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

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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^o 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

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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_1	$w/m^2 \text{ } ^\circ\text{C}$	Heat transfer coefficient from product surface to ambient
$T_a(t)$	$^\circ\text{C}$	ambient air temperature,
k	$w/m \text{ } ^\circ\text{C}$	Thermal Conductivity of the ground
x	m	Thickness of the product
t	h	Time
h_{ev}		Heat Transfer coefficient
$P_s[T_a]$		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	$J/kg \text{ } ^\circ\text{C}$	Specific heat of the product
T	$^\circ\text{C}$	Temperature
X		Position
P		Density
C_p		Material of heat capacity
K		Thermal conductivity
k_f	$w/m^2 \text{ } ^\circ\text{C}$	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
\emptyset_t		Total drying time
\emptyset_c		Constant rate drying period
\emptyset_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
$(t-t_m)I_m$	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
$\text{Tan } \alpha$		slope of the dryer
n		dynamic angle of repose of solid
Q	J/s	rate of heat transfer
$U_v a$	J/sm ³ k	volumetric heat transfer coefficient
V	m ³	Dryer volume
$(\Delta t)_m$		true mean temperature difference between the hot gas and the material