

## ROTORVANE MANUFACTURE

A. Thevathasan

*(Research Officer, Technology Division, Tea Research Institute of Sri Lanka, Talawakele, Sri Lanka)*

### INTRODUCTION

Rotorvane continuous tea roller was introduced to tea factories of Sri Lanka in the early sixties. Since then it has been widely used as an alternative to the Orthodox roller in most Up Country and Mid Country factories. Its use in Low Country factories has been minimal.

There is variation in the manner in which the Rotorvane is used in factories. As each factory has its own strategy slight variations in the manner in which it is used could be permissible. However, in practice wide variations are noted in its use and in some instances it has even been misused. Sufficient work has been done to establish the proper use of the Rotorvane and the purpose of this article is to review the work carried out, in this regard and to highlight the optimum conditions under which Rotorvane manufacture could be done which would lead to a better appreciation of its use.

Rotorvanes are available in 8" and 15" sizes. The 15" Rotorvane was introduced to the factories of Sri Lanka very much later than the 8" Rotorvane. It is thought that the capacity of 15" Rotorvane is very large and that it may not be suitable for use in Sri Lankan tea factories as they are relatively small in size. However, the 15" rotorvane when introduced, was used as a conditioner and not as a dhool producer. Now its importance as a dhool

producer has been realised and it is used in many factories producing 0.5 million kg of made tea per annum or more. It is claimed by the users of 15" Rotorvanes, that it can also be used in a similar manner to that of the 8" Rotorvane. However, as this is not substantiated by experimental evidence this article is confined only to the use of the 8" Rotorvane.

There are different makes of 8" Rotorvanes available in Sri Lanka. Basically, the differences are in the materials used on the barrel of the Rotorvanes. One is made out of gun metal and the other out of steel. The mechanical arrangement to drive the shaft is also different; one is fairly compact while the other is slightly large. Apart from these small differences their performance is similar and therefore, what is said in this article will be equally applicable to all makes.

#### **TYPE AND STANDARD OF LEAF**

It was earlier assumed that a better standard of leaf was needed for Rotorvane manufacture to produce teas comparable to that produced from Orthodox manufacture. This assumption was made because the tea manufactured by Rotorvane was rather brownish and not as well twisted as that from an Orthodox roller and the tip was also destroyed (Weragoda, 1964). But later it was established that with good average standard of leaf, good withers and correct application of speed and pressure it too can produce almost similar or better teas (de Silva and Sanderson, 1964). It is obvious that a good standard leaf is the better choice for better final product, whether it is a pure Orthodox or for Rotorvane manufacture.

As far as the type of leaf is concerned it has been generally thought that a better leaf could be manufactured from a high jat Assam type of leaf by the use of the Rotorvane compared to that from a low jat china leaf. However, experimental evidence has shown that tea manufactured from the low jat china

leaf by the Rotorvane process is superior to that of the corresponding Orthodox control in respect to colour of liquor (Kirtisinghe and de Silva, 1970). Other liquoring characteristics and valuations were also not different from that of the control.

## **DEGREE OF WITHER**

The degree of wither and its influence on Rotorvane manufacture has been investigated (de Silva and Kirtisinghe, 1966). Various degrees of wither ranging from soft (47-43% OT.MT/WL) to hard (47-49% OT.MT/WL) were studied in relation to dhool out-turns, grade out-turns and made tea characteristics. It has been found that soft and medium (44-46% OT.MT/WL) withers are preferred to hard withers. On the other hand some estates claim that the hard withers are better for Rotorvane tea provided the leaf standard is better than average. Our personal experience has shown that among the soft and the medium withers, soft withers are preferred to medium withers if the standard of leaf is below average otherwise medium withers are preferred for both Orthodox and Rotorvane manufacture. This is because of the difficulty in getting uniform withers with relatively poor standard of leaf.

## **CONDITIONING OF LEAF PRIOR TO ROTORVANING**

At the commencement when Rotorvane was used as an alternative to the Orthodox roller, unconditioned withered leaf was fed into the Rotorvane. The tea produced thus was brownish in colour and the style too was inferior to that of Orthodox tea. Consequently studies were undertaken to improve the brownness and the appearance of the leaf. Conditioning of the leaf by rolling in an Orthodox roller with very light pressure for a short time prior to Rotorvaning has improved the appearance. Light rolling in an Orthodox roller imparts mechanical twist to the leaf and preserves the traditional appearance. In addition it also improves the blackness of the tea.

Wickremasinghe et al. (1965) studied the proportion of oxidized to unoxidized and partially oxidized polyphenols in tea manufactured by different processes. In this study it was shown that more drastic methods of leaf maceration reduce the degree of oxidization undergone by polyphenols during manufacture. It was also found that the conversion of the chlorophylls of tea leaf to breakdown products was less during Rotorvane and CTC than in the conventional manufacture and it was suggested that this may contribute to the relative brownness of tea made by the Rotorvane and CTC process of manufacture. In Orthodox manufacture, chlorophyll and chlorophyllase are allowed to mix only gradually and at a slower rate and this gives time for enzyme inhibiting compounds (theaflavins, tannins) to interact with and inhibit chlorophyllase activity and so favour the production of blacker tea (Wickremasinghe, 1978). Careful conditioning of withered leaf by rolling in an Orthodox roller with little or no pressure prior to Rotorvaning will also favour the above condition and help to produce blacker tea in a mixed Rotorvane - Orthodox manufacture.

In order to achieve proper conditioned effect, withered leaf should be rolled lightly in an Orthodox roller to ensure minimum breaking up of leaf into pieces. Ideally this causes internal cell rupture and imparts twist. In practice this could be judged by visual observation of the conditioned leaf mass where not many broken pieces should be noticed and the leaf should be well twisted and squeezed.

## COMMON ERRORS IN CONDITIONING

### 1. Load

For conditioning, the charge should be very much lower than the charge that is recommended for rolling normally. For example the charge of about 250 kg (550 lb) of withered leaf in a 46.5"/47" roller can be considered optimum for conditioning.

2. Pressure

Little or no pressure should be applied. The pressure cap should be just touching the leaf to prevent the leaf spill off.

3. Choice of Cone

The roller used for conditioning should have a mild cone like Keegel or mild Rettle cone.

4. Period

The period of conditioning should not exceed 15 minutes.

### **ARRANGEMENT OF FEED WORM, VANES, END PLATES AND CONE ATTACHMENT**

Feed worm is a short screw type conveyor which feeds the leaf into the barrel of the Rotorvane. At the end of the feed worm there are vanes which are of different types. These are the forward and reverse pitch vanes. As the vanes are positioned at an angle to the plane of rotation, they impart, simultaneously, rotary and linear motion to the leaf. This results in the rolling and rupturing of the leaf. The forward pitch vane propels the leaf in the forward direction to help feeding while the reverse pitch vane resists forward motion and therefore increases the barrel pressure. It should be noted that the action of forward and reverse pitch vanes is reversed if the rotation of the shaft is changed in direction. Therefore care should be taken to select the forward and reverse pitch vanes for handed pairs of Rotorvanes where the rotation of the shafts are in opposite direction.

End plates which fit neatly into the discharge end of the Rotorvane cylinder have been designed to add pressure to the leaf within the cylinder. Iris and Floral end plates are popularly used. The cone attachment to the Rotorvane roller was developed for the purpose of improving the twisting and cell rupturing action of the Rotorvane machine. A comparative study has shown that the cone attachment is not superior to the Iris end plate in performance (Samarasingham, 1976).

Vanes, end plates, etc. put out in the market recently are of varying dimensions and the angle of pitch and thickness appears to vary considerably. Since the performance of the Rotorvane is governed mostly by these parameters it is necessary to have some standard for the dimensions of the vanes, end plates, internal diameter of the barrel, size of the resisters, etc.

The influence of different types of vanes like distance pieces, conical vanes, forward pitch vanes, reverse pitch vanes, etc. on dhool and grade out-turns has also been studied (Kirtisinghe, 1967). It has been established that the dhool out-turn can be varied by different combinations of vanes. However, these combinations could not produce any significant difference in the grade out-turn or the total main grade percentage.

A combination of eight forward pitch vanes and a reverse pitch vane at the centre coupled with Iris end plate at maximum pressure position was considered superior in relation to made tea characteristics and overall valuation among the combinations tried (de Silva, 1965).

## **FEEDING RATE AND ROTOR SHAFT SPEED**

For a given rotor shaft speed the feeding rate is one of the factors that determines the quantity of leaf held within the Rotorvane barrel under equilibrium conditions. Further, it has been

mathematically shown that as the feed rate increases, the amount of leaf held within the Rotorvane barrel also increases. In addition, the relative feed rate which is defined as the ratio of absolute feeding rate (lb/min) and the speed of the rotation of the shaft (rev./min), has been shown to be the most important parameter in Rotorvane rolling (de Silva, 1965). In this experiment it has been concluded that most probably a feed rate of around 0.5 (lb/min) (revolution of rotor shaft/min) is ideal for development of made tea characteristics. The rotor shaft speeds considered for the above experiment were 16, 25.5 and 36 rpm. However, employing rotor shaft speeds of 16, 25.5, 36 and 50 rpm it has been postulated that the dhool outturns, grade outturns and made tea characteristics produced using similar Rotorvanes to be independent of rotor shaft speeds or absolute feed rates provided the relative feeding rate is kept constant (de Silva, 1970).

Consistent performance of Rotorvaning can be obtained by maintaining the feeding rate constant throughout the process. This can be achieved by means of a conveyor feed.

## ROLLING PROGRAMMES

Among a number of rolling programmes tried out using Rotorvanes the following rolling programme has been found to be the most desirable (de Silva and Sanderson, 1964):

Leaf was conditioned in an Orthodox roller for a period of 10 minutes under light pressure. The conditioned leaf was passed through the Rotorvane once and the dhool was extracted using a Rotorvane Ball breaker (aerator ball breaker) and an ordinary roll breaker. The bulk was given two 30 minute Orthodox rolls. The dhool percentage aimed at the 1st, 2nd and

3rd rollings were 40, 25 and 25 respectively to reduce the Big Bulk to about 10 %. It was claimed that this programme had produced a tea that was superior to that manufactured by the pure Orthodox programme. In the above mixed Rotorvane - Orthodox programme the dhools were extracted over No. 5 and 6 mesh combination on the roll breaker. The total main grades obtained were not less than 80 % and consisted of BOP about 45 %, BOPF about 20 % and Dust about 15 %.

The present trend is for larger percentage of small leaf grades. Use of small roll breaker mesh No. 7 has increased the percentage of small leaf grades like BOPF and Dust by about 15 % (Abdul Gaffar and Thevathasan, 1981) at the expense of BOP percentage.

Until recently two consecutive passes through the Rotorvane were found to be unsatisfactory to produce more small leaf grades due to the adverse effect on the appearance of the tea produced. An alternative to the widely accepted method of Rotorvane - Orthodox manufacture has been worked out (Abdul Gaffar and Thevathasan, 1981). In this programme the conditioned leaf was given one pass through the Rotorvane followed by an Orthodox roll for a period of 30 minutes prior to the second Rotorvane pass. This work has shown that the introduction of the Orthodox roll between the two Rotorvane passes overcomes the disadvantage of inferior appearance and also brings about a small increase in the BOPF grade percentage.

### **ROTORVANE AERATOR BALL BREAKER**

In Rotorvane manufacture the leaf particles tend to ball very tight and the conventional paddle type ball breaker arrangement on the roll breakers does not have the desired effect of breaking up these 'balls' satisfactorily (Weragoda, 1964). It was for this reason that the Rotorvane ball breaker and aerator were

introduced. This machine is a simplified Rotorvane. It consists of a cylinder of internal diameter of about 12" and approximately 1.5 feet in length with a worm and six forward pitch vanes rotating between smooth round resisters fixed inside the barrel with an open discharge end. The speed of the aerator shaft is relatively high (650 rpm). Its function is supplementary to the Rotorvane, loosening the balled leaf discharge from the Rotorvane. It also induces evaporation cooling of the leaf by a high degree of aeration. The fear of opening up of leaf in this process is unfounded. It is known that this machine is used in many factories quite successfully.

## PERIOD OF FERMENTATION

Experiments carried out at high elevations have indicated that the normal periods of fermentation as given to Orthodox dhools are equally suitable for Rotorvane dhools (de Silva and Sanderson, 1964).

## GENERAL

The advantages of Rotorvane manufacture found at Aislaby Estate (Lushington, 1965) are listed below:

1. Greater rolling capacity for a given capital outlay.
2. Quicker fermentation and easier control.
3. Better and larger initial dhool percentages.
4. Saving in handling, labour and power.
5. Improvement in Factory lay-out due to less rolling room machinery requirements and easier erection of conveyor systems.
6. Saving in machinery maintenance and repairs to rollers and tables.
7. Improved percentages of main grade tea and
8. Improved liquors and better prices of all grades.

## CONCLUSIONS

1. Considerable amount of research has been done in Sri Lanka in the use of Rotorvane in tea manufacture.
2. Any type of leaf can be processed by Rotorvane. Better results are expected with better standard of leaf.
3. Soft or medium wither is preferred for Rotorvane processing. Slightly harder withers can also be adopted provided the leaf standard is good.
4. Conditioning of withered leaf in an Orthodox roller for a period of 10 to 15 minutes is a must prior to Rotorvaning to improve the blackness and twist.
5. Eight forward pitch vanes and one reverse pitch vane, the latter being placed at the centre coupled with Iris end plate at maximum pressure is generally the ideal arrangement in a Rotorvane.
6. The recommended Rotorvane - Orthodox programme is:
  - a. 10-15 minutes conditioning in an Orthodox roller - No dhools
  - b. One Rotorvane pass - 40% dhools
  - c. 2 x 30 minutes Orthodox rolls - 25% dhools each
  - d. Big Bulk - less than 10%
7. In the above programme the total main grade percentage of 40 - 45% BOP, 20-25% BOPF and 10-15% Dust can be obtained by the use of No. 6 meshes on the roll breaker with an average standard of leaf.

8. Use of smaller meshes - No. 6 and 7 or No. 7 - instead of No. 6 mesh on the roll breaker will bring about 10-15% more BOPF at the expense of BOP percentage .
9. An alternative Rotorvane - Orthodox programme with two Rotorvane passes is:
  - a. 10-15 minutes conditioning in an Orthodox roller - No dhools
  - b. One Rotorvane pass - 40% dhool
  - c. One x 30 minutes Orthodox rolling - 20% dhools
  - d. 2nd Rotorvane pass - 30% dhools
  - e. Big Bulk less than 10%

This programme brings about a small increase in the BOPF percentage.

10. Generally more than two Rotorvane passes in a programme is not recommended due to the adverse effect on the appearance of the tea produced.

#### REFERENCES

- ABDUL GAFFAR, N.M. and THEVATHASAN, A. (1981). Methods to increase the production of small leaf grades using existing machinery. Tea Q. 50, 11-15.
- DE SILVA, W.C.A. and SANDERSON, G.W. (1964). Rotorvane manufacture techniques. Tea Q. 35, 230-234.

- DE SILVA, W.C.A. (1965). The importance of feeding rates in Rotorvane manufacture. Tea Q. 36, 151-166.
- DE SILVA, W.C.A. and Kirtisinghe, D (1966). The influence of the degree of wither on Rotorvane manufacture of high grown leaf. Tea Q. 37, 114-120.
- DE SILVA, W.C.A. and KIRTISINGHE, D. (1970). The influence of feeding rates and rotor-shaft speeds on residence times of tea leaf within Rotorvanes. Tea Q. 41, 127-140.
- KIRTISINGHE, D. and DE SILVA, W.C.A. (1970). Rotorvane Manufacture of China jat leaf and effects of the Floral and Iris end plates. Tea Q. 41, 121-126.
- KIRTISINGHE, D. (1967). Report of the Technologist. Ann. Rep. Tea Res. Inst. Cey. 112-126.
- LUSHINGTON, R.A. (1965). Some investigations on Rotorvane manufacture. Tea Q. 36, 72-81.
- SAMARASINGHAM, S. (1976). Comparison of cone attachment and Iris end plate in mixed Rotorvane - Orthodox manufacture. Tea Q. 46, 37-38.
- WERAGODA, L.S. (1964). Developments in Rotorvane Manufacture. Tea Q. 36, 72-81.
- WICKREMASINGHE, R.L., KIRTISINGHE, D., PERERA, K.P.W.C. and PERERA, V.H. (1965). Effects of method of manufacture on the oxidization of polyphenols and chlorophylls. Tea Q. 36, 167-177.
- WICKREMASINGHE, R.L. (1978). Monographs on tea production in Sri Lanka, No. 7, Facets of Tea Research in practice. (Tea Research Institute of Sri Lanka) pp 65.