

## THE TRI—CCC FLUID-BED TEA DRIER DEVELOPED IN SRI LANKA

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Fluid-bed technology has been successfully applied to the drying of tea dhools and has resulted in the production of a simple drier, smaller, more efficient and cheaper in terms of both capital and operative costs than a modern endless-chain pressure (ECP) drier.

The 'TRI-CCC Fluid Bed Tea Drier' developed in Sri Lanka utilizes only about half as much fuel, requires less power than a conventional ECP drier per unit of output and produces about three times as much tea as an ECP drier per sq. metre of floor area occupied by the drying chambers. An added advantage is that teas are cooled before discharge, eliminating the need for cooling tables.

Tasting reports indicate that the quality of tea dried on the fluid bed is at least equal to, if not superior to those dried conventionally. Drying on a fluid bed also results in improved main grade outturns and in teas with better dry leaf appearance.

### INTRODUCTION

Based on current fuel prices, the cost of fuel is by far the largest single item of factory cost of production, and besides, the capital cost of a drier is also the heaviest item of capital expenditure of tea factory machinery. Notwithstanding these considerations, no basic changes have been instituted in the drying operation since the ECP driers were first introduced in 1907. In ECP driers, drying of tea dhools is carried out on perforated trays arranged one on top of another and fitted on two or three endless bands. While these driers are robust and can dry a tea satisfactorily, the chief disadvantages are

- a) fuel efficiencies are low, resulting in high operating costs,
- b) the high capital cost,
- c) the high maintenance cost on moving parts such as chains and trays,
- d) uneven firing due to fall through and sometimes because of uneven spreading or uneven temperatures or air-flows within the chamber,
- e) the machine, once constructed, has a fixed capacity which cannot be increased or decreased without heavy expenditure.

Despite some difficulties which were earlier expected, the application of fluid-bed technology to the drying of tea was considered the most promising approach for instituting improvements in the tea drying operation. The Tea Research Institute of Sri Lanka (TRI) and the Colombo Commercial Company (Engineers) Limited (CCC) jointly embarked on a programme of research in 1968 to incorporate the advances in techniques, equipment and machinery made in recent years by the food and allied chemical industries, into a modern tea drier. This research has led to the production of the Fluid Bed Tea Drier (FBD), developed in Sri Lanka.

### BEHAVIOUR OF FLUIDIZED SYSTEMS

When air is passed through a bed of granular particles of a suitable size, shape and specific weight, under suitably controlled conditions, the particles can be made to float in the air stream and behave as though it were a liquid. Under these conditions the system is said to be 'fluidized'. In fluidized systems the air stream and

the solid make intimate contact resulting in high rates of drying without the risk of case-hardening. The improved thermal contact between the particles of tea dhool on the bed and the hot air stream result in uniform drying of each particle and in higher drying efficiency at lower drying cost. In a fluidized bed, each particle of tea is surrounded by a cushion of air. This air cushion minimizes particle-to-particle attrition as well as between the particles and the base and side-walls of the drier during the drying process and leads to the production of a tea with a better dry leaf appearance and bloom.

Under fluidized conditions, particles of tea can be made to flow from the feed end of the drier to the discharge end in a manner analogous to that of a fluid and at any predetermined rate without recourse to means of mechanical conveying.

### THE SRI LANKA TRI-CCC FLUID-BED TEA DRIER

Just as in a conventional ECP drier, the Fluid Bed Drier (FBD) consists of a drying chamber connected by duct to a airheater (Fig. 1).

The drying chamber of the FBD is made up of an 'Entry Section', a number of 'Intermediary Mid-Sections' and a 'Cooling *cum* Discharge Section'. The entry and intermediary mid-sections are referred to as drying stages, each having an output capacity of about 75 kg made tea/h with medium-withered leaf. The last stage which is the cooling *cum* discharge section, lowers the tea temperature down to about 5°C above ambient before discharging the dried tea with a final moisture content of 2.5 to 3%.

Modular construction gives the drier flexibility in output, the smallest unit consisting of an entry section and a discharge section without the intermediary sections. This model is referred to as FBD 1, having an output of 75 kg (165 lb) made tea per hour. With the addition of each intermediary mid-section the output capacity increases by an increment of 75 kg made tea/h. The addition of one intermediary mid section, therefore, gives a drier (FBD 2) output of 150 kg (330 lb) made tea/h. Two mid sections (FBD 3) give an hourly output of 225 kg (495 lb), FBD 4 with three mid-sections produces 300 kg (660 lb), FBD 5 with four mid-sections gives 375 Kg, (836 lb) and so on. A single FBD can therefore give an output of over 450 kg (1000 lb) made tea/h if necessary, and a factory could add to, or even decrease, the capacity of an existing FBD machine simply by the addition or removal of mid-sections.

Inside each of these sections is a perforated, stainless steel grid plate which acts as the support for the fluidized bed of tea. Just above this plate is a set of slow-moving 'blow-hole suppressors' whose function is to clear the bed of any blow hole or channel that may be formed while in use. A set of direction control dampers fitted under this grid plate help control the bed at start-up and also help clear the bed at the end of each working day.

Hot air is supplied to the drying chamber from the air heater by means of a heat-insulated underground duct. A special fan of mixed-flow design is used to deliver hot air from the air heater to the drying chamber at a higher temperature and pressure than is normal for a conventional ECP drier. A separate fan, also of mixed-flow design, delivers ambient air to the cooling *cum* discharge section.

## CAPITAL AND OPERATING COSTS

Simplicity of design, higher operational efficiency combined with better thermal insulation have resulted in the production of a drier which is cheaper in capital outlay and in operational cost than an ECP drier of equivalent output. With medium-withered leaf, and an indirectly fired furnace, the following outputs can be expected.

FBD 6.5—7.5 Kg made tea/1 of oil (65-75 lb/gallon)  
ECP 2.5—4.5 Kg made tea/1 of oil (25-45 lb/gallon)

Electrical power consumption is also a factor to be considered carefully, as this too, adds to the cost of production. Comparative figures are

FBD 18—20 Kg made tea/h/Kw (30-34 lb/h/hp)  
ECP 12—17 Kg made tea/h/Kw (20-27 lb/h/hp)

Fewer moving parts mean less maintenance costs on the FBD as compared with the ECP drier. Simplicity of design coupled with higher efficiency have resulted in the production of a smaller and cheaper drier whose capital cost is about 60% of that of an ECP drier of the same output.

## PERFORMANCE

Blow out ranges from 1.0 to 3.8% and is appreciably lower than with ECP driers, and fall through in an FBD is negligible at 0.002%. FBD blow out is constituted almost entirely of particles of fibre, and loss of good tea through entrainment is avoided. A significant increase in main grade return is therefore obtained with the use of the FBD. Big bulk can be dried effectively in the FBD. It cannot, however, cope simultaneously with both of dhool and big bulk in the conventional order of firing.

Partly because there is less attrition during the drying process and partly because of the altered operating parameters, teas dried in the FBD have a blacker dry leaf appearance than teas dried in an ECP drier. Tasting opinions confirm this, and sale price both at the Colombo and London Auctions indicate that teas dried in the FBD are at least equal to, if not superior to comparable teas dried in an ECP drier.

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