DEVOLOPMENT OF A MECHANICAL DRYER FOR DRYING COCO PEAT TO USE GROWING MEDIA

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Thesis/Dissertation submitted in partial fulfilment for the

Master of Engineering in Manufacturing Systems Engineering

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Sri Lanka

November 2016

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 belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Acknowledgement

The experiments, data analysis and other related works performed during the degree of
Master of Science (MSc) studentship are the main inclusions of the thesis you are holding in your hand. But the path to this achievement was a hard one. Without the supports and inputs from different people this would not be here.
The completion of this research couldn't have been possible without having gaudiness and assistance of them. Their contribution are sincerely appreciated and gratefully acknowledged.
Among those who supported, one who comes first to my mind in is my supervisor Dr . H.K.G. Punchihewa. First of all I would thank him for offering me the opportunity to follow this MSc thesis work, and secondly for his guidance through the whole research work. I was very lucky to have such a supportive supervisor, especially with the preparations and thesis writing.
I would like to thank my co-supervisor, Dr. (Mrs) M.M.I.D Manthilaka for valuable discussions and guidance.
MSc coordinator Dr. R.A.R.C. Gopura always guided me towards the completion of the thesis in the absence of Dr. H.K.G. Punchihewa. So, my special thank goes to him for his support.
Special thanks to Mr. Sandeeptha Gamalath, Managing Director Jiffy Product SL (Pvt) Ltd for facilitating and directing to the success of this exercise which is one of the major parts of this research. Sincere gratitude to my friends, fellow students, colleagues and subordinate in Jiffy products SL (pvt) ltd for their inspiration, support, company and contribution.
Special thank goes to my family member, relatives and friends who sheared their support, either morally and physically.
The authors and past researchers where I got the knowledge and wisdom to the success of this research almighty gratitude.

Abstract

Coir peat which is a by-product of extracting fibre from coconut husk is considered an excellent growing media in horticulture industry. The basic features of coco peat is having good water holding capacity, ability to control PH and EC (electric conductivity) and good air porosity. Demand for the coco peat is increased continuously due to the above reasons. In addition, use of sphagnum peat moss and rock wool is replaced by coco peat very easily due to scarcity and environment issues of those growing media.

In the present Sri Lankan context, sun drying is widely using to dry the wet coco peat up to the required moisture level before it is compressed. Since coco peat is having a low density (0.1 kg/L), it is needed to be compress before transportation. However sun drying is totally depending on the weather pattern and it is not advisable to depend on sun shine due to the present demand and reliability on the industry. Therefore possibility to look at thermal drying is important while retaining the relevant properties of coco peat.

Studies were carried out to evaluate the performance of combining both rotary drum dryer and flash dryer which are used in similar industries. Four key factors were taken into the study are moisture level, temperature, feed rate and residence time. A set of combinations of the above factors were tested and studied. More than two hundred samples were taken under different settings and corresponding output moisture percentages were measured. Compressed coco pellets were made out of dried samples and then expansion height of each sample was also measured for verification of the expansion quality of dry material.

The low moisture levels of feeding material affected the temperature of the system and feed rate. The frequency didn't play a major role. However feed material with high moisture, temperature and rotating frequency positively affected the output moisture while feeding rate was negatively affected. According to the research and considered input variable, this system shows coco peat can be dried when input material moisture is around 60% and temperature 90 -100^0 C and feed rate around 15 l/min and output material will be comply the requirement to use as growing media.

Coco peat with low moisture contents should be exposed to heat at low temperature with higher feed rates, but, material with high moisture content should be exposed to high temperatures and low feed rates as seen with this research. However, it is advisable to take more measurements with very close steps to fine tune the model parameters before implemented on the field.

Key words – Coir peat, Rotary drum dryer, Flash dryer, Moisture, Expansion property

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

Page

LIST OF ABBREVIATION

Abbreviation	Description
V/W	Volume Weight
PLS	Partial Least Regression
NIPLS	Nonlinear Iterative Partial Least Squares
PCA	Principle Component Analysis
RMSEP	Root Mean Square Error of Prediction

Nomenclature

Symbol	Unit	Description
α		Absorptivity of the product
S(t)	w/m^2	Solar intensity
h_l	$w/m^2\ c^o$	Heat transfer coefficient from product surface to ambient
Ta (t)	c^o	ambient air temperature,
k	$w/m\ c^o$	Thermal Conductivity of the ground
x	m	Thickness of the product
t	h	Time
h_{ev}		Heat Transfer coefficient
P_s[Ta]		Saturated vapour pressure at temperature of the upper layer of material
r		Relative humidity
ε		Bed porosity , decimal
k_p		Thermal Conductivity of product
k_{air}		Thermal Conductivity of air
c_p	$J/kg\ c^o$	Specific heat of the product
T	C^o	Temperature
X		Position
P		Density
C_p		Material of heat capacity
K		Thermal conductivity
k_f	$w/m^2\ c$	Thermal conductance of air film
A	m^2	Water surface area
h_{fg}	J/kg	Latent heat of vaporization
$\frac{dm_w}{dt}$	Kg/s	Drying rate
M		Moisture content at time
M_c		Equilibrium moisture content
X_w		Moisture content of wet basis

X_d		Moisture content of dry basis
$Ø_t$		Total drying time
$Ø_c$		Constant rate drying period
$Ø_f$		Falling rate drying period
t_m	k	Product temperature
t	k	Inlet temperature
h_a	k cal/s km^3	volumetric heat transfer coefficient
$(t-t_m)l_m$	k	logarithmic mean of the temperature difference between the hot air and the product at inlet and outlet
U	k cal/s km^2	overall heat transfer coefficient
A	m^2	Heating area contact with the product
t_k		Temperature of heat source
t_m	k	Product temperature
τ	min	Residence time
L		length of rotary drum
D		Diameter
N	rev/min	Rotational speed
Tan α		slope of the dryer
n		dynamic angle of repose of solid
Q	J/s	rate of heat transfer
$U_v a$	J/sm^3k	volumetric heat transfer coefficient
V	m^3	Dryer volume
$(\Delta t)_m$		true mean temperature difference between the hot gas and the material