# PERFORMANCE EVALUATION OF AN INNOVATIVE TEA DRYER USING MATHEMATICAL MODELING

K Y H D Shantha

08/8036



Degree of Master of Science

Department of Mechanical Engineering

University of Moratuwa

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Kottawa Yaddehige Harsha Dilip Shantha

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Thesis submitted in partial fulfillment of requirement of the degree Master of Science

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## Declaration

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and behalf it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

……. ……

K. Y. H. D Shantha Date



The above candidate has carried out research for the Masters/ M Phil/ PhD thesis/ Dissertation under my supervision.

…… ……..……

Prof. R. A Attalage Mr. D. D Ananda Namal

Supervisor Supervisor

# ABSTRACT

This entire research work is focused for the performance evaluation of an Innovative tea dryer using a technique of mathematical modeling. The innovative tea dryer was designed and fabricated targeting the group of farmers who cultivate bio tea /organic tea in few acres amidst of lot of constraints. Main challenge for the production of tea at small scale is consistent drying. Since drying is a key factor affecting the quality of the ultimate product of tea, the simulation results of the mathematical model explain the drying performance and how the physical model or the prototype could be scaled.

The tea sector has always been a vital component of Sri Lanka's economy. Sri Lanka as the third biggest tea producing country globally, has a production share of 9% in the international sphere, and one of the world's leading exporters with a share of around 19% of the global demand. The total extent of land under tea cultivation has been assessed at approximately 187,309 hectares.



Much of the growth boost in low grown tea production is attributed to the rise of the tea smallholders who are concentrated in the low-country. It is estimated that the smallholders occupy about 65 to 70% of the tea extent in the country and their contribution to overall production has also now risen to around 65 to 70%. Since the organic tea has an increasing demand and a good overseas market the tea cultivators of small holders are encouraged to produce organic tea.

In the traditional or 'orthodox' procedure, the process used to make loose tea, the leaves must go through a process of *Withering*, *Rolling*, *Oxidation /fermentation* and *Drying*. Among these processes, *withering* and *fermentation* are taken place as a result of environmental conditions except rolling and drying. Rolling could be done manually on a serrated timber plank as the quantity is small. Dholes followed by the above three processes are fed into the innovative dryer for the making of tea. This dryer was completed as two stages with two cylinders having concentric perforated cylinders inside. Two hot air generators are being used to supply the hot air where

saw dust is burnt for the supply of thermal energy for the first stage drying and the electricity is used in second stage drying, The cylinders are rotating at the same speed of about 12 rpm, and screw feeder is used for the feeding of material into rotating inner cylinder at a constant rate without the material being clogged at the entrance. Analyzing the direction of material and hot air flow inside the cylinder the dryer is said to be the type of cross-flow co-current. The two drums and the material feeder are powered by a single motor of ½ hp with a gearing ratio of 1:30. As the heat transfer is direct from the heat transfer medium to product the dryer is also called direct or adiabatic dryer.

The adiabatic dryer is more closely related to the humidification process than is the indirect one. As per the raw material and other drying parameters, the dryer type for the innovative dryer has been selected as cross flow, co current rotary type considering physical properties of the drying materials.

Testing of this innovative dryer under real conditions and its results are further illustrated in the report. Based on the physical and thermodynamic parameters of the design and experimental data, a mathematical model has been developed studying various drying models and simulation methods using experimental figures in the report in details. The mathematical model and simulated results using Matlab show how far the model relate with the actual performance. The accuracy of simulation results of the mathematical model is highly depend upon the accuracy of the experiments carried out at various situations for finding out the dryer constant and the characteristic constants using physical models.

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