Trends in Indian Flue Cured Virginia Tobacco (Nicotiana tabacum) Processing: II. Threshing, Packing and Warehousing

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Abstract: After purchasing the tobacco from farmers, processors and manufacturers continue further processing. Lamina and midrib of a leaf are separated and dried to safe storage moisture content in a tobacco threshing factory. Blending, tipping, conditioning, classification and re-drying are the important unit operations in tobacco threshing. The quality specifications during threshing operations are stringent and difficult to adhere. For the quality analysis of threshed lamina and midrib, a huge quantity of tobacco is being destroyed due to the destructive nature of the test procedures. Packed tobacco products are stored in a warehouse for 6 to 12 months. Bug count is taken in the warehouses (by pheromone traps) almost every day and fumigated with phosphine whenever it exceeds a threshold value.

Keywords: Threshing, Quality analysis, Redrying, Packing, Warehousing

INTRODUCTION

In India, the marketing of FCV tobacco through auction system was started in 1984. Even though, the Indian auction system was designed after Zimbabwe model, the distinct features of several auction systems in the world were incorporated based on the socio-economic conditions of the Indian growers and the traders[8]. In each auction platform, around 25 to 30 buyers participate in the auction system. The manufacturers and the processors move the purchased tobacco to their handling centres, where a different grade is assigned to the tobacco. Sometimes the tobacco bales are opened and graded further based on company’s requirement. Most of the graded tobacco is subjected to threshing however some quantity is manually stripped for specific applications.

In tobacco threshing, lamina and midrib (called as stem in tobacco terminology) are separated mechanically, and then processed, and packed separately. These packed products are stored in a warehouse for about 6 to 12 months (or even more) and then used for cigarette production. This paper describes the operations involved in tobacco threshing, quality testing procedures during threshing, and warehousing.

Green Leaf Threshing (GLT): Tobacco threshing is an important stage in the post harvest processing of tobacco because at this stage, the tobacco is packed for the final consumption from its raw form. The flow diagram of a threshing factory with all unit operations is given in Fig. 1. In a threshing factory, different grades of tobacco are blended at the feeding table. Since the stem in the tip portion (called as “tips”) of the tobacco leaves are thin, the tips are cut and separated, and not sent for threshing. This process is called as tipping, and normally carried out immediately after blending. The remaining portion of the leaves, after tipping, is called as “butts”. The tobacco leaves always form pads due to waxy material on the surface. The leaves are conditioned to high moisture by adding steam, hot air and water, to open the pads and make the leaves more pliable for better threshing. The threshed products (containing lamina, stem and unthreshed leaves) are subjected to pneumatic classification. Threshing and classifications are repeated several times till different products are classified thoroughly. Then threshed lamina and tips are blended together and dried, and conditioned to 12% moisture content. Threshed and dried lamina is packed in corrugated fibre board (CFB) cartons (180 to 200 kg) or bale board packs (80 to 100 kg).

Tipping: The leaves in small bunch form are straight laid on a moving belt conveyer (normally from 10 to 12 tables) manually. The tips which contain thin stems, are cut up to the extent where the stem diameter
Fig. 1: Flow diagram of a tobacco threshing plant

confining to the specified objectionable stem size (usually (3/32)” diameter). Mechanically driven knives (circular shearing knives made of tungsten carbide) cut the leaf into two parts as tips and butts which are carried away by separate conveyors. The tips generally bypass the threshing operation and join the lamina emanating from the threshing operation. Blending of different grades of tobaccos can also be done conveniently on the tipping table as per the requirement.

**Conditioning:** Tobacco pads are opened by means of forced hot air and steam in a conditioning cylinder. Conditioning cylinder is a rotating drum in which steam is injected which passes through the tobacco. Steam jet nozzles are arranged on either end of the cylinder, which can be controlled independently. The conditioning process for butts is normally done in two stages namely primary and secondary conditioning, in order to provide gradual increase of temperature and moisture for the butts. In primary conditioning, the moisture content of butts is increased to 15 to 17% at around 45 to 50°C. The secondary conditioning is carried out to increase the moisture content of the butts to 17 to 22% at 60 to 70°C. After conditioning, the leaves become more pliable and ready for threshing. The tips are also conditioned in order to increase the moisture content of tips to match the final threshed lamina, and to break the pads.

**Threshing:** The conditioned leaf is equally divided and fed into a series of threshers (normally 3 to 4). Thresher incorporates a cylindrical body within which a rotor is fitted with number of blades at equal distance. There are also fixed teeth on the front and rear doors of the thresher drums. The bottom half of the cylindrical body of the thresher constitutes a removable basket (concave) with holes of size 50 to 75 mm diameter. Baskets with different sizes and shapes of perforations are used to suit to the type of tobacco being processed. The leaves fall on the rotor of the thresher and are forced to pass through the fixed teeth. At this point the lamina gets torn away from the stem. This product is taken by the rotor teeth along the
Fig. 2: Degradation shaker to measure the lamina particle size$^{[5]}$

direction of rotation and is forced down through the perforations of the basket. The ejected product contains a mixture of lamina, stem, and unthreshed leaf. The factors affecting the efficiency of threshing are, the degree of conditioning, machine settings (clearance between basket and rotor blade end, basket type, roughness and speed of the blades) and operational factors like feed rate and distribution of tobacco into threshers. The threshed product is pneumatically lifted and fed into the classifier.

**Classification:** Air classifiers are used to separate threshed lamina from unthreshed leaf and stem. The density difference between threshed lamina and unthreshed leaf is used for separation. Generally, counter flow classifiers are used in a tobacco threshing factory. The classifier efficiency mainly depends on the distribution of tobacco inside the classifier. The classified lamina is discharged on a conveyor and taken to the final sieving section. The heavies, which contain stem and unthreshed leaf, are sent to the next thresher. Threshing and classification are repeated (4 to 5 stages) till the lamina and stem are completely separated. Tips are blended with the threshed lamina and then sieved before they are fed to the redrier.

**Drying:** Lamina coming from different classifiers contains various moisture contents. The objective of redrying is to standardize the moisture content of tobacco to a safe storage level. Generally, a redryer consists of three drying chambers, one cooling chamber and one conditioning chamber. The product (mixture of threshed lamina and tips) which is coming from the final lamina sieve is uniformly spread on an apron conveyor with the help of an auto feeder so as to have a uniform bed thickness of 80 to 120 mm all over the apron width. A perforated rotating apron carries the tobacco through all the chambers in a redrier unit. In drying chambers, hot air is blown alternately up and down through the tobacco bed to make the drying uniform. While leaving the drying chamber, the moisture content of tobacco is around 6 to 8%. The tobacco is cooled down by exhausting the hot air and blowing fresh atmospheric air in the cooling chamber. The temperature of the cooling chamber is normally set at ambient temperature. The cooled tobacco is exposed to a high humidity zone in the conditioning chamber (created by steam and water). The tobacco absorbs moisture and reaches an equilibrium condition. While leaving the redrying unit, the tobacco is at a safe storage moisture level (11 to 12%).

**Packing:** Several materials are used to pack the redried tobacco products. Redried threshed lamina (RTL) is normally packed in CFB cartons and bale board packs. In cartons, about 180 to 200 kg of RTL is packed and sealed with 3 to 4 plastic straps. In a bale board pack, about 80 to 100 kg of RTL is pressed between two wooden boards and tied with 2 to 3 galvanized iron (GI) wires and covered with a gunny bag. In both packing, polythene or kraft paper sheets are used as liners inside the packs based on the customer requirements (in case of export packing) and company policy (in case of domestic packing). In some cases, tobacco is packed in bales (gunny bags) without wooden boards and thoroughly tied with a rope.
Table 1: Commonly measured quality parameters and test procedures in a tobacco threshing factory

<table>
<thead>
<tr>
<th>Quality parameter</th>
<th>Approximate test interval (min)</th>
<th>Sample size (g)</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LAMINA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particle size</td>
<td>20</td>
<td>2500 to 3500</td>
<td>Lamina particle size tester (Degradation shaker)</td>
</tr>
<tr>
<td>Stem content</td>
<td>20</td>
<td>2500 to 3500</td>
<td>Stem tester</td>
</tr>
<tr>
<td>Moisture</td>
<td>5</td>
<td>50</td>
<td>Brabander (quick moisture analyzer) and Hearson oven</td>
</tr>
<tr>
<td><strong>STEM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>60</td>
<td>250</td>
<td>Stem length board</td>
</tr>
<tr>
<td>Diameter</td>
<td>60</td>
<td>250</td>
<td>Rotap tester</td>
</tr>
<tr>
<td>Moisture</td>
<td>30</td>
<td>50</td>
<td>Brabander and Hearson oven</td>
</tr>
</tbody>
</table>

Fig. 3: Stem tester to measure the stem content in lamina

Quality Analysis: Even though, each company has its own quality specifications for threshed tobacco products, everybody uses common quality parameters and testing procedures. The quality analysis in a tobacco threshing factory is a laborious and time consuming process. Around 25% of the workers in a threshing factory are used for the quality testing operations. Apart from moisture content and temperature of the products during processing, particle size of lamina (before and after redrying), stem content in lamina, and, moisture content of lamina and stem are the important quality parameters to be measured in a threshing factory. The details of the quality analysis are given in Table 1. A sample of approximately 3 kg of RTL is collected from the outlet of the redrier (about 20 min interval) to measure the particle size of the lamina. After completing the particle size test, the same sample is used to measure the “stem content in lamina”. “Degradation shaker” and “stem tester” are used to measure the particle size of the lamina, and stem content in lamina, respectively (Figs. 2 and 3). After the test, 3 kg sample becomes scrap (almost powder) and can not be reused. Assuming a tobacco threshing factory in India is packing six months in a year at 24 h shift, about 40000 kg of RTL is wasted as scrap through quality analysis, which is valued at US $ 100000. Furthermore, the test results are highly subjective as many manual methods are involved in this process (sample collection at re-drier outlet, weighing of different fractions from degradation shaker and stem tester).

Warehousing: The packed tobacco products are stored in a warehouse for at least 6 months before used in cigarette production. In storage, aging or mellowing of tobacco takes place which brings many desired chemical changes to the packed products. The critical task in a warehouse is to protect the packed products from insects. Cigarette beetle (*Lasioderma serricorne*) and cigarette moth (*Ephestia elutella*) are the most commonly infesting insects in tobacco. Among these two insects, cigarette beetle causes severe damage to the stored tobacco at all life stages. Phermone traps are normally used to measure the degree of infestation in a warehouse. The traps are placed approximately at 20 m interval on walls, roofs or structural supports. By taking bug count from the trap daily, the infestation level is monitored. While a particular trap is showing a bug count which is greater than a threshold value, the nearby lots are subjected to fumigation. Phosphine is the commonly used fumigant in the tobacco warehouses and in transit. The tobacco stacks should
be kept under the phosphine gas environment for at least five days to kill the insects at all life stages (egg, larvae, pupae and adult).

In warehouses, the tobacco bales and cases are handled manually and in some places by fork lifts. The cases are stored up to 3 to 4 levels and bales are stored up to 6 levels. The space utilization (kg/unit area) is an important criterion especially when the tobacco is stored for a long time. However, while stacking the tobacco packs at higher levels, the tobacco which is present at the bottom receives more stress and becomes very hard.

Opportunities for Research and Development: As the tobacco is undergoing several treatments for about 30 min in threshing process, the processing loss is high. New methods and process optimization must be tried for all stages such as conditioning, threshing and classification to minimize the processing loss. In GLT operation of FCV tobacco, around 8 to 12% of the tobacco is packed as scrap (by-products) and these products are sold for the production of bidi and other low quality products at a low price. In some developed countries, the tobacco by-products are converted into sheet tobacco or reconstituted tobacco and used along with the lamina. But due to high initial investment, this technology has not been used in India. Low cost methods to produce reconstituted tobacco must be developed to give value addition to the tobacco by-products.

Frequent quality testing of lamina and stem in a tobacco threshing factory is inevitable. The existing methods for quality testing are laborious and time consuming. Large quantity of FCV tobacco is destroyed for the quality analysis purpose due to the destructive nature of the present methods. There is a need for an alternative quality analysis method to evaluate the problems in the existing method. Machine vision technology may be a viable method for the quality analysis of tobacco in a threshing factory. In machine vision method, an image of a real scene is acquired and analyzed by computers and other devices to obtain information. This novel technology can be used for objective, non-contact, non-destructive and automated quality inspection. Recently, rapid development has been taking place on quality inspection and classification of wide range of agricultural products by machine vision[1]. Machine vision technology provides a high level of flexibility and repeatability in quality analysis at relatively low cost[4]. This system has proven to be successful for objective measurements of various quality parameters in agricultural industries[2]. In a tobacco threshing factory, lamina particle size, stem length, stem diameter, and stem content in lamina can be measured using machine vision method.

After packing, the inspection of the packed tobacco for grade standards is carried out manually. This task can also be achieved using machine vision method. Machine vision technology can be used to determine the maturity, ripeness, quality, variety, composition, and contamination of agricultural materials[3]. A charged coupled device (CCD) camera with image processing software is enough to capture and analyze the images, and get the information on the quality of the product. However, intensive research should be carried out on all grades of FCV tobacco before replacing the manual method. To confirm the accuracy of the machine vision method in tobacco quality inspection, both manual and machine vision analyses should be carried out simultaneously for at least two seasons.

Phosphine gas fumigation is the only approved method for the disinfestations of the tobacco products. The products have to be under phosphine gas environment for five days in order to kill the insects at all life stages. Phosphine residue was measured in food material after fumigation[5]. Phosphine is currently under the regulatory review in several developed countries[6]. Alternative disinfestations methods such as heat treatment, CO₂ fumigation must be investigated for their capability to disinfect stored tobacco products.

REFERENCES