International Journal of Engineering Science and Applied Mathematics
Volume.14, Number 10; October-2023;
ISSN: 2836-9521| Impact Factor: 6.64
https://zapjournals.com/Journals/index.php/ijesam
Published By: Zendo Academic Publishing

DEVELOPMENT AND PERFORMANCE EVALUATION OF A POLY FILM DEHUMIDIFICATION MACHINE FOR PLASTIC PROCESSING INDUSTRY

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Article Info

Keywords: Dehumidification, Development, Machine, Performance, Plastic

DOI
10.5281/zenodo.8410367

Abstract

The Poly Film Dehumidification Machine for Plastic Processing Industry was developed as an ideal equipment to handle the effects of moisture in wet poly films. The machine which comprises the electric motor, dehumidifying barrel, turning blade, adjustable knife and the PLC discharge control was developed using locally sourced materials to handle the challenges in extrusion and reprocessing of poly films in plastic recycling value chain. Design analysis and calculations of the performance test evaluations were carried out to determine the drying rate and drying efficiency for the dehumidifier as 3.48kg/hr and 60% respectively at an input quantity of 10kg with 66.67% moisture content (dry basis). Hence, the Poly Film Dehumidification Machine would be applicable for both medium scale and large scale services in Plastic Processing Industries.

1.0 Introduction

Plastics are wide range of synthetic or semi-synthetic materials that use polymers as a main ingredient. Their plasticity makes it possible for plastics to be molded, extruded or pressed into solid objects of various shapes. This adaptability plus a wide range of other properties such as being light weight, durable, flexible and expensive to produce, has led to its wide spread use. Plastics are typically made through human industrial systems. The modern day plastics are mostly derived from fossil fuel-based chemicals like natural gas or petroleum; however recent industrial methods use variants made from renewable materials such as corn cotton derivatives (American chemistry.com, 2010). Plastics are made up of synthetic organic polymers which are widely used in different applications ranging from water bottles, clothing, food packaging, medical supplies, electronic goods, construction materials etc.

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Nearly all types of plastics can be recycled. However, the extent to which they are recycled depend upon technical, economic and logistic factors. Plastics are a finite and variable resource, so the best outcome after their initial use is typically to be recycled into a new product (British Plastics Federation).

Advantages of plastic recycling

- Provides a sustainable source of raw materials to the industry
- Greatly reduces the environmental (especially the CO_2 impact of plastic-rich products.
- Minimizes the amount of plastic being sent to the country's landfill sites.
- Avoids the consumption of the earth's oil stocks
- Consumes less energy than producing new, virgin polymers.
- Embeds the right values and behaviour to reduce human impact on the environment.

Dehumidifying or drying plastics in the processing phase is a vital part of injection molding. Drying plastics resins such as poly films is used to minimize or eliminate complications that may be caused by too much moisture in a plastic material. Dehumidifying dryers are designed to eliminate moisture in the plastic material before processing. The extent to which moisture affects the quality of a molded part is determined by the specific plastic resin being processed and the intended purpose of the part (Adeyanju, 2018).

Poly films attract water after being washed as well as through exposure to the atmosphere because of its hygroscopic nature. If the washed (wet) poly films are not dehumidified, the moisture will cause the flakes to pick water during pelletizing from the water trough designed for cooling and solidification of the extrudate due to heat gained from the recycling machine. This will lead to loss of molecular weight. This loss leads to lowered physical properties such as reduced tensile and impact strength. The dehumidifier must be used to dry poly films prior to recycling in any plastic recycling and processing industry. However, the resultant product produced when used for reprocessing may not show noticeable defects such as splay or strain but may still exhibit lower physical properties without proper drying (Plastics Technology, 2022). Moisture in films can cause issue during extrusion such as bubbles, under size filaments or brittle section of filament.

1.1 Objectives and Scope of Study

Specific objectives of this study are to;

i. Design and develop a poly film dehumidification machine for plastic processing industry.

ii. Performance evaluation of the machine.

1.2 Justification

Drying is an absolute necessity to prepare polymers for moulding/extrusion. Polymers can absorb moisture from the air or if washed when sourced from scavengers. If poly films are not dry during pelletizing process, the moisture will react with the molten polymer at processing temperatures resulting in a loss of molecular weight. The loss leads to lowered physical properties such as reduced tensile and impact strength. Therefore, dehumidification machine must be used to dry the poly films prior to processing in any kind of plastic processing machine. However, moulded parts may not show any noticeable defects such as splay but may still exhibit lower physical properties without proper drying. Consequently, moisture in poly films can cause issues during extrusion, such as bubbles, undersized filament and brittle sections of filament. However, the manual process of dehumidification is energy consuming and leads to loss of materials, hence the need for an efficient process to handle the effects of moisture. Dehumidification, the major process in the unit operation/value chain is the focus of this work, to develop and evaluate the performance of an effective dehumidifier and its suitability for applications in plastic processing industry.

2.0 DESIGN ANALYSIS AND SPECIFICATIONS OF THE POLY FIIM DEHUMIDIFICATION MACHINE FOR PLASTIC PROCESSING INDUSTRY

2.1 Design Concepts and Considerations

1. The machine was designed to dehumidify poly films in a manner to remove the moisture in the wet poly film for it to be dried and enhance the production of adequate quantity and quality of flakes during further processing.
2. Incorporation of an industrial temperature gauge with thermo well into the system to read the operating temperature at any point in time.
3. Incorporation of a digital timer to get the residence time. Residence time is the time taken for a material to be dehumidified.

Right from the beginning, it was our intention to make our design incorporate already available components instead of requiring the production of part which will add to the cost of the machine. The machine should be able to generate friction which will in turn generate heat within the shortest possible time. Operators wouldn't want to wait all day waiting for the machine to warm up to operating state.

The specification process was rather iterative in nature. From the literature we had to set a drying temperature (amount of heat generated) for the drying chamber and then employ engineering equations to work backwards to obtain the other parameters and specifications of the components. The determination of the minimum force needed to drive the machine and hence the specification for the electric motor followed the same process. The following was determined; machine production capacity, drying speed, yield/finishing efficiency of the machine, power consumption, energy requirements/specific mechanical energy consumption and diameter of shaft conveyor.

The following machine specifications were selected for the design;

Motor power 75kw

Motor speed 1470rpm

Motor pulley (driving) 190mm

Shaft pulley (driven) 220mm

2.2 Determination of the Speed of the Drive (Shaft Speed)

The system requires two pulleys for the drive; one on the end of the shaft and the other on the end of the electric motor. Due to its high transmission efficiency and with indication of occurrence of belt slipping which decreases velocity ratio of the drive. Thus, the shaft speed is determined as 1269.55rpm

Equation (1) is a relationship used to determine the transmitted speed according to Khurmi and Gupta 2012;

$$\frac{N1}{N2} = \frac{D2}{D1} \tag{1}$$

N_1 = speed of rotation of driving pulley in rpm

N_2 = speed of rotation of driven pulley in rpm

D_1 = diameter of the driving pulley

D_2 = diameter of the driven pulley

2.3 Determination of Velocity Ratio of Belt Drive

The velocity ratio was determined as 1.16rpm from the equation (2):

$$V.R = \frac{N_1}{N_2} = \frac{D_2}{D_1} \tag{2}$$

Where; N_1 is speed of rotation of driving pulley, 1410rpm

N_2 is speed of rotation driven pulley, 1269.55rpm
D_1 is diameter of the driving
D_2 is diameter of the driven

2.4 Shaft Design Consideration/Analysis

The shaft is cylindrical with circular cross section and pulleys and bearings mounted on them. The shaft will be subjected to fluctuating torque and bending moments, and therefore combined shock and fatigue factors are taken into account. Bending moment and shear force bending can occur as a result of the applied loads on the shaft and belt tensions.

i) Shaft subjected to twisting moment only

Torsion equation

$$\frac{F_t}{r} = \frac{T}{J} = \frac{C\theta}{t} \quad (3)$$

Where, F_t = tensional shear stress
R = distance from neutral axis to outermost
J = twisting moment (or torque)
C = modulus of rigidity of shaft material
L = length of shaft
θ = angle of twist in radius on a length l
(ASME 1995)

Polar moment of sound solid shaft

$$J = \frac{\pi}{32} \text{ x } d^4 \quad (4)$$

$$\frac{T}{\frac{\pi}{32} X d4} = \frac{f_t}{\frac{d}{2}}, \text{ where } r = \frac{d}{2}$$

$$T = f_t \text{ x } \frac{\pi}{32} \text{ x } d^4 \text{ x } \frac{2}{d}$$

$$T = f_t \text{ x } \frac{\pi}{16} \text{ x } d^3 \quad (5)$$

Twisting moment, T can be obtained from $P = \frac{2\pi NT}{60}$ (6)

From P = Tω (7)

Given; Power, p = 75kw

ω = angular velocity = $\frac{2\pi N}{60}$ (8)

N = speed of machine = 1269.55rpm

$$\omega = 2 \text{ x } 3.142 \text{ x } \frac{1269.55}{60}$$

ω = 132.96rad/s

Therefore; 75 = T x 132.96

$$\text{Torque, } T = \frac{75000}{132.96}$$

$T = 564.08Nm = 564.08 \text{ x } 10^3 Nm$

ii) Shaft subjected to bending moment only bending equation is given by

$\frac{M}{I} = \frac{f_b}{y}$ (9)

Where, M = bending moment

I= moment of merits of cross-sectional area of the shaft about axis of rotation

f_b = bending stress

y = distance from neutral axis to outer most fibre#

But, $I = \frac{\pi}{64} \times d^4$ (10)

Then $M = \frac{f_b}{y} \times I$

$M = \frac{f_b}{y} \times \frac{\pi}{64} \times d^3$

but $y = \frac{d}{2}$ (11)

$M = \frac{\pi f_b}{32} \times d^3$ (12)

Also bending moment equation is given by M = w x L (13)

But for a shaft at tangential or perpendicular, the bending moment is negligible because there is no load impact on the shaft, the force acting on it is compressive/angular.

Hence the bending moment M is termed zero. (i.e. M = 0)

2.5 Determination of Shaft Diameter

The diameter, *d* of the poly film dehumidification machine transmission shafts was determined from the maximum stress relations given by Khurmi and Gupta (2012) as:

$$d = \left[\frac{16}{\pi\tau}\sqrt{(k_b m_b)^2 + (k_t m_t)^2}\right]^{1/3} \quad (14)$$

But equivalent maximum twisting moment is given as

$T_e = \frac{\pi}{16} \times \tau \times d^3 = \sqrt{M^2 + T^2}$ (15)

$T_e = \sqrt{(0)^2 + (564.08)^2}$

$T_e = \sqrt{(564.08)^2}$

T_e = 564.08Nm

Since, $T_e = \frac{\pi}{16} \times \tau \times d^3$

$d^3 = \frac{16}{\tau\pi} \times Te$

$d^3 = 16 \, x \, 564.08 \, x \, \frac{1000}{131.964}$

Assuming τ =42 N/m for safe stress

$d = \sqrt[3]{564080}$

d = 83.77mm

For factor of safety diameter d, is taken as 100mm

2.6 Selection of Electric Motor for the Operation of Dehumidification Machine

The power required to drive the drying machine is determined as

$$P = T\omega \tag{16}$$

Where p = power, T= torque and ω = angular velocity

$$\text{But } \omega = \frac{2\pi N}{60} \tag{17}$$

Where, N= speed of machine.

$$P = \frac{2T\pi N}{60} \tag{18}$$

$$T = \frac{\pi}{16} \text{ x } d^4 \text{ x } f_t \tag{19}$$

Where f_t = shear stress (torsional)

2.7 Selection of Belt Drive

Important factors upon which the selection of a belt drive depends are speed of the driving and driven shafts, speed reduction ratio, power to be transmitted, centre distance between the shafts positive drive requirements, shafts layout, space available and service conditions.

Thus, the average velocity of the belt drive is given by

$$VR = \frac{\pi DN}{60} = \frac{TPN}{60} \tag{20}$$

2.8 Determination of Centre Distance between the Two Pulleys

The centre distance was obtained as 395mm from the relation below from Khurmi and Gupta 2012.

$$x = \frac{p}{4}[K - \frac{T_1 - T_2}{2} + \sqrt{[(K - \frac{T_1 + T_2}{2})^2 - 8(\frac{T_2 - T_1}{2\pi})^2]} \tag{21}$$

Considering fig. 1.

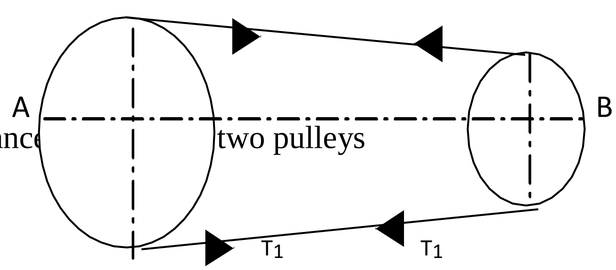

Fig. 1: Centre distanc two pulleys

2.9 Determination of Length of Belt Drive (Open Belt)

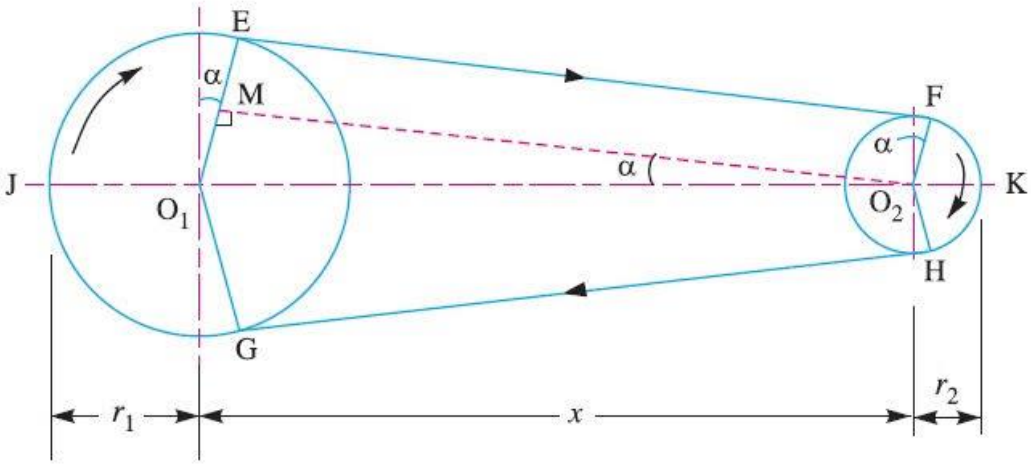

Fig. 2: Open belt drive

The belt length, L required was computed as 1434.68mm from the following relations given by Khurmi and Gupta (2005) as;

$$L = (\frac{\pi}{2}) \frac{d_1 + dT_2}{2} + \frac{2x}{\;} + [\frac{d_1 - d_2}{4x}]^2 \quad (22)$$

Where r_1 and r_2 is radius of the larger and smaller pulleys

x_1 is distance between the centres of two pulleys (i.e O_1, O_2)

L is total length of belt.

2.10 Determination of the Frictional Force Generated

$$F = \mu N \quad (23)$$

$$\text{But, } N = mg \quad (24)$$

$$F = \mu mg \quad (25)$$

Where m is mass of poly film

g is acceleration due to gravity

μ is coefficient of static friction

N is normal force

F is frictional force

2.11 Determination of Power Transmitted by the Belt

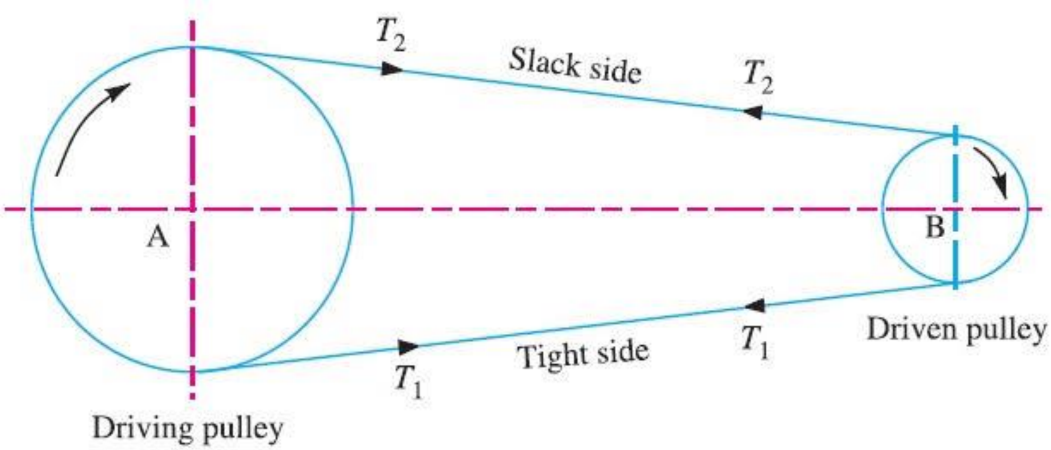

Fig. 3: Power transmitted by a belt

Let T_1 and T_2 = Tensions in the tight side and slack side of the belt respectively in newtons

r_1 and r_2 = Radii of the driving and driven pulleys respectively

v is velocity of the belt in m/s

The effective turning (driving) force at the circumference of the driven pulley or followers is the difference between the two tensions (i.e $T_1 – T_2$)

Work done per second = $(T_1 – T_2)v$ N-m/s (26)

Hence; power transmitted = $(T_1 – T_2)v$ W (27)

2.12 Determination of the quantity of heat needed for drying

The drying temperature of most plastics is between 70^0C – 120^0C. We choose 120^0 C target temperature of the drying chamber (barrel). The materials must be raised from room temperature 25^0 C to 120^0C. Assuming a polycarbonate of mass 25kg as dehumidified and bagged, so the quantity of heat needed to raise this temperature from 25^0C to 120^0C can be calculated thus;

Q = heat needed to raise the material to its drying point

$Q = mC_p\theta$ (28)

Where; m = mass of material and measured at 25kg

C_p = specific heat capacity of material and has been determined from standard table as 2.004KJ/KgK

θ = temperature change = 120 - 25 = 95^0C.

The frictional force must be able to generate this amount of heat with consideration of the amount of heat that will be lost through the walls of the drying chamber.

3.0 DEVELOPMENTAL PROCEDURE/DESCRIPTION OF THE POLY FILM DEHUMIDIFICATION MACHINE FOR PLASTIC PROCESSING INDUSTRY

The major components of the developed poly film dehumidification machine (Figure 1) include dehumidifying barrel/drum, swing blade, adjustable knife, propeller (shaft) conyeyor ring, frame and electric motor. The detailed production drawings for this machine fabrication are contained in the Appendix

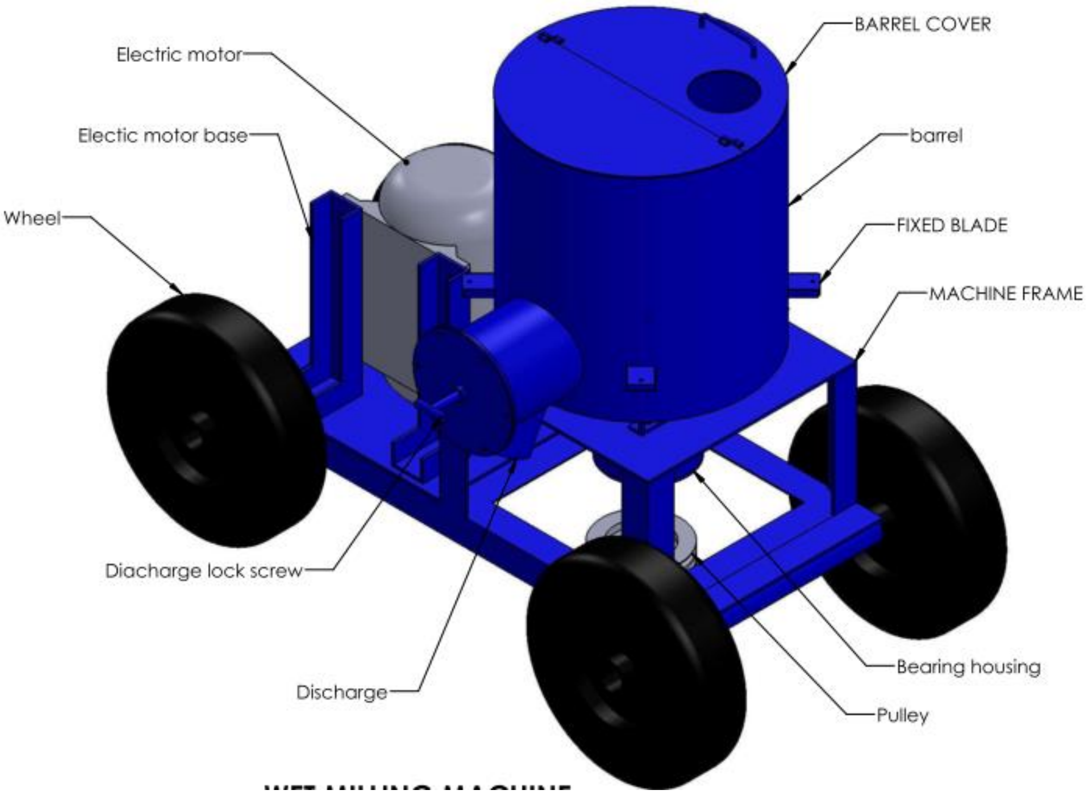

Fig. 4: The Isometric view of the developed Poly film Dehumidification Machine

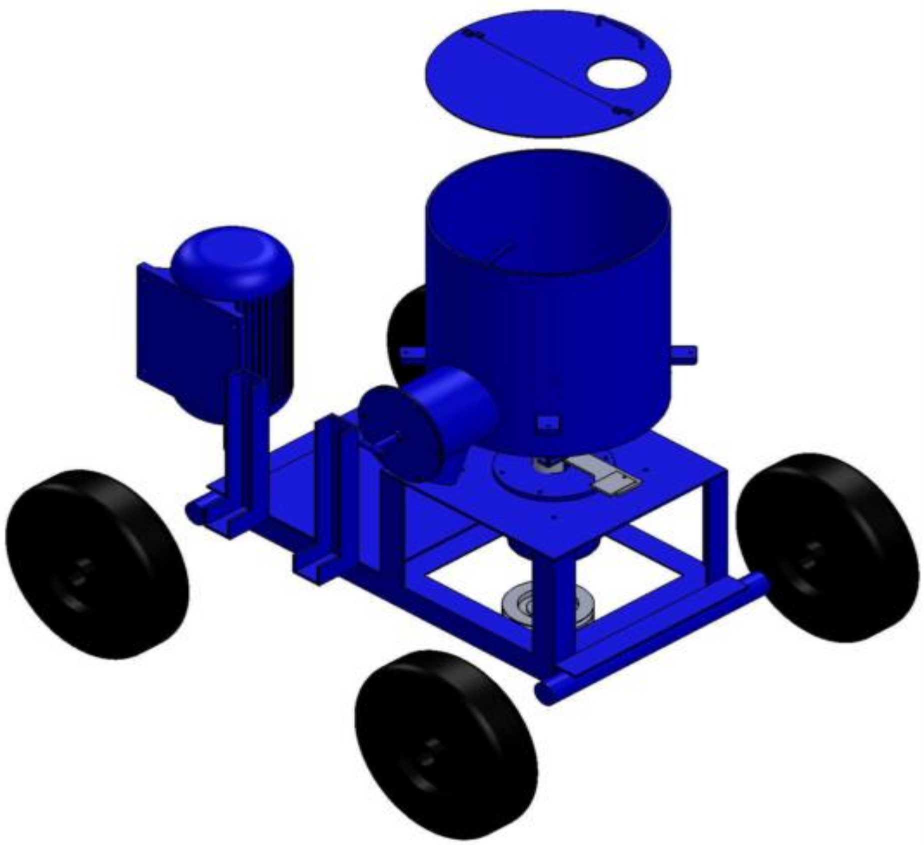

Fig. 5: The Exploded view of the developed Poly film Dehumidification Machine

The machine is ideal equipment for the dehumidification of poly film (such product from polyethylene, polypropylene etc) into flakes of small bulk densities in the plastic processing industry. The main important and relevant components to be used for the development of the dehumidification machine based on the material properties are; dehumidifying barrel, swing blade, frame, electric motor, adjustable knife, conveyor ring, propeller (shaft).

However, the design of the dehumidification machine include; the determination of the volume of the drying chamber, turning/swing blade and adjustable knife and also the selection of the convenient materials for the fabrication of the individual units.

The dehumidification of the poly films is achieved when the electric motor is powered which turns the propeller/shaft by the connections of two pulleys each to the shaft of the electric motor and machine shaft respectively via a belt. As the shaft turns, the swing blade revolves or rotates which cause the poly films to swing within the drying chamber, colliding with each other and with the walls of the drying chamber. This collision produces kinetic energy which makes the poly films susceptible to the effect of heat.

Inside the drying barrel are conveyor rings in opposite directions to counter the turning of the poly films. Also, inside the drying barrel are adjustable knifes situated by the internal walls of the drying barrel to help in tearing and shearing of the poly films for moisture to drop off.

These actions generate a frictional force which in turn generates heat since the entire process is partially a closed system. As these operations get heated up by the effect of friction, the moisture inside the poly film is forced to leave in form of vapour through the vent and after a time frame, the poly films begin to shrink as moisture is lost and as the system gains heat.

Consequently, as the operations last for a period of time, the poly film continues to shrink forming a small bulk density and later discharged through the outlet unit with the end product called poly film flakes and this is later sent to the pelletizing machine for extrusion or pelletizing.

3.1 Poly Film Flakes

A type of flake produced by dehumidifying washed (wet) waste poly films. Poly film flakes are achieved by the dehumidification of poly films which is one of the unit operations involved in the recycling of plastic for plastic processing industry. However, pre-recycling processes involved in the recycling of plastics include;

- **Plastic waste sourcing** – plastic wastes such as poly film wastes, plastic scraps (lumps and bottles) are sourced from plastic industries or from scavengers via waste bins from the environment.
- **Bailing** – this involves packaging the waste in a more compact form for easy and convenient transportation to the factory for reprocessing. This can be done manually (in the case of film) or more conveniently using the bailing machine (in the case of bottles).
- **Sorting** – plastic wastes are sorted by types of polymer, colour of polymer, size of poly waste, nature of waste (films or lumps).
- **Crushing** – the plastic lumps are crushed into smaller particles to increase its surface area for recycling or pelletizing with the crushing machine.
- **Washing** – the sorted wastes are washed to remove sands and other debris from scavengers.
- **Dehumidification** – the wet plastics either films or crushed waste are shredded and dried into flakes by the removal of moisture droplets or moisture adsorbed for effective recycling or pelletizing. This is achieved with wet milling machine.
- **Pelletizin**g – the pre-recycled wastes are fed into a pelletizing machine for conversion into granules (plastic pellets).

FLOW CHART OF PLASTIC RECYCLING UNIT OPERATIONS

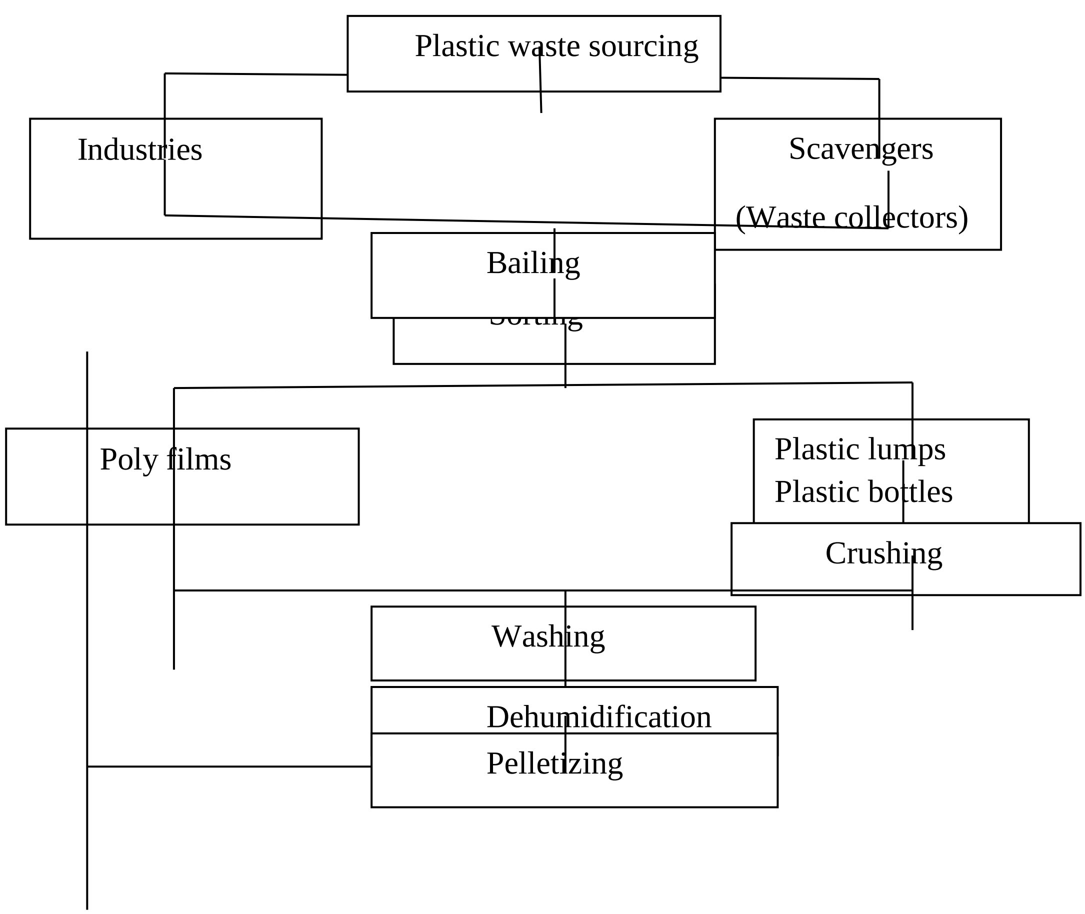

Fig. 3.1 Block diagram showing plastic recycling unit operations

3.2 Performance Testing Procedure

Poly films of polyethylene wastes were used for evaluation of the machine. Evaluation of the machine was carried out at speed1269.55rpm, atmospheric temperature and pressure condition. The electric motor and thermo well were designed to be 75kw (100HP) and 120^0C respectively. The shaft diameter and length are given to be 100mm and 700mm respectively. The wet polyethylene films samples will then be weighed to determine the weight before loading into the machine. The weighed samples will be fed into the drying barrel to be dehumidified before discharge. The material will also be weighed after dehumidification to know the quantity of polyethylene film dried and the polyethylene film yield calculated.

The dehumidified poly film will be weighed after the operation to know the amount of moisture removed and the dehumidifying rate was calculated to obtain the drying efficiency, moisture content (wet and dry basis) input and output capacities, in accordance to association of official analytical chemist (AOAC 2000). The performance evaluation will be carried out more times to obtain the average performance of the machine.

3.3 Development of mathematical model procedures for performance evaluation of the machine

The effects of shaft speed, temperature, power and torque parameters on system responses: specific mechanical energy (SME), drying efficiency and throughput were investigated. The temperature attained by the effect of heat generated through frictional force at the time of drying was read by a thermo well embedded on the drying barrel. The objective was to understand the effect of shaft speed and drying system variables (power, speed, temperature and torque) on the performance of the machine.

From the table, the following independent factors or variables were considered; electric motor power, shaft diameter, amount of heat generated, shaft speed, torque etc. The dependent variables/responses of the machine are moisture content, drying efficiency (DE), drying rate (throughput TP), and specific mechanical energy (SME).

Amount of moisture removed M_w, (kg)

The amount of moisture to be removed from a given quantity of poly film waste to bring the moisture content to a safe usable/processing level in a specified time is calculated from the equation below according Khurmi and Gupta (2012);

$$M_r = M_o \frac{M_i - M_f}{100 - M_f} \quad (29)$$

Where;

M_o = initial mass of the poly film waste to be dried

M_i = initial moisture content, % wet basis

M_f = final moisture content, % wet basis

Moisture content (M_c)

The moisture content was determined by the gravimetric method according to the official methods of analysis employed by Association of Official Analytical Chemist (AOAC) 2009.

$$M_c = \frac{M_i - M_f}{M_i} \times 100 \quad (30)$$

where;

M_i = mass of poly film waste before drying

M_f = mass of poly film waste after drying

Percentage Moisture content of the wet basis

$$\%\ \text{wet basis} = \frac{\text{moisture retained}}{\text{sample weight}} \times 100 \quad (31)$$

Percentage Moisture content of the dry basis

$$\%\ \text{dry basis} = \frac{\text{moisture retained}}{\text{weight of sample} - \text{moisture retained}} \times 100 \quad (32)$$

Average drying rate, M_{dr} (kg/hr)

Average drying rate, M_{dr} was determined from the mass of moisture to be removed by heat generated through frictional force and drying time by the equation below;

$$M_{dr} = \frac{M_W}{T_d} \quad (33)$$

Where,

M_{dr} = drying rate

M_w = moisture to be removed

T_d = time taken for drying to occur

Quantity of heat needed to evaporate water (KJ), Q

$$Q = M_w \times h_{fg} \quad (34)$$

Where;

M_w = amount of moisture removed

h_{fg} = the latent heat of evaporation of water (KJ/kg)

Note: amount of heat needed is a function of frictional force generated and moisture content of the poly film waste.

Drying Efficiency DE,

$$DE = \frac{\text{wet basis}}{\text{dry basis}} \times 100 \quad (35)$$

$$DE = \frac{\text{output weight of dried poly films}}{\text{input weight of wet poly films}} \times \text{Throughput} \quad (36)$$

$$DE = \frac{\text{output weight of dried poly films}}{\text{time taken for drying}} \quad (37)$$

Specific Mechanical Energy,

$$SME = \frac{\text{power x time}}{\text{output weight of dried poly films}} \quad (38)$$

4.0 RESULTS AND DISCUSSION

The poly film dehumidification machine performance test results in tables 4.1 and 4.2 revealed that its respective drying rate (throughput) and efficiency at a fixed quantity of 10kg is 3.48kg/hr and 60%. Thus, the cabinet drying machine has a very good drying rate throughput and drying efficiency for mass production. It is also affordable.

Table 1: Performance test for the (Effect of process variables on the machine responses) development and performance evaluation of Poly Film Dehumidification Machine

s/no	Input mass of poly film (kg)	Variable Responses				
		Shaft Speed (m/s)	Time (mins)	Total mass output (kg)	Dehumidifying Efficiency (%)	Throughput (kg/hr)
1	10	1269.55	60	5.8	60.0	3.70
2	10	1269.55	70	5.9	59.4	3.10
3	10	1269.55	80	6.0	60.0	2.62
4	10	1269.55	90	6.1	61.0	2.25
5	10	1269.55	100	6.2	62.0	1.95

Table 1 shows the calculated throughput, the design efficiency of the developed system with varying time at constant input mass of poly film waste. The increase in interval time of the dehumidification of the poly film results to a high efficiency for the product as the poly film tends to form a bulk density which ensures easy feeding through the hopper of a pelletizing machine during further processing.

Table 2: Performance Test Results of the development and performance evaluation of poly film dehumidification machine for plastic processing industry at a fixed quantity of 10kg.

S/no	Mass of wet poly film, M_i (kg)	Time, T (mins)	Mass of dried poly film, M_f (kg)	Moisture loss, M_l (kg)	Percentage moisture loss (%)
1	10	60	5.8	4.2	42
2	10	70	5.9	4.1	41
3	10	80	6.0	4.0	40
4	10	90	6.1	3.9	39
5	10	100	6.2	3.8	38
Average	10	10	6.0	4.0	40

Table 2 shows the mass and percentage loss of moisture of a constant mass of wet poly film at varying time. As the time interval increases the mass of dried poly film increases due to effect of crystallinity of the polymer resulting to increase in density of the polymer.

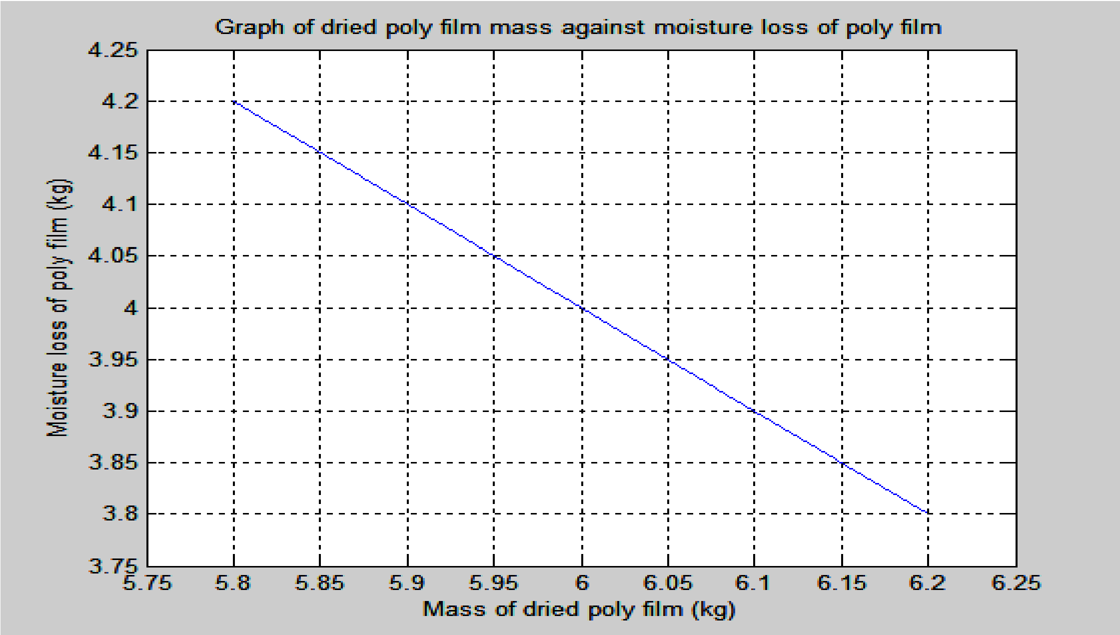

Fig 6: Interval plot of moisture loss versus mass of dried poly film

Fig. 6 shows the various moisture losses for different mass of dried poly films at different time taken. This shows that moisture loss will affect the mass of dried plastic pellets with high moisture loss indicating greater efficiency of the dryer.

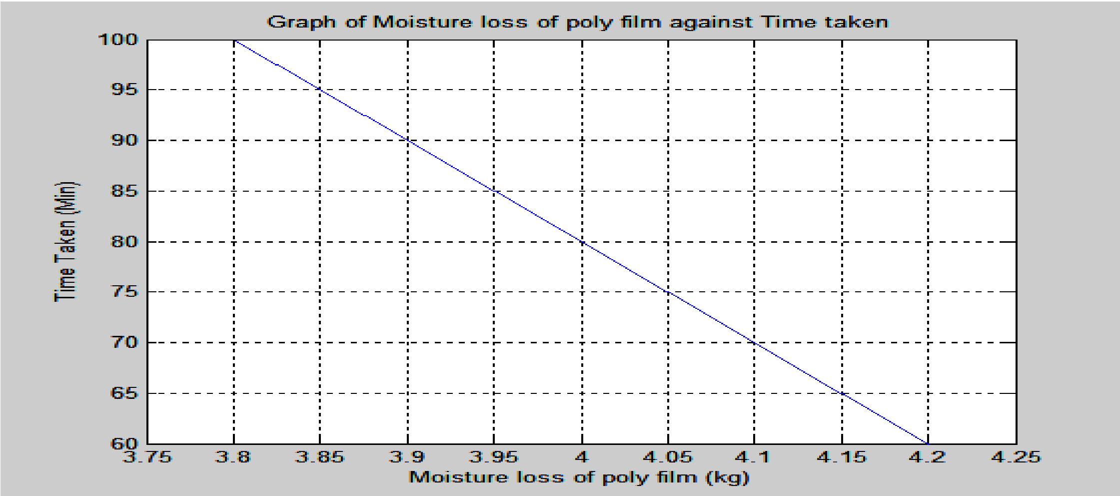

Fig. 7: Interval plot of time versus moisture loss of poly film

Fig. 7 shows the various moisture losses for different time intervals. The times taken at 60, 70, 80, 90 and 100minutes respectively. As time increased, the moisture loss increased but the chemical change resulting from the drying operation as result of heating effect caused the polymer to be in more crystalline form and its chain to be more regularly aligned thereby resulting in increase in hardness and density.

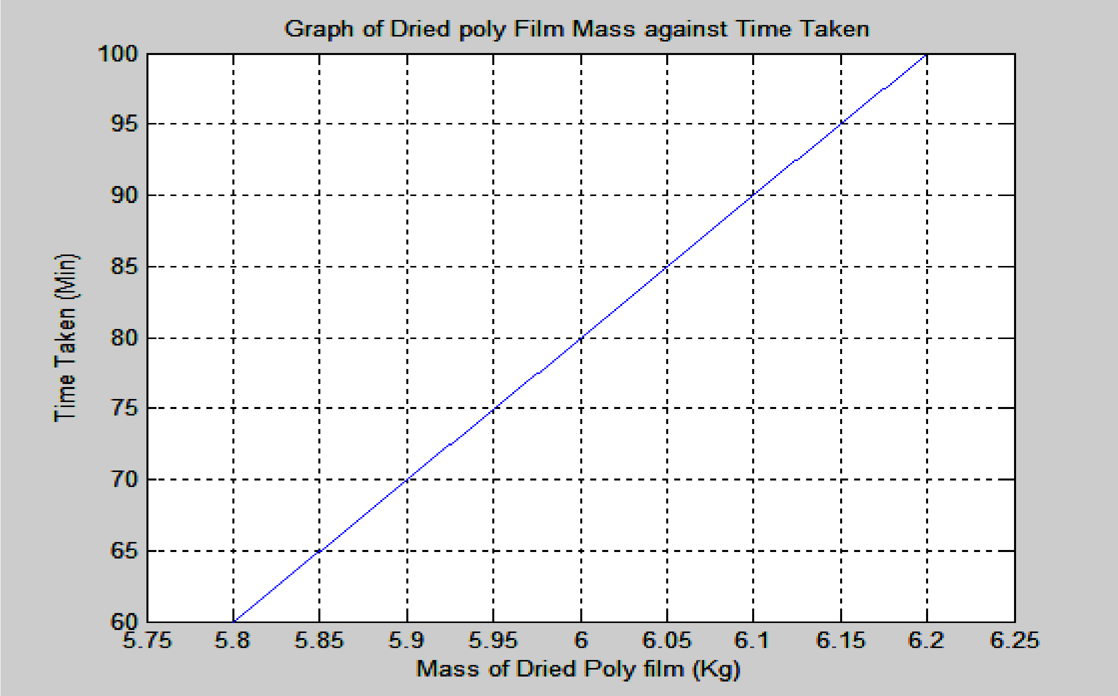

Fig 8: Interval plot of time taken versus mass of dried poly film

Fig. 8 illustrates the various mass of dried plastic pellets for different time taken. The times taken at 60, 70, 80, 90 and 100 minutes respectively. As time taken increases the poly films get more crystalline and the chains more regularly aligned and tend to form bulk density. Increasing the degree of crystallinity increases hardness and density. Time taken at 100 minutes has the optimum bulk density with efficient moisture loss and least with time taken at 60 minutes. This shows that the time taken at 100 minutes has a very good drying efficiency while the time taken at 60 minutes of drying has the least.

5.0 CONCLUSION AND RECOMMENDATIONS

A poly film dehumidification machine was designed, developed and its performance evaluated at Enugu State University and Technology, Enugu using locally sourced standard materials. The machine eliminates drudgery and tedium in the drying of wet poly films for plastic processing industry and production of flakes as well as the excessive loss generated during the production of the desired product. The machine equally reduced the loss accumulated in sun/manual drying process and enhanced the production of adequate quality and quantity of flakes. Adoption of this machine is recommended to facilitate recycling and recycled material for further processing into any plastic product in plastic processing industries as well as its degradation of the environment.

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