# TECHNOLOGICAL DEVELOPMENT OF THE TEA INDUSTRY IN SRI LANKA

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*"With regard to the manufacture of tea, I learned that mainly from others and from reading, but it took a lot of experimenting before I was very successful. About the time that we began planting China tea from seed got from Peradeniya Garden, a Mr Noble; an Indian tea planter from Cachar passed through to see a neighbouring coffee estate, and I got him to show me the way to pluck and wither and roll tea with a little leaf growing on some old tea bushes in my bungalow garden. It was all rolled by hand then. He told me about fermenting and panning and the process. After that I frequently made experimental lots, as I got leaf to pluck". (James Taylor writing of his first experiments of tea leaf processing in 1870).*

The technology pertaining to the processing of tea was first introduced to Sri Lanka in the 1870's by pioneer tea planter, James Taylor, who learnt the process from visiting British planters from Assam, and further developed it through his own experiments and trials. The green leaf was subjected to the process of withering naturally without the use of hot air, the factories being ideally located at a high elevation to take in the direct draft of ambient air. The naturally withered leaf was then rolled on orthodox Rollers an the dhools extracted on manually operated mesh frames, were fired on multiple tray Driers heated by direct fired heaters. Grading was again on manually operated mesh frames after which the made tea was hand packed and dispatched to the auctions.

Since then the Industry has seen many changes in each stage of processing, but due to the stringent controls and traditional market demands covering a period of more than 100 years, technological development has been relatively slow, resulting in a very gradual change in each stage of manufacture, as indicated below.

## WITHERING

As natural withering depended on weather conditions, this restricted the intake of crops, and hence it was necessary to introduce withering fans which were located in a central bulking chamber in the case of most average size factories. In larger factories two gable end fans were also required particularly to reverse the direction of air by means of trap doors located at the delivery end of the fans.

Initially the leaf was spread on collapsible wooden tats for ease of collecting after withering, but this was improved on with the introduction of jute hessian tats which permitted air flow, but were not collapsible, the leaf being swept down after withering.

With the steady increase in crops natural withers were not possible and hot air had to be provided into the loft, the source of heat being the same as that used for drying.

With the introduction of polyvinyl fibres, the jute hessian was gradually replaced by nylon netting, and due to the increased air flow possible the spreading capacity also increased by about 40 percent.

With the introduction of V.P tea with very much higher yields, the crops increased still further, necessitating a considerable increase in tat capacity which meant addditional lofts which proved very expensive.

As a result withering troughs were introduced with individual fans and controls, with a very much higher capacity and gave better and quicker withers than the tats. Withering is thus now confined mainly to these through units which can vary in length to suit any factory, being fitted with varying sizes of fans and motors.

Recording hygrometers which were installed earlier in central bulking chambers however, are now not provided with the trough units due to cost considerations, although an ordinary hygrometer is fitted to each trough. In some instances recording thermographs have been fitted to record the inslet temperature at each trough unit.

## ROLLING

The early 'triple' and 'double' action orthodox Rollers have been replaced with the single action rollers in the low country districts which resort to orthodox Rolling. Roller capacities have remained the same largely due to the action required and more rollers being made available for the larger crops. There has not been very much of a change in the roller table and door fittings in the recent past. Rollbreaking is still carried out on reciprocating rollbreakers in the low country which are found preferable to the more recently introduced rotary rollerbreaker.

In the higher elevations orthodox rolling was gradually replaced by the higher capacity Rotorvanes in the early sixties, particularly as better and brighter liquores were obtained through the relatively more severe action of the Rotorvane, despite a slight drop in appearence. Initially although only one Rotorvane pass was carried out, gradually three passes were found acceptable without much loss in apperance.

Orthodox rollers are however still retained for a condition roll prior to Rotorvaning and also for a final roll of the big bulk.

In the early seventies another new machine was introduced to Sri Lanka after satisfactory performance in neighbouring India. This was the CTC (Crush/Tear/Curl) machine which did not perform as well as in India due to the different jat of tea grown here, despite several attempts to produce a

good CTC tea. However with the increase in demand for CTC teas with the introduction of the tea bag, CTC manufacture is once again being tried out in Sri Lanka on a larger scale than before.

With the continuing increase in crops throughout the world another new machine, called the Lawrie Tea Processor (LTP) was successfully tried out in Malawi, in the mid seventies. This is a hammer mill with a very high output and suitable only for very large factories. This machine was introduced to Sri Lanka in 1981 and although tried out in over ten factories, has not proved a winner as yet; The Sri Lanka Tea Board has yet to approve this machine for the industry.

In the higher elevations the earlier reciprocating rollbreakers have been replaced by the Rotary Rollbreaker which has been found preferable for Rotorvane manufacture.

Rollbreaker design has also improved over the years with the production of smaller dhools.The recently introduced Aerator Bellbreaker is now considered standard with every Rotorvane.

Adequate Humidification required for the rolling process provided earlier from Humidifying Chambers fitted with water jets and fans, has now been superseded by individual electrically driven Humidifying units of both the directional and non-directional type.

Although Fermentation Units have been tried out from time to time these do not appear to have proved sucessful, and best results continue to be obtained from the tables or on the floor, possibly due to the varied conditions of both weather and wither we experience.

With the introduction of Rotorvanes which are smaller machines with much higher capacities, a considerable reduction in Rolling room space was possible, and this available space was used for additional Driers required, thereby avoiding major extensions to factory buildings.

## DRYING

The process of tea drying is considered the most important stage of making black tea and hence there has been technological development both in respect of the chamber in which the tea is dried and the source of heat and type of fuel used.

The early conventional orthodox driers consisted of three sets of large perforation trays which moved the wet dhools in a stream of hot air provided by a paddle type fan and an indirect fired tubular heater using firewood. With the introduction of vane manufacture producing smaller dhools the size of perforation had to be reduced to prevent the fall-through of dhools.

When CIC manufacture was introduced the three sets of trays band) were reduced to two long sets of trays (two band) with a by-pass arrangement for hot air to be chanell ed direct to the feeding end with a view to arresting the process of fermentation before drying took place. Although this proved useful in the case of CTC teas requiring a high rate of moisture extraction, it was not much of an advantage in the case of Orthodox/Rotorvane teas which require a much lower rate of moisture extrac tion.

Whilst the two band drier chambers are shorter and thereby enable the operator to see the movement of tea in the chamber, it occupies more space than the three band drier chamber which is taller but shorter.

The basic design of this type of perforation tray chamber has remaind the same over the past 50 years or so, but improvements have been made in respect of fine control of the tray speed by the introduction of the continuously variable spee reduction gear units, the monitoring of inlet and exhaust temperature by thermograph units, and discharge of fall-through by means of a mechanical scraper at the bottom of the chamber. Different types of the baffles and brushers have also been introduced to reduce turbulence and thereby maintain an even spread of dhools in the chamber.

The stem type vertical thermometers have also been replaced with the capillary wire and probe type dial thermometers, enabling the thermometers to be installed at a conveient location for easy viewing.

The capacity of the perforated tray dryer however was limited by the size of fan and horse power required, and the physical size of the chamber itself. Thus the only possible means of increasing capacity was by improving the means of moving the dhools in the stream of hot air. It was in the late sixties that the principle of 'Fluidisation' was applied to the drying of tea dhools on an experimental basis and after a period of 5 years of research and development by the T.R.I. Sri Lanka and the C.C.C.(Engineers) Ltd., the first commercial model of the fluid bed Tea Drier was introduced to the tea industry in 1973.

This consisted of a series of compartments with a common slotted grid plate through which hot air at a temperature much higher than usual was passed at different air velocities under pressure enabling the particles of tea dhools to be fluidised in constant motion, and thereby facilitate the even extraction of moisture from all sides of the particles. As the moisture was extracted the particles of tea became lighter and automatically flowed down, to the end of the chamber to be cooled in a separate cooling chamber from where the tea discharged ready for sifting.

The main advantages of this 'Fluidbed' technology was the increase in drier capacity by about 35 percent, the more even extraction of moisture, the blacker teas due to less moving parts in the chamber, the automatic blowout of fluff and fibre du-

ring the process of drying, the very much higher fuel efficiency and the immediate sifting of the cooled fired teas. As a result this machine revolutionised the whole concept of tea drying throughout the world, and is thus covered by world patents.

The type of heater used was the oil fired heat exchnger which provided the higher temperature required for the high thermal efficiency possible on the principle of fluidisation.

Over the past 10 years the chamber has been improved upon, increasing fluidisation, minimising air leaks, and facilitating the convenient cleaning and maintenance of the chamber.

The type of air heater has remained the same for the same period of time as the tray chamber, particularly as the fuel used has been firewood. With the availability of industrial liquid fuel (both diesel and furnance) in the early sixties the tubeless heat exchanger was developed, increasing heater efficiency quite considerably as due to the absence of any residues it was possible to have a direct fired heater where the products of combustion were part of the hot air stream. Although this proved to be very economical and convenient initially, complaints of taint in the tea were received as time went on, possibly when oil burners malfunctioned and there was incomplete combustion. The problem was further aggravated when the sulphur deposits in the furnance fuel tended to cause corrosion of the metal in both the machine and the factory.

As a result the indrectly fired fine type tubeless Heat Exchanger was designed for oil firing and, although less efficient than the direct fired heater, was considerably more efficient and convenient than the Tubular Heater on firewood.

Diesel fuel was at the time preferable to furnace fuel due to the small price differential, and the lessser problems with the products of combustion.

The type of fan also improved to the centrifugal type permitting the higher speeds required for the new type of heater. However with the sudden increase in the cost of oil in the late seventies and the continuous increase thereafter, the use of firewood had to be reintroduced on the less efficient tubular heaters due to the very high price difference involved.

Certain areas however where firewood is not readily available have continued to use diesel fuel, and have considered coverting back to furnace fuel due to the high price differential prevailing at present, taking adequate care with regard to the products of combustion.

Attempts have also been made to convert the oil fired Heat Exchanger used with fluidbed driers to firewood firing, and this has still to be perfected.

Very recently 'Gasifer' units have also been tried out but are considerably more expensive than the conventional heaters. A new type of directly fired heater using firewood has also been tried out again, but has not proved satisfactory due to problems of taint as experienced earlier. However this process which works on the principle of burning firewood under limited availability of air, is very economical and simple to operate, but must be in terms of an indirectly fired heater to prevent possible tainting of teas.

The type of oil burner has also improved from the semi-automatic to the automatic dual pressure type, to the automatic single pressure type

which appears to work better and requires less adjustments and is thus easier to maintain. Pre-heaters have also been supplied with the burners for the use of furnace fuel if and when necessary.

Exhaust full-height chimneys constructed earlier were replaced with stub chimneys and long flues subsequently, but have since been once again re-introduced due to the problem of smoke blowing back into the factory.

As about 25 percent of the heat is lost in the exhaust system, a small heat exchanger through which the flue gases could be passed, has been suggested to pre-heat the incoming cold air into the heater, and thereby increase the overall heater efficiency. The flue gases could then be channelled into firewood sheds for the drying of firewood, thereby, making full use of the waster heat before these flue gases are released.

## SIFTING

Sifting or grading machinery has developed to some extent to keep up with market trends and can be catogorised into three types, namely stalk extracting, grading and cutting or crushing.

The extraction of stalks and fibre earlier done manually and later on reciprocating bubble trays, is now done by means of static electricity specially generated through the A.C. mains for the purpose. Simple PVC rollers are also used on conveyors to extract stalk and fibre electro statically generated by friction.

Grading performed earlier on multiple trays with the reciprocating action has now been replaced by a rotary action which gives a more even grading. The cleaning and grading carried out on blowers located in front of dust extraction fans in sifting rooms has also now been repalced with the Suction Winnower, the tea being graded into separate compartments and the dust collected separately in a cyclone or dust bag.

Cutting or crushing which did not form a significant part of the sifting process earlier, has played a greater part since the demand for smaller grades increased more recently, and thus in addition to the conventional cutter and nippers, grinding machines have become necessary in most factories.

The extraction of dust from sifting rooms using ducting and ceiling mounted extraction fans, and cyclone dust collectors, have been replaced by ordinary wing type dust fans erected in the sifting room wall, extracting the dust outside the factory, mainly due to the bulkness of the earlier system which was also less efficient.

## BULKING & PACKING

Bulking and packing earlier carried out manually is now done automatically, mainly in larger factories where teas are discharged from individual bins on to a common conveyor which feeds a bulking unit, which in turn after bulking feeds direct into vibratory packers complete with magnetic refuse extractions.

The single packer has now been replaced by the double packer capable of holding two chests, and they are also operated now by means of vibratory electric motors instead of the eccentric "crack" driven units.