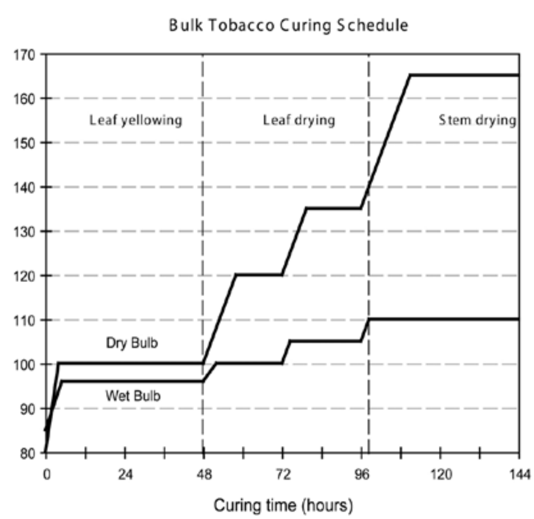
1. Remove all surface moisture from the leaves before beginning to yellow them. This may take up to 12 hours, depending on weather and tobacco conditions when the barn is filled. Lower leaves are often more difficult to yellow without developing soft rot.

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 take care to avoid setting green color by lowering the 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 temperature 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 graphic representation of a bulk tobacco curing schedule provided by ______ Boyette and ______ Watkins of NCSU follows. 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 the tobacco.

Retrofitting 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 the calculation of pounds of cured tobacco per gallon of fuel. Although there will be varieties dependent on the senor, 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. Uniformity in filling the barn 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 traditionally has 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. The 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, increases 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 the Bulk Tobacco Curing Schedule graph).

Energy-Efficient Curing Practices

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

1. Use a wet-bulb thermometer. Ventilate only enough to hold the humidity down (wet-bulb temperature); the wider the vent opening, the more fuel that is consumed.

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. Tune up the fuel burner; 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 percent to 20 percent of fuel consumed per cure. Insulate new barn pads with 1-inch thick insulation board.

Tobacco-Specific Nitrosamines

Tobacco-specific nitrosamines (TSNAs) are considered to be a group of the most potent carcinogens found in tobacco. These compounds form by two different pathways. In burley tobacco and fire-cured tobacco, TSNAs 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 reduce the activity of the microorganisms responsible for TSNA formation. However, the pathway for TSNA formation in flue-cured tobacco involves nitrous oxides (NOx) produced as a by-product of combustion of LP or fuel oil with alkaloids present in the tobacco. The use of indirect-fired heating, where a heat exchanger removes the combustion gases from the barn, has been found to reduce TSNA when compared to direct-fired curing barns.

In 1999, the Tobacco Industry Leadership Group proposed retrofitting all direct-fired bulk curing barns to indirect-fired heating. This became a requirement for the full-grade loan rate (price support) the following season and is currently required by contract purchasers. More than 30,000 barns were retrofitted across the flue-cured tobacco belts with some of the expense reimbursed by an industry supported cost-share program. Over the brief period of time since the barn retrofit program was implemented, the industry has recognized that the maintenance and testing of heat exchangers will be an ongoing process to ensure that leaks do not occur and NOx does not cause TSNA levels to increase. For the 2003 growing season, the Tobacco Industry Leadership Group has provided funding to tobacco extension programs in all tobacco producing states to conduct education programs to introduce the need for heat exchanger testing. In Virginia, local Extension agents have access to CO_2 meters for barn testing and will visit barns at a grower's request. This program is not intended to provide any form of barn certification and results of barn testing are reported only to the grower.

Barn Testing. Although NOx is the actual concern with a leaking heat exchanger, carbon dioxide (CO_2) will also be present in the curing air space. Carbon dioxide is measured because it is present in much higher amounts than NOx and measuring devices for CO_2 are much cheaper and portable than those for NOx. The procedure involves measuring the ambient CO_2 level (typically 350 to 500 ppm) in the barn with the burner off and then recording the increase in CO_2 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 CO_2 Meter Test Results:

- No increase in CO_2 above the ambient indicates that the entire system is intact at the time of testing.
- An increase in CO_2 less than 100 ppm indicates the present of a minimal leak somewhere in the furnace system.
- An increase in CO_2 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 CO_2 level indicates that a crack in the heat exchanger is likely.

Removing and examining a heat exchanger for a crack can be difficult. High-temperature (2,500°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 NOx from the curing chamber, it is critically important to remember that microbial production of TSNAs 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.