# COCOON COOKING/BOILING

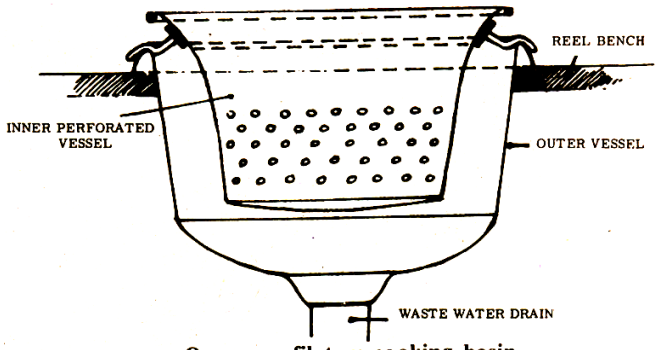
The sericin or the silk gum present on the cocoon filament keeps them together compactly in the shell. This is softened with hot water or steam, so that the filament can be wound on the reel without breaks or entanglement. This process is called cocoon cooking. There are different methods of cooking to suit the different reeling systems. Important among them are cooking for float reeling and for sunken reeling.

**Cooking for float reeling**

In India, generally cooking for float reeling is followed both in small and big reeling establishments. The cooking for float reeling is divided into two types namely open pan cooking and three pan cooking.

## Open pan cooking

This method consists in cooking cocoons in ordinary open pans or vessels made of either earthenware or copper sheet with tinning inside the vessel (Fig.). Water is poured into the vessel and brought to boiling by application of direct heat from the fire below the basins. When the water begins to boil a handful of cocoons is put into the boiling water and kept immersed in water for a few minutes by using a perforated ladle. When the cocoons appear dull in colour and somewhat translucent, they feel soapy to touch and the filaments easily come off when pulled. Cocoons in this condition are reckoned to be cooked.




**Open pan filature cooking basin**

This method of cooking though simple is technically defective. The outer layers of the cocoon in contact with hot water get cooked earlier than the middle or inner layers and if the cooking is continued till these layers also get properly cooked, the outer layer gets overcooked. This results in unnecessary dissolution or over-softening of the gum which causes the filament to come off in lump and also spoils the cohesion, lustre and cleanness of the reeled silk.

Whereas, if the cocoons are removed for reeling soon after the outer layers are cooked, reeling becomes difficult when the middle and inner layers are reached.In either case wastage of silk increases. However, the defect of under cooking is overcome to some extent by keeping the reeling water at a high temperature, which adds to the cost of reeling besides causing other inconveniences to the reeler.

These defects of the common open-pan system of cooking are reduced to some extent in cooking basins provided with an automatic brushing device. In this method when the brush is lowered into the basin after the exterior of the cocoons is cooked, the brush fits snugly into the basin and keeps the cocoons well pressed down in the boiling water. This enables cooking to be continued under covered conditions when the brushing is in progress, thereby forcing the boiling water to in flit rate through the shell layers, and soften and loosen the layers evenly throughout.

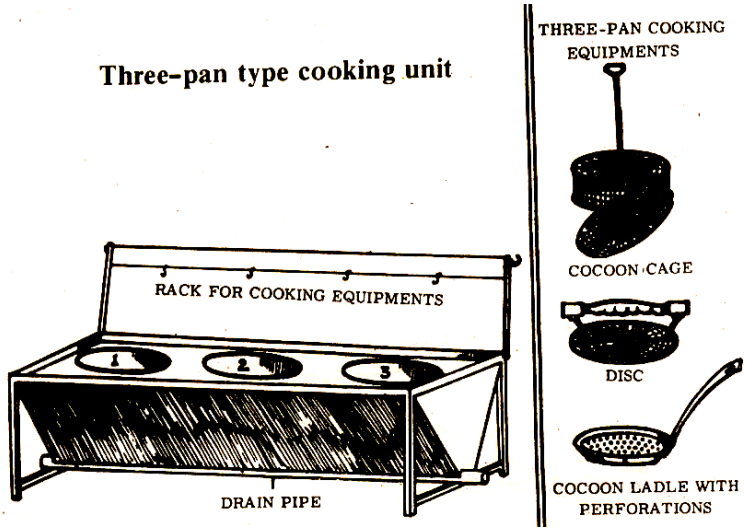
As cooking and brushing are done in the same small basin containing a small quantity of water, the dirt and deleterious substances released from the cocoons make the water dirty with suspended impurities very soon, and the cooking operative has to keep draining the water regularly and adding freshwater to the basin. This naturally increases the consumption of water and steam for heating the water. Increased consumption of water and steam becomes a serious problem where good reeling water and boiler fuel are scarce and costly.

Due to the smallness of the size of cooking basin only small quantities of cocoons can be cooked at a time with the result that the capacity of the basin to supply cooked cocoons for reeling becomes limited. This limitation has to be compensated by increasing the number of cooking units and employing more cooking operatives. All this involves considerable extra expenditure on equipment, labour and space.

Lastly, as cooking of cocoons even of the same batch is done in several basins in small quantities by different operatives, there are bound to be variations in the degree of cooking or in the quantity of waste removed from cocoons in the several basins. Thus, this type of cooking is not conducive to standardization of cooking and removal of waste, and therefore, offers no scope for standardization of the economics of cooking operation.

The only advantage of importance in this system is that the cooking operations are done in front of the reeler himself who can give timely instructions and guidance to the cooker regarding the degree of cooking required, and the cooker can easily manipulate the operations to suit the requirements of the reeler.

## Three Pan Type




The deficiencies of the open pan type cooking have been overcome to a considerable extent by adopting a system of cooking totally different from that of the basin type, (Fig.) and it is popularly called "three pan type of cooking." This method consists of simple cooking equipment having three fairly large sized porcelain basins fitted in a row on a platform or table. The basins are provided with water and steam connections. The accessory equipment consists of a long handled brass wire cage for holding the cocoons, a wiremesh disc of a special design with wooden handle for keeping the cocoons immersed in the basin, and long handled perforated ladles. An open shelf is provided as an integral part of the table in front of the basins for keeping the accessories. Towards the end of the table a platform for keeping the trough which receives the boiled cocoons is provided. In addition to these, the cooking unit is served by trolleys for carrying small wooden tubs with water for transporting the cooked cocoons from the cooking unit to the reeling basins.

The three large basins are filled with water and the temperature brought up to 90ºC or 95ºC in the first and last pans while the temperature in the mid pan is kept at 60ºC-65ºC. The water in the receiving trough and in the cocoon carrier basins is kept at 40ºC-45ºC. A required quantity of cocoons is taken and placed in the wire cage and after securely fastening the cage it is immersed in the first pan for about 60 seconds. In this pan air in the cocoon cavity is heated and expelled. The cocoon cage is briskly lifted out of this pan and immersed in the second pan containing water at 65ºC for 30 or 40 seconds. Here the air inside the cocoons contracts and water from the basin is sucked in. Hot water permeates as a result of the first dip. In this process

the cocoon shell layers are loosened and the hot water entering through the shell softens and swells the sericin layer and water partly fills the cocoon cavity. From the second pan the cocoons are discharged into the third pan having water at 90 or 95ºC, and the cocoons are kept immersed by pressing down with the specially designed wire mesh disc. Sometimes the pan is also closed with a lid. In this basin the hot water at 90 or 95°C thoroughly soaks the cocoons and fills up the cavity to a considerable extent. A small quantity of sericin is also dissolved. The cocoons are kept immersed in this basin for one to two minutes depending on the quality of the cocoons used and the degree of cooking required.

From the third pan the cocoons are transferred using long handled perforated ladles to the cocoon-receiving trough for onward supply in small buckets to the reeling basins for brushing and reeling. The process is made continuous by having two or more sets of the accessories and charging the vacant basins with cages with freshly filled cocoons as quickly as possible.

**The advantages of this method are:**

(i)Cocoon in sufficiently large quantities are cooked in a short time, and as the capacity of each unit is about 60 to 70 kg of cocoons per day, one unit can easily supply cocoons to ten or twelve multi-end reeling basins with one or two operatives attending to the cooking unit. Thus labour is saved to a considerable extent.

(ii) As the method involves permeation of water into the cocoon the intricate crossings at the different cocoon layers gets wollen and loosened and thus improve the unwinding quality of the filament.

(iii) All the cocoons are subjected to the same treatment and for the same period and hence uniformity in cooking is obtained.

(iv) As brushing of cocoons is done separately the cooking water does not soon become turbid.

(v) As the cooking unit is situated away from the reeling basin and attended to by a separate skilled operator exclusively for the purpose, more efficient cooking becomes possible and the reelers can concentrate their attention on the all important and skilled work or reeling without any distraction.

**The disadvantages of both open-pan and three-pan cooking for float reeling are:**

(i) Reeling has to be done at a higher temperature which tends to affect the palm and fingers of the reelers and thus impair their reeling efficiency.

(ii) Larger quantities of steam are required for heating the reeling water and water vapour from

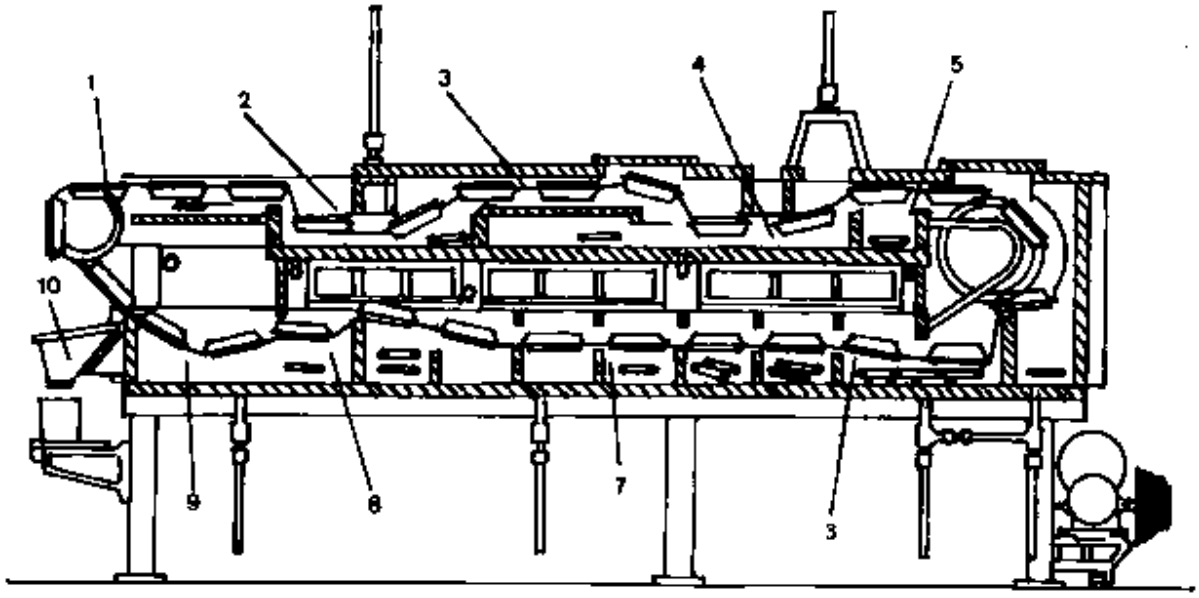
the reeling basin increases the humidity in the hall and decreases the visibility especially during the rainy and winter seasons. Increased steam requirements also add to the cost of reeling.

(iii) As cocoons are not brushed in the cooking basin except in the case where mechanical brushing is provided, brushing would have to be done by a separate set of operatives using separate equipment, or reelers themselves would have to brush the cocoons in a part of the reeling basin. The former would complicate the mechanism and design of the reeling basin besides increasing the workload on the reeler.

(iv) Further as cooking and reeling are separated, cost on equipment and supervisory staff and the additional space required would increase. However, the qualitative output would amply compensate the extra cost.

**Cocoon cooking for sunken reeling**

**Cocoon Cooking Machine**



1.Cocoon hopper part, 2. Soaking part, 3.High temperature permeating part, 4.low temperature permeating part, 5. Cooking part, 6-7.Adjusting part, 8-9.Low temperature finishing part, 10. Cocoon outlet.

This system is so called because the cocoons cooked by this method sink in the water at the time of reeling. Research on the problems of cocoon boiling and their effect on reeling has revealed that the raw silk reeled is greatly influenced by the technique adopted in boiling the cocoons and the conditions of the cocoons at the time of reeling. It is found that cocoons in a sunken condition in the reeling basin yield the silk bave more readily than when they float, thus adding to the ease and efficiency of reeling. Hence attempts were made to obtain the cooked cocoons in a condition which would make them sink in the reeling water. This could be done only by increasing the weight of the cocoons by expelling the air contained in the cocoon cavity and replacing it with water. In this process of filling the cocoons with water, the shell also gets uniformly cooked in all the layers. To achieve this, a special technique is adopted partly derived from the three-pan method of cooking.

One of the methods adopted is to cook the cocoons in a basin containing water at 83-93°C and boil the cocoons under covered conditions. The cover is then removed after a short time and boiling continued for about one third the predetermined time for boiling. Then the cocoons are douched in a cold water spray. Thereafter boiling is again continued for some time under covered conditions. When the boiling has progressed for some time, the heat supply to the water is stopped and the cocoons are once more sprayed with cold water. Then the cocoons are transferred to wooden cocoon carrier tube of convenient size and containing water at 40-45$^0$C for the brushing and reeling units. Cocoons cooked in this method are filled to an extent of 97 per cent of the cavity and therefore sink in the reeling water. As the cocoons have been thoroughly boiled and their sericin softened uniformly in all the layers, there is no need to keep the reeling basin water at a very high temperature, as in the floating system. Tepid or lukewarm water is quite sufficient for the sunken system of reeling.

In all large scale modern reeling establishments using highly developed reeling machinery for large scale production of superior quality raw silk, the three-pan system has been replaced by the conveyor cooking machine or a central cocoon boiling machine.

This equipment consists of a sturdily built long rectangular wooden container (of best quality non-water absorbant cypress wood) firmly held in an iron frame. This container is sub-

divided internally into six processing chambers and one open chamber for loading the cocoons. Each processing chamber has its own specifications of size and constructional design to suit its particular function, (Fig.). Each chamber is also provided with independent water and steam circuits to facilitate maintenance of proper temperature and steam pressure, thermometer and pressure gauges and inspection windows. The chambers containing water are also provided with overflow pipes for draining and maintaining a steady level of water. In some types of cooking machines even automatic devices are provided for obtaining the exact temperature and pressure in the several chambers.

The machine is internally equipped with an endless chain conveyor carrying on it a series of wire cages generally made of brass (as brass has no action on silk) for holding cocoons intended for cooking.

When the machine is in operation the conveyor slowly carries the cocoon cages through the several chambers of the machine. Generally a cone pulley is provided on the main drive shaft to enable adjustment of the speed of the conveyor. This is necessary because the time factor of each process in the several chambers depends upon the length of passage in the chamber and the speed of the conveyor moving through it. As the size of the chamber is fixed, adjustment in speed of the conveyor regulates the time factor for the particular process. As regards cocoon boiling capacity, it is different for different types.

In spite of the seemingly elaborate mechanism of the machine, it is quite simple to operate and needs only one H.P. motor. Only two persons are required to operate it. The operatives however should be technicians and must know how to handle the various controls of the boiling machine. Carelessness in regulating the temperatures and pressures will result in destruction of the cocoons. Hence it is of the utmost importance to determine the temperature and pressure required for a particular lot of cocoons by actual pre-testing of the cocoons for quality, especially regarding percentage of silk, compactness of shell, size and shape. Best results are obtained only when the cocoons are quite uniform in these qualities. The conveyor method of cocoon boiling is a common feature in all modern reeling factories in sericulturally advanced countries. The six different processes or treatments to the cocoons passing through the six chambers of the machine are as follows:

**First Chamber**

This is called the "Dipping" or "Wetting" chamber. It contains water at 40°C to 42°C where the

cocoons are treated for about 30 to 50 seconds. The surface layers of the cocoons which will be in direct contact with hot water swell slightly due to wetting.

**Second Chamber**

This is the steaming or steam blasting chamber. The wetted cocoons coming in from the first chamber are exposed to the action of steam at about 90°-95°C at proper steam pressure. The effect of this treatment is that the air inside the cocoon cavity is heated up to cause its expansion and partial replacement. As the hot dry steam is likely to make the sericin layers stiff and slightly less soluble, the optimum duration of treatment is limited to 60 seconds.

**Third Chamber**

This is the permeating or infiltration chamber and contains water at 40°-60°C. Due to the lower temperature, a partial condensation of the steam occurs in the cocoon cavity and the cocoon sucks in water thereby uniformly wetting all the layers of the silk in the shell, without dissolving the sericin. Treatment time is 30 seconds.

**Fourth Chamber**

This is the steam cooking chamber in which the cocoons from the third chamber are subjected to steam treatment for 118 to 120 seconds keeping the temperature and pressure at 95°C to 98°C and 0.33 kg per $cm^3$ respectively. This treatment causes the sericin to swell and soften the silk layers, and the steam to fill up the cocoon cavity.

**Fifth Chamber**

This is the cocoon boiling and adjusting chamber and is very important because it is in this chamber that the steam contents of the cocoon cavity is replaced by water by gradual condensation of steam in the cocoon obtained by gradual cooling of the water from 98° to 60°C. Accurate maintenance of the reducing temperature - gradient is most important because too sudden cooling causes the cocoon to collapse or buckle. Actual time for the operation depends upon the compactness and other qualities of the shell. Weaker cocoons naturally require a prolonged gradient in temperature adjustment, and therefore takes longer time.

**Sixth Chamber**

This is the finishing chamber containing water at 50°-60°C. In this chamber water easily enters and fills up whatever space is still left in the cocoon cavity leaving only about 3% or less of air space. Cocoons in this condition after 10 or 11 minutes are automatically discharged into a receiving trough containing hot water at 40°-50°C for transfer to the next process of brushing.

The cocoons discharged from the boiling machine are filled with water and therefore sink in reeling water during the reeling operations. Sometimes certain chemicals are also used in the infiltration chamber to enhance reelability. In that event the degree of boiling according to the quality of cocoons is adjusted. Generally the fiber swells and the surrounding area is loosened. The swelling or softening can be accelerated with the aid of swelling agents of the non-ionic or anionic type to improve the unwinding ratio of the filament. These agents are selected according to the hardness of the cocoon shell. Optimum dosages are arrived at after trials with the quality of cocoons available in different regions and seasons.

The main advantages of this method of cocoon boiling for the sunken system of reeling are:

(i) Degree of cooking is uniformly achieved in all cocoons and in all layers.

(ii) Reelability is improved and enables reeling of 40 to 50 ends by one reeler thus increasing the output per reeler.

(iii) Only nine to ten trained workers are required for supplying cooked cocoons to about 400 multi-end basins, whereas in the ordinary type a minimum of 200 cookers would be required. This economy in labour requirements is of special importance in countries where labour is scarce and costly.

(iv) The percentage of wastage is reduced and standardized.

(v) As reeling is done in tepid or lukewarm water, steam consumption for heating reeling water is considerably reduced and therefore, water and fuel economy is attained. Using less steam in the reeling hall reduces mill dampness and vapour formation in summer and winter. Reduced mill' dampness considerably prevents occurrence of such defects as hard gum spots, ribbing and plastering defects and improves ventilation and visibility.

(vi) Low temperature of reeling water does not injure the fingers and palm of the reelers and, therefore, does not in any way impair their reeling efficiency.

(vii) Due to non dissolution of sericin and avoidance of over-softening of the sericin, cohesion of' reeled silk is very good.

The modern concept of rational reeling is to unwind the filament at a slow speed to avoid excessive tension and to provide sufficient opportunity to maintain the requisite number of cocoons at each end. In other words, slow reeling over a number of ends ensures higher productivity and greater evenness and cleanness standards for the raw silk.

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