Cocoon Stifling

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Cocoons in their fresh condition with the pupae alive in them cannot be stored for a long time as the living pupae are soon transformed into moths (*i.e.*,generally within eight to ten days in a warm climate and ten to twenty days in a very cold climate), which emerge from the cocoons by piercing the shell through one end. Cocoons from which moths have emerged are called pierced cocoons. They are useless for reeling raw silk because the continuity of the bave in them is broken. Reeling cocoons, therefore, have to be subjected to a process of stifling with the object of killing the pupae inside without interfering with the structure of the silk shell around it. Cocoons can be stifled by several methods but the popular methods in reeling industry are sun drying, steam stifling and hot air conditioning.

Sun drying

Sun drying consists in killing and drying the pupae by prolonged exposure of freshly harvested cocoons to scorching hot sun. The cocoons so treated can be preserved for any length of time without fear of moth emergence or their deterioration by any means. The method is simple. Immediately after the harvest of cocoons they are thinly spread out on mats and kept in the hot sun from sunrise to sunset every day for several days till the pupae are killed and the cocoons completely dried. Sun dried cocoons are very light and when shaken make a rattling sound.

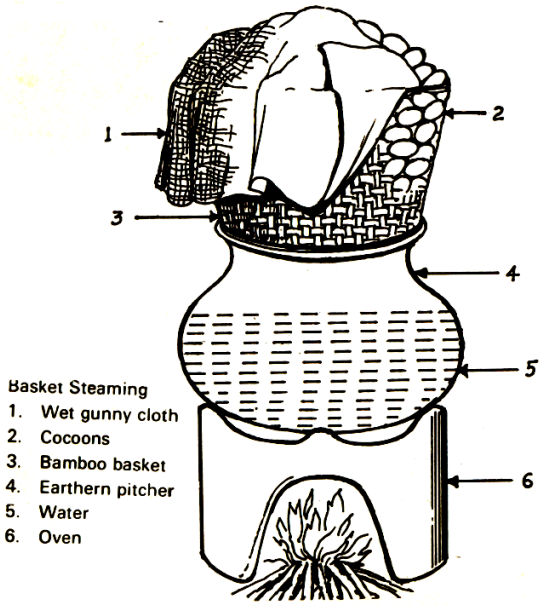
Although sun drying is simple and cheap, it is not suitable for modern reeling. Sun drying is possible only when there is bright and hot sunlight continuously for several days soon after cocoon harvest. Silk is very sensitive to sunlight and when cocoons are exposed to action of bright and hot sunlight for a prolonged period as in the

sun drying process, the original strength of the bave is very much affected impairing reelability of the cocoons and injuring the quality besides increasing wastage of silk in reeling. It has been proved conclusively that silk suffers a high rate of tendering when exposed to sunlight on account of the action of ultra violet rays. Sun drying itself is cumbersome and wasteful in space and labour. However, in spite of these shortcomings, sundrying continues to be practiced in those areas lacking alternative methods of stifling the cocoons economically.

Steam Stifling

Steam stifling means killing the pupa in the cocoon by exposing the fresh cocoons to the direct action of very hot wet steam for the required period. It is done in small containers if the quantity of cocoons to be stifled is small; if large, stifling is done in specially designed chambers supplied with steam from steam generating boilers.

Basket Steaming



Basket Steaming
1. Wet gunny cloth
2. Cocoons
3. Bamboo basket
4. Earthern pitcher
5. Water
6. Oven

In small reeling establishments, which handle only small quantities of cocoons at a time, fresh cocoons are stifled in a simple manner. About 10-15 kg of fresh cocoons, from which all the obviously defective cocoons have been picked out, are loosely filled in a basket woven of bamboo, or any other suitable material, (Fig.) in which the sides are closely woven but the bottom is loosely woven so as to allow steam to pass through easily. A thick wet cloth is then tightly stretched over the top of the basket, and tied at

the sides leaving the bottom free. The basket thus filled with cocoons is placed over the mouth of a vessel in which water is boiled. Sometimes the reeling basin itself is used for this purpose as in the case of Indian Charkas. The hot steam from the vessel below soon fills the basket and stifles the pupae in the cocoons and kills them in about half an hour. Steaming is stopped when dense steam starts coming out of the basket through the sides of the basket and emits a smell peculiar to the freshly steamed cocoons.

When the open palm is lightly placed on the freshly steamed cocoons, the cocoons feel hot, damp, slimy and sticky. The cocoons yield even under slight pressure between the fingers because the cocoons will be soft and wet due to the steaming. Cocoons in this condition are reckoned to be properly stifled. But in order to make sure that the stifling has been effectively done, a few cocoons of good build or double cocoons are picked out from the freshly steamed cocoons still in the basket, their shells are cut open and pupae placed on the open palm and examined to see if they are killed. If the stifling is not thorough, they will be still alive and promptly react to the exposure to cold air and start wriggling. In such an event, the steaming is continued for some more time. The freshly steamed cocoons are then poured out and thinly spread on mats for airing in the shade for several hours till the cocoons feel dry, firm and cool and nolonger sticky. Wet cocoons are not stored, as they are easily attacked by fungus. Freshly steamed cocoons are not suitable for immediate reeling because the sericin will be too soft and dissolves readily in cooking and reeling basins, and the silk bave instead of unravelling steadily will come off in lumps and spoil the quality of the reeled silk. The freshly steamed cocoons are kept, therefore, in the shade at least for three to four days to allow the damp or wet sericin to dry set and the cocoon will become firm and fit for reeling. This is known as seasoning of the cocoons.

Barrel Steaming

Sometimes instead of the bamboo basket, a convenient sized metal barrel is used for steaming. The barrel which is permanently fixed over an oven is provided with a platform inside on the bottom plate on which is kept the basket filled with fresh cocoons for steaming. The barrel is also provided with a close fitting lid to cover the barrel when steaming is in progress.

Water is poured into the barrel to about two thirds height of the platform and

boiled over a fire in the oven below. When the water starts steaming, the basket loaded with about 15-20 kg of fresh cocoons is placed on the platform in the barrel and the barrel lid securely closed to prevent escape of steam. Due to increasing temperature and pressure of steam building up, cocoons are stifled in ten to fifteen minutes.

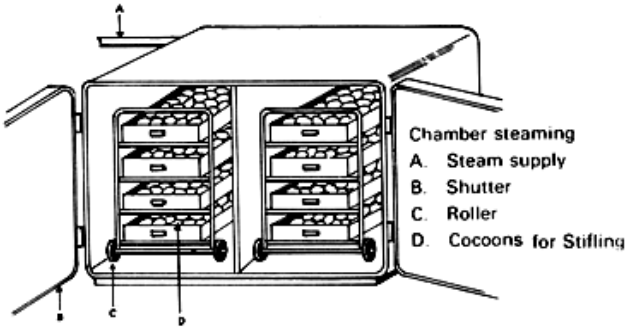
Barrel steaming in process

Removal of steamed cocoons from the barrel

Chamber Steaming

CSTRI Batch type hot air drier

Fixed shelves



Movable Shelves

In large reeling organizations which buy very large quantities of cocoons not only for day-to-day use, but also for holding over reserve stocks, specially designed and conveniently large sized chambers are constructed for steaming the cocoons. These chambers are internally provided with perforated steam pipes (Fig.) which are connected inside to the steam supply pipe from the steam boiler. In some types of chambers, shelves for keeping the fresh cocoons are permanently fixed while in certain other types, the chambers are provided with movable shelves on wheels.

In the fixed-shelf type, the trays filled with fresh cocoons are placed in the shelves and after closing the chamber door, the steam under pressure is let into the chamber by opening the steam valve provided outside the chamber. After about fifteen

to twenty minutes, the steam supply is shut off, the chamber door opened and the cocoon trays removed for airing. The next load of fresh cocoon trays will be kept in the vacated shelves in the chamber and the steaming process repeated.

In the other type of chamber provided with movable shelves on wheels, the process of steaming can be made more or less continuous with very little wastage of time between discharge of steamed cocoons and the reloading of fresh cocoons in the chamber, by providing a set of two trolley-shelves for each chamber. When one shelf carrying the fresh cocoon trays is being steamed, the other similar trolley shelf waiting outside could be kept charged with fresh cocoon trays to be pushed into the steaming chamber immediately the first trolley is drawn out.

Disadvantages of Steam Stifling

Steam stifling of cocoons has certain drawbacks. Steam stifling only kills the pupa inside and does not dry it. The pupa normally contains moisture in the form of body fluids, to the extent of nearly 65 per cent of its own weight. This large moisture content makes the pupa fragile and weak, and so such cocoons cannot be kept stored in thick layers, because of the risk of the pupae in the lower layers getting crushed under the weight of the cocoons above and the body fluids spoiling the silk of the cocoons. Steamed cocoons, therefore, are spread in thin layers in trays and the trays kept in shelves with sufficient space between them for satisfactory aeration of cocoons. In addition to this elaborate arrangement, additional labour is employed for giving frequent turnings to the cocoons in storage in order to prevent mould attack and to ensure uniform and quick drying. In spite of the care taken, often humidity in the store room increases due to natural evaporation of the moisture from the pupae and as a result, conditions favorable for formation of mould on the stored cocoons are created. This is really a serious problem specially during the rainy season. Further, the damaged wet pupae decompose rapidly and stain the silk shell, and damage the reeling properties of the cocoons. Prolonged exposure of fresh cocoons to wet hot steam also denatures sericin in the cocoon and consequently alters the behavior of cocoons in the cooking process and later in the reeling process, resulting in increased silk wastage and spoilage of the quality of reeled silk in respect of cleanness. Steamed cocoons cannot be reeled immediately after steaming because the sericin will be wet, hot

swollen and soft. Cocoons reeled in this condition lead to too much wastage of silk in cooking and reeling, and cleanness defects also increase in the raw silk reeled. Hence the steamed cocoons are aired at least for two to three days for seasoning before storing.

In the sericulturally advanced countries, stifling of cocoons by steam has been largely replaced by hot air which also dries the stifled cocoons, in all the modern silk reeling factories. This method of stifling and drying the cocoons is known as hot air conditioning. Hot air conditioning is carried out in chambers of special design for a required period with the object of killing the pupae and drying it either fully or partially to the desired degree of dryness.

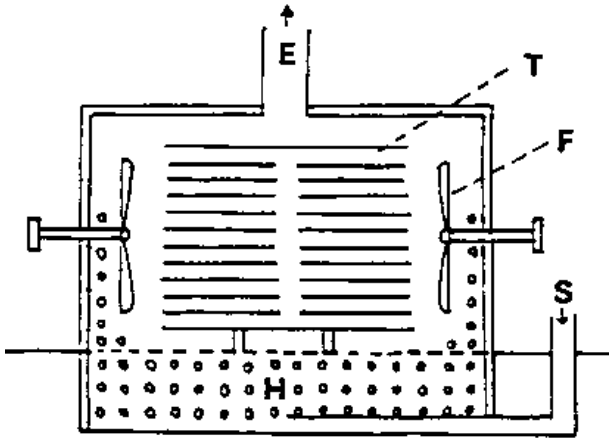
Hot Air Dryer

Hot air conditioning is carried out in specially designed chambers for a required period with the twin objectives of killing the pupae and drying them either fully or partially to a desired degree of dryness. This method of stifling is most scientific. The raw silk from the cocoons stifled by hot air will have superior technological qualities than the steam stifled ones.

Shelf-carrier/Cabinet type dryer: Shelf carrier type drying performs the drying operations in a chamber which has shelf carrier with many trays. The cocoons are dried by the flow of hot air current. This type of driers is very much convenient for small reeling establishments, cocoon testing laboratories and research institutes.

Shelf-carrier/Cabinet type dryer

T: cocoon tray, H: heater, F: fan, S: air inlet, E: air outlet



ii. Conveyor Type: A **conveyor** system is a common piece of mechanical handling equipment that moves cocoons from one location to another.

In the **Yamato dryer**, there are eight conveyor platforms - one in each chamber - arranged one below the other in zig-zag fashion (Fig.). Such platforms are usually 18 m long and in operation move at a speed of 18 to 24 m per hour. Thus the total length traversed by the cocoons in the process of conditioning is 144 m and the time taken for full conditioning is about six to eight hours depending upon the speed of the conveyor platform or belts. In order to make the movement of cocoons from one platform to another automatic and continuous, the movement of the conveyor belts are regulated in such a way that each conveyor moves in the direction opposite to the conveyor next to it in the lower chamber. There are special arrangements to control the air current and to diffuse the hot air in the several layers of the cocoons in the conveyor belt for ensuring uniform and efficient drying of the cocoons. In a cocoon drying chamber having 8000 kg capacity the following indicates the process of conditioning. The first five chambers have temperatures in the following descending order:

1st -93-95°C	4th- 77-80°C
2nd- 84-85°C	5th-74-75°C
3rd- 80-82°C	

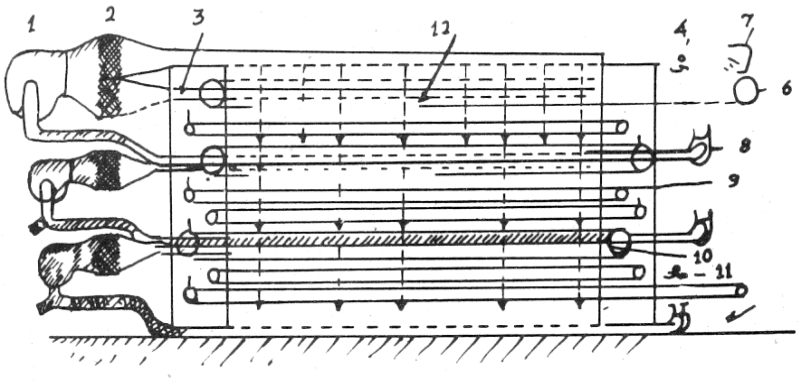
These five shelves are the shelves in which drying occurs progressively. In the succeeding three shelves the temperature is as follows

6th-65°C	8th- 54°C
7th- 60°C	

And here the gradual cooling of the cocoons occurs along with drying of the remaining moisture in the cocoons. The total time taken for the whole process from charge to discharge is eight hours. As most of the operations are done mechanically, two or three operators can easily look after the drying and bagging operations. The conditioned cocoons are automatically packed in large moisture and insect proof paper bags with double covering.

What makes the conveyor system successful and efficient in the sericulturally progressive countries is firstly that the cocoons produced are hard and more or less uniform in size and shape, and secondly that the surface of the cocoons are clean and

free from floss. The former characteristics enable the cocoons to pass through the small openings between the moving platforms or conveyors and the fixed or stationary edges, without the cocoons getting flattened or damaged, while the less flossy quality helps the cocoons to remain loose and independent and fall off at required places without sticking to the conveyor or to any other projections in the chamber. Further the clean or floss free cocoons do not lump or club together and abstract uniform drying.



"Yamoto" hot air drying machine

1.Blower 2. Heater 3. Hot Air Duct into Chamber 4. Air Exhaust from chamber 5. Air inlet 6. Conveyer 7. Automatic cocoon feeder 8. Exhaust fan 9. Screen type cocoon conveyer 10. Chamber partition board 11. Cocoon cooler 12. Thermo indicator

Other Methods: Many methods other than steam and hot air have also been tried for killing the pupae. They are i. Use of infra red rays, ii. Cold air killing, iii.Radio wave killing, iv. Poisonous gases etc.,

Storage of Cocoons

Storage of cocoons is an important problem especially when the stifled cocoons have to be stored for a very long period as in the case of univoltine areas, or when the seasonal conditions are unfavourable. Complete desiccation of cocoons is a fairly satisfactory solution to the problem but even fully desiccated cocoons are liable to

mould damage if the storage room is not kept dry. The other source of damage to cocoons in storage comes from the *Dermested*beetle. This beetle feeds on the fat contents of the pupae and to do so it cuts the silk shell and damages the cocoons. The beetle is attracted to the cocoon by the smell of the putrefying pupa as in the case of stained cocoons. Preventive measures against this pest are more efficacious than curative ones. The primary care to be taken is to pick out all spotted and stained cocoons and throw them out as far away as possible from the healthy cocoons. Similarly care must be taken to see that waste cocoons and silk are stored as far away as possible from the cocoon stores. The walls and ceilings should be periodically disinfected. If insects are found in a package of cocoons all the cocoons in the container should be passed through dry hot air at 60-70°C for some time, till all the insects are killed.

Damage due to moulds

Mould develops when the cocoon store becomes damp and humid and when the cocoons are not hilly dryas in the case of partial conditioning or steaming. Hence it is of utmost importance to prevent such conditions by taking the following precautions:

(1) Complete desiccation of cocoons before storing should be ensured.

(2) All care should be taken to see that the relative humidity in the store room does not rise above 70%.

(3) The store room must have good ventilation.

(4) Cocoons should be given regular and frequent turnings during the period of storage and on no account should they be allowed to become damp. When fumigants are used care should be taken to keep the doors and windows open until all the traces of fumigants are removed.

Sorting of Cocoons

Although the rearers of silkworms sort out the defective cocoons as well as the double cocoons before taking the cocoon produce to the market, there may still be a small percentage of defective cocoons which would have escaped preliminary sorting. It is also possible that some of the cocoons become defective when they are subsequently handled in the process of transporting, stifling, storing etc. Hence the cocoons require a second sorting to ensure uniform good quality cocoons for reeling.

The type of defectives generally encountered in the second sorting are double cocoons, crushed and stained cocoons, cocoons with flimsy shell, malformed cocoons, fluffy cocoons and insect-damaged cocoons. These may be found only in very small quantities but even then they should be removed and rejected for production of high grade raw silk. .

The cocoons are spread out on tables with low partitions and the sorters sit around the tables and pick out the defective and double cocoons separately. The double cocoons are later used for reeling dupion silk. The sorting room is generally located close to the cocoon stores and is provided with good ventilation and lighting.

In many filatures the cocoon stores are invariable provided with spacious open verandahs which are used for cocoon sorting operations. In Indian filatures, instead of using tables with low partitions, convenient sized bamboo trays or mats are used for keeping the cocoons for sorting. Rejections are placed in separate containers.

The disadvantage in the methods described above is that they do not detect defects that may be inside the cocoon shell, and such cocoons pass on to the lot of reeling cocoons. Only the obviously defective cocoons are rejected. This system of sorting, therefore, does not commend itself to modem techniques of reeling which aim at producing predetermined qualities of raw silk.

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