Thermal Design of Dryer for Tur Dal Mill

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Abstract- Tur dal also called Piegon Pea in botanical language. It is a major food grown and consumed extensively in India. It has market potential throughout the country, since in many areas it is used in daily consumption, secondly it has the good market for preparation of ready to use product such as instant dal ,idli mix etc.

Keywords – Peigeon pea ,Mill,V-belt,Bucket elevator ,dryer, thermal analysis.

I. Introduction

The various Botanical name of tur dal are i) Cajanas cajan ii) Arhar iii) Piegon Pea.The tur dal contains i) Moisture content-10.33%, ii) Protien-24.19%, iii) Ether extract-01.89%, iv) Ash-03.55%, v) Crude fibre-01.01%, vi) Carbohydrates 51.21%, vii) Husk-15.00%, viii) Endosperm-85.00%. Dal Mill is th eprocesing centre where the convertion of pulses(eg:- tur grain, black gram, channa etc) into dal is carried out. The requirement of Dall Mill (single unit) are as follows:i) Area:- 4000-500 sq.feet.(sun drying are included). ii) Cost:-10-15 lakhs(including equipment cost) iii) Labour requirement:- 8-10 labours. iv) Power requirement:-24 hrs power required, v) Water requirement:- 5-6 lit per 100 kg.vi) Machine requirement:- separator, pitting/dehusking machine,grader machine, splitting machine, polisher, Dryer.IJIET paper format font should be 10 in times new roman with single spacing.In recent years, the accessing of multimedia data or digital data has become very easy because of the fast development of the Internet. In other words, this development makes unauthorized distribution of multimedia data. For the protection of multimedia data, a solution known as watermarking is used. After the approximate 20 years' research, different kinds of watermarking algorithm based on different theory concepts were introduced [1-3]. A digital watermark encodes the owner's license information and embeds it into data. Watermarking may be used to identify the image of owners' license information and to track illegal copies.

The rest of the paper is organized as follows. Proposed embedding and extraction algorithms are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. Plant Layout with General Data

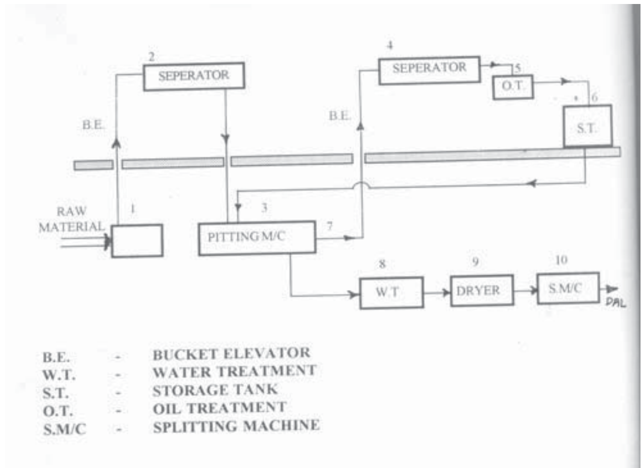
(A) Types of conveyer used:
1. Screw conveyer: for oil water treatment.
2. Bucket elevator: for the transportation of Dal in vertical/upward direction.

(B) Types of Drives: V-belt drive

(C) Types of Dryers: Coal fired (manual feed) dryer, cost-1.25 lakhs, fuel as coal, Blower motor of 10 hp, Blower rpm as 1100rpm.

(D) Labour charges:
1) By sun drying: Rs. 50-80 per 100kg's bag per labour.
2) By using Dryer: Rs. 100-150 per 100kg's bag per labour.

(E)RPM Requirement:
1) Seperator: 60rpm, 2) Worm: 200rpm, 3) Bucket elevator: 250rpm 4) Pitting Machine:1000rpm 5) Spliting Machine:350 rpm.



III. Porcessing of Dal

Piegon pea grain is considered to be the most difficult to mill due to farm attachment of seed coat with cotyledons. It requires pretreatment for loosening of seed coat before dehauling process. The steps involved in dry method are:-

i) Cleaning/grading: Since the physiological maturity of pigeon Pea grain in the field does not occur at one time, the occurrence of the immature grain is unavoidable such grains foreign matter, stones, dirt etc can eliminated by cleaning and grading before pitting. Cleaner and grader are used for this purpose. The type of cleaner used is rotary cleaner cum grader.

ii) Pitting: The pretreated and well dried grains should be passed through the abrasive roller with properly controlled feed rate. The optimum feed rate can be asset by the observation of impression of the holes on grain outlet. The purpose of pitting is to increase the adorability of grain so that it absorbs more oil in fewer rates which help for easy removal of seed coat.

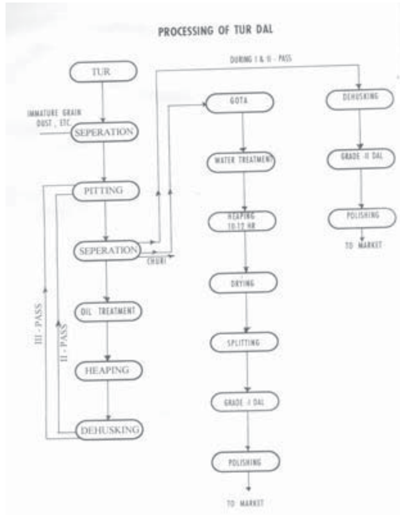
iii) Oil treatment: After passing the grains through the abrasive roller, the pitted grains are mixed with edible oil (linsed oil,,250-300gm/100kg) with the worm screw conveyor.

iv)Drying(if excessive moisture content): The pretreated grains can be dried after heaping for about 5 to 6 hours, under the sunlight or using dryer with about 650C, drying air temperature for about 5 to 6 hours,. The drying of grain may be required about 2days for sun drying whereas about 5 to 6 hrs by using dryer.

vi) Dehusking / separation: Dehusking of pulses refers to first loosening of seed coat from cotyledons by pretreatment. Secondaly removal of seed coat and then splitting the grain into two cotyledons. Obtaining teh maximum dal of good quality with less chipped of edges, broken and powdered per units of the whole grain is called the good dehusking quality.

vii) Polishing (Grade-I/GradeII): Polishing of dal is carried out so that the overall appearance improves and also the shining look increases so that the maximum price can be fetched in the market. In polishing process the dal is treated with a water in very less amount.

viii) Packing: The packing is done in gunny bags with weighs of 30 to 5o kgs. This is done manually.



Types of dryers:

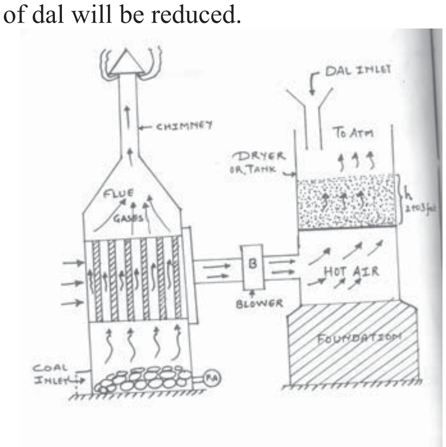
The removal of liquids from solids is one of the largest consumers of energy in industry. The moisture content of solid should be reduced to proper extent by drying process. While selecting a dryer following aspects should be taken into consideration:

i) If the feed is liquid then dryers such as spray or drum dryers can be adapted.
ii) It should be reliable and have long life.
iii) It should be energy efficient and should not have any dust problem.
iv) Its capital investments and accessories cost should be low.
v) Maintenance cost should be low.

IV. Thermal analysis of dryer

Conventional dryer:

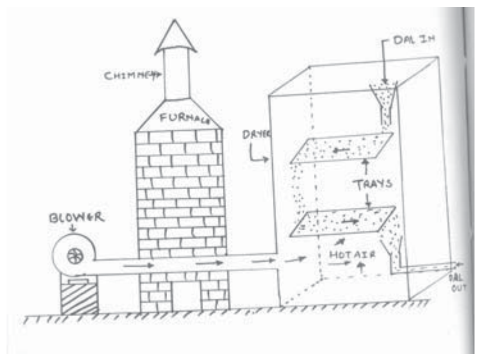
The conventional dryer have following drawbacks:
i) It gives batch type or intermittent type of production.
ii) Uniform heating of dal is not achieved.
Iii) There is no proper mixing of layer of dal hence uneven heating and low heat transfer rate.
iv) Due to this non-uniform heating there is possibility of reduction in moisture of dal, which accounts a loss of 2-5 kg of dal per bag.
v) Due to above all the market value of dal will be reduced.



CONVENTIONAL DRYER :- (PRESENT)

V. MODIFIED DRYER

All the above drawbacks are overcome by using modified dryer, which has got the following features:
i) The dryer is a rectangular chamber in which horizontal plates are arranged one over another.
ii) These horizontal plates having mesh like structure.
iii) Vibratory motion is provided to these trays so that the uniform heating can be achieved.
iv) These vibrated beds are perforated because due to perforation the hot compressed air from the blower supplies uniform heat to the gota.
v) The gota(bed) is heated by convection phenomenon from hot air through the bed in the upward direction.
vi) The dal is allowed to flow over the vibrated trays and the hot air is forced to blow from bottom of teh chamber.
vii) The vibration in the mesh trays can be produced with the help of slider crank mechanism or whole shaft eccentricity method.



PROPOSED DESIGN OF DRYER:-

Thermal design of dryer:
Aim:
i) Required temp of dal at outlet should be euqal to 60^0 C
ii) Desired Moisture content of dal is 10.5%
iii) Processing capacity should be 500kg/hr

i.e mass flow rate of dal = 500kg/hr

$\dot{m}_d = 500/3600$

$\dot{m}_d = 0.1389$kg/sec

Procedure:

Temp of inlet of dal = 25^0C = T_{id} (Atmospheric temp)

Required temp of outlet of dal = 60^0C = T_{od} (RequiredTemp)

Secific heta of tur dal = 2.09Kj/kgK= C_{pd}

Now

Heat absorbed by dal is given by:

$\dot{Q}_{absorb} = \dot{m}_d \times C_{pd} (T_{od} - T_{id})$

$\dot{Q}_{absorb} = 0.1389 \times 2.09 \times (60-25)$

$\dot{Q}_{absorb} = 10.16$ KW

Considering the losses of 35% from furnace to chamber

Thermal efficiency = 65%

Now

Heat Supplied by air $= Q^{\cdot}_{air}$

$= Q^{\cdot}_{absorb} / \eta_{th}$

$= 10.61/0.65$

$Q^{\cdot}_{air} = 15.63$KW

Now Calculation of mass flow rate of air

At furnace,

T_{ai} = inlet temp of air = 25^0C

T_{ao} = outlet temp of air = 80^0C

C_{pa} = Sp. Heat of air = 1.005Kj/kgk

Now,

$Q^{\cdot}_{air} = m^{\cdot}_a \times C_{pa} (T_{ao} - T_{ai})$

$(15.63 \times 10^3)/(1.005 \times 10^3 x(80-25)) = m^{\cdot}_a$

$m^{\cdot}_a = 0.2827$ kg/s

But $m^{\cdot}_a = \rho_a \times Q^{\cdot}_{va}$

Where ρ_a = density of air at mean temp = 1.06kg/m^3

$Q^{\cdot}_{va}$ = Vol. Flow rate of air

= 0.2827/1.06 = 0.266 kg/s

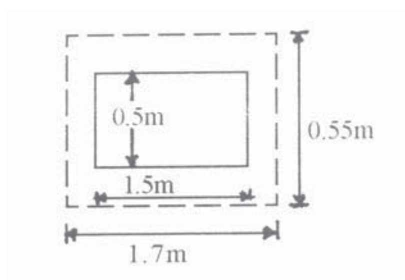
$Q^{\cdot}_{va}$ = 16 m^3/min

Now blower capacity = 16 m^3/min

As we know $Q^{\cdot}_{va}$ = Area x Velocity

Now in chamber

Area = Area through clearance + Area through mesh



Dimension of chamber = 1.7 x 0.55 m

Dimension of vibratory mesh tray = 1.5 x 0.5 m

Area through clearance = (1.7 x 0.55) – (1.5 x0.5) =0.185m^2.

Area through mesh =Assuming 20% of area will be available for air flow = 0.2x 1.5x0.5=0.15m^2

Total effective area = 0.185 + 0.15 = 0.335m^2

Now Effective velocity of air through chamber = $Q^{\cdot}_{va}$ / Total effective area

V = 16/0.335= 47.76 m/min

V= 0.8m/s.

Now Reynold No , $Re = \rho V L_c / \mu$

where L_c = Characteristic length = $2a/\pi$, where a= length of tray or plate= 1.5m

$L_c = 2 \times 1.5/\mu = 0.9549m$

ρ = density of air at $80^0C = 0.9980kg/m^3$

V = velocity of air in chamber = 0.8 m/s

μ = dynamic viscocity at $80^0C = 2.075 \times 10^{-5}$ kg/ms.

Hence Re = $(0.998 \times 0.8 \times 0.9549)/ 2.075 \times 10^{-5}$

Re = 36741

Now Prandtil Number, Pr = $\mu Cp/K$

$Pr = (2.075 \times 10^{-5} \times 1.005 \times 10^3)/ 0.03003$

Pr = 0.694

Now using corelation $Nu = 0.43 + C(Re)^n . Pr^{1/3}$

Where C = 0.227, n = 0.731

$Nu = 0.43 + 0.227 \times (36741)^{0.731} \times (0.694)^{1/3}$

Nu = 440.95

$Nu = h L_c / k$

$h_1 = (440.95 \times 0.03003)/ 0.9549$

$h_1 = 13.867$ W/m^{2}k

Now heat transfer and friction factor for flow through packed beds of sphere,

$h_2 = (0.72 \times m^2 \times D_s \times C_p)/\mu$

where m = mass flow rate = 0.1389kg/s

D_s = diameter of dal = 0.003m

C_p = Sp heat of dal = 2.09KJ/kgK

μ = dynamic viscosity = 2.075×10^{-5}

$h_2 = (0.72 \times 0.1389^2 \times 0.003 \times 2.09 \times 10^3) /2.075 \times 10^{-5}$

$h_2 = 4197.45$ W/m^{2}K

Now R_{th} = Thermal resistance of mesh plate = L/Akm

where L= thickness of plate = 1mm = 0.001m

A = Area of cross section = 0.5x1.5= 0.75m^2

K= conductivity of plate = 53.4W/m^{2}K

$R_{th} = (0.001/0.75) \times 53.4 = 24.96 \times 10^{-6}$

Now overall heat transfer co-efficient Uo = 243.35 W/m^{2}K

Now Q = heat supplied to dal

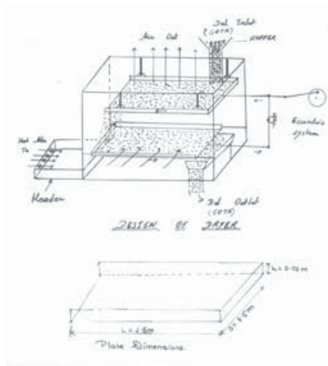
$10.61 \times 10^3 = U_o \times A_s \times \Delta T$

Total surface area required = As = $(10.61 \times 10^3) / (243.35 \times (60-25)) = 1.192m^2$.

Now No of mesh plates required = As / Actual area of one tray

Number of trays = 1.192/0.75

Number of trays = 2.



VI.CONCLUSION

i) In an artificial drying process by the help of dryer uniform heating of tur dal is achieved. Hence quality of tur dal is improved to a great extent.

ii) Due to this continuous heating maximum amount of grade I dal is obtained up to 70 to 80 %. Thus losses are minimized to a great extent.

iii) Since it is a continuous flow process, mass production can be achieved instead of batch wise production.

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