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Design and Fabrication of Shrink Wrapping Machine

Dr. P. G. Mehar[1], Suraj Dhande[2], Bhavesh Hatzade[3], Rohan Mankar[4], Atharv Meshram[5], Vivek Binzade[6]
[1]*Asst. Professor,* [2, 3, 4, 5, 6] *Students, Dept.Of Mechanical Engineering K.D.K.College Of Engineering, Nagpur, Maharashtra, India*

Abstract: ***In order to handle most of the products like cloth peg, container, hanger, tooth brush, shaving blades, heay duty cell etc. shrink wrapping machine is universally used. By shrink wrapping of the products, it is possible to handle the products conveniently,it make the packing attractive,itisveryconvenientduringtransportalso.Anattemptismadeh ere to discuss the development and design of shrink wrapping machine for cloth peg. The various components of machine are gearised d.c.motor ,sprocket, chain, rollers, heater, structure etc.***

Keywords: Shrink Wrapping Machine, Shrinkage Film, Polymer, Polythene

I. INTRODUCTION

Shrink wrapping machine is a device that wraps a product with heat shrinkable film, then heats and shrinks the film to wrap around the product. Automatic shrink packaging machine is mainly composed of wrapping machine, heat shrinkage channel conveying device, etc. The conveying device conveys the packaged goods to be wrapped and sealed in shrinkable material packing film according to package specifications, before they pass through the heat shrinkable channel. Such films revolve tightly around the products and packed it properly. .It is also expected that quality of shrink wrapping will be excellent as there will be uniform heating of the packet .In shrink wrapping ,a shrink film i.e. polyvinylchloride(PVC)is used as basic material and heat forms an important part of the operation .Shrink wrapping is done in 4 stages namely wrapping ,sealing ,shrinking and cooling .When the film is stretch axially oriented in one direction while it is heated then it is randomly twisted and inter twined molecules lineup.

II. LITERATURE REVIEW

1) *Design and Development of Shrink Wrapping Machine for Wrapping of Cloth Peg:* In order to handle most of the products like cloth peg, container, hanger, tooth brush, shaving blades, heavy duty cell etc.[1] shrink wrapping machine is universally used. By shrink wrapping of the products, it is possible to handle the products conveniently, it make the packing attractive, it is very convenient during transport also. An attempt is made here to discuss the development and design of shrink wrapping machine for cloth peg. The various components of machine are gearised d.c. motor, sprocket, chain, rollers, heater, structure etc.
2) *Design And Analysis Of Multipurpose Conveyor For Shrink Wrapping Machine:* Conveyor units play an important role in packaging industries for material handling purpose.[2] Different type of conveyors are using for industrial application now-a-days like belt conveyors, screw conveyors, bucket conveyors etc. This paper mainly focus on the design& analysisof a multipurpose conveyor system for shrink wrapping machine which can adjust its length, height used as powered & gravity type.
3) *A Categorical Review of Shrink Wrap Packaging:* In this paper, in order to carry out in-depth study regarding shrink wrap packaging , generalized design of shrink wrap packaging machine.[3] properties of shrinkable film and research methodology and exhaustive literature review is carried out and is presented in this paper.

III. SPECIFICATION OF SHRINK WRAPPING MACHINE

1) *Gear D.C motor :*

- Torque - 10 Nm
- Power - 100 Watt
- Speed - 60 Rpm
- 24 V Dc

2) *A.c to D.c convertor :*

- It convert A.c current to D.c current.

- Provide D.c to motor.

3) Heater:
- Motor Speed 3000 Rpm
- Capacity – 100 Watt coil
- 90-350 kw Heat Is Produce
- Blower fan motor speed 3000rpm

4) Adjustable Settings:
- Temperature control for sealing.
- Conveyor speed adjustment.
- Shrink time and temperature settings.

5) Control System:
- Manual & semi-automatic

6) Optional Features:
- Print registration for printed films.
- Automatic film feed.
- Film perforation devices

7) Conveyor System:
- Conveyor chain speed and type**.**

Typical Shrink Film Properties

Film type	Tensile Strength psi (mpa)	Elongation (%)	Tear Strength gf / mil (m N / M)	Maximum Shrink %	Shrink Tension psi (MPa)	Film Shrink Temperature Range $^0F(^0C)$
Polyethylene (low density)	9000(62)	120	8(3.1)	80	250 – 400 (1.7-2.8)	150 – 250 (65 – 120)
Polyethylene (low density irradiated)	8000-13000	115	5-10 (1.9 – 3.9)	80	400 (2.8)	170 – 250 (75 – 120)
Polyethylene (copolymer	19000(131)	130	7 (2.7)	50	450 (3.1)	180 – 260 (85 – 125)

IV. DESIGN OF VARIOUS COMPONENTS

After carrying out type synthesis, design of various components of shrink wrapping machine for cloth peg is carried out. Various components are geared D.C motor. motor, sprocket, chain, roller, heater. Initially process force is estimated and based on the process force remaining components are designed. Various stresses coming are shear stress, tensile stress, bending stress etc. The design procedure is mentioned as below:

1) Process force is estimated and considered by taking into account friction, maximum expected load as 1200N. How ever weight of one packet is 1.5N and such 10 packets are placed at a time. Thus total weight of 15 N is placed on rollers. The system process force is1200N, hence it is safe

2) Torque required(T)= F*r
Where F = force on roller = 1200 N ,r = outer radius of roller = 13 mm,
Speed of motor (N)= 300rpm
T=1200*13 =15600 N-mm =15.6 N-m
Thus, power = 2*π*N*T/ 60 = 471 W
Assuming standard power (pR)as350W

3) Design of chain drive
Design power (PD) = PR *K1 = 350 * 1.0 = 350 W
Where K1 = Load factor (1.0 for uniform and for 10hrs of service)
Pitch line velocity (V) = R *ω
Where R = pitch radius of Sprocket = 20 mm
ω = angular velocity of sprocket = 2*π*N/60 = 5.235 V =
0.02 * 5.235 = 0.1047 m/s

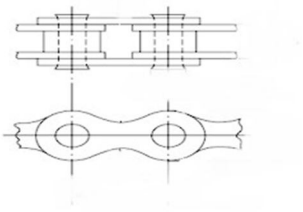

Fig-1: Roller chain

4) Tooth load (FT) = PD / V = 35 / 0.1047 = 3342.2 N = 3.35 KN
5) Power capacity of roller chain P = p2 * {V/104 - V1.41/526*(26-25cos (180/t)) * KC
Where KC =1 (Capacity factor for number of strands)
P = 12.5 * {0.1047/104 – 0.10471.41/526* (26-25cos (180/10))} =
0.129 W
6) Length of chain in pitches (L) = (T1+T2) / 2 + 2*C/P + P*(T1 – T2) / 40*C
Where T1&T2 = t= 10 L= 20/2 + (2*700) / 12.5 = 122 mm
Therefore, total chain length = 122*pitch 1525 mm
7) Pitch Diameter of sprocket = P / sin (180 / t) = 12.5 / sin (180 / 10) = 40.45 mm Sprocket teeth design

- Width of sprocket (T0) = 0.58*P – 0.15 = 0.58*12.5 – 0.15 = 7.1 mm
- Outside Diameter (D0) = P*[0.6 + cot (180 / 10)] = 46 mm
- Root Diameter = DP = 0.0625P = 32 mm
- Pitch circle diameter of sprocket = 40 mm
- Pitch of sprocket (P) = 12.5,
- No of teeth (t) = 10

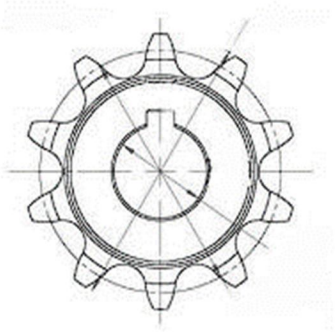

Fig -2 : Spocket wheel

- Design of rollers We know, T = π*Fs*D0*(1 – K4) / 16

Where, k =Di / D0 = 19.6 / 26 = 0.7538 & Fs = shear stress Therefore,
Fs (Induced) = (15 * 16 * 103) / (π* 263 * (1 – 0.7538)) = 6.419 MPa
Also, Fs (allowable) = 140/4 = 35 MPa
So, as Fs (Induced) < Fs (allowable)
Thus the design for roller is safe

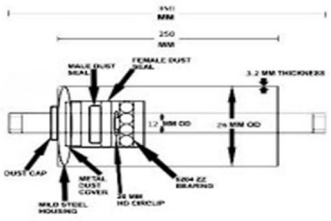

Fig-3: Pipe and shaft of roller

Dimensions of roller (in mm)
Pipe length (D0) = 250,
Shaft length = 350,
Pipe OD = 26,
Pipe ID (Di) =19.6,
Shaft OD = 12,
Pipe thickness = 3.2, Sprocket OD = 40

- Heater – Room heater which are readily available in market of 1000 W and giving air flow of 80 ° C temperature and consuming 1.5 units per hour is selected. Such two room heaters are incorporated in the system. Thus total electrical power consumption is 3 unit per hour

V. WORKING OF SHRINK WRAPPING MACHINE

1) Product Feeding: The products to be shrink-wrapped are placed on a conveyor belt or other feeding mechanism. Depending on the machine design, products can be manually loaded or automatically fed into the machine.
2) Film Unwind: The plastic film roll is mounted on the machine, and the film is unwound as the product passes through. The film used for shrink wrapping is usually a polyolefin or PVC material.
3) Film Forming and Sealing: The film is shaped around the product using various mechanisms such as forming shoes, cradles, or collators. The film is then sealed using heat-sealing bars or wires. This creates a loose bag around the product.
4) Shrink Tunnel: After sealing and, if applicable, trimming, the product is conveyed through a shrink tunnel. The shrink tunnel exposes the package to controlled heat, causing the plastic film to shrink tightly around the product.
5) Heat Shrinkage: The heat in the shrink tunnel activates the molecular properties of the plastic film, causing it to shrink uniformly and tightly conform to the shape of the product. The heat source can be infrared, hot air, or steam, depending on the type of shrink wrapping machine.
6) Product Discharge: Once the film has fully shrunk and cooled, the sealed and wrapped products are discharged from the machine. They can then be collected for further processing, labeling, or packaging.

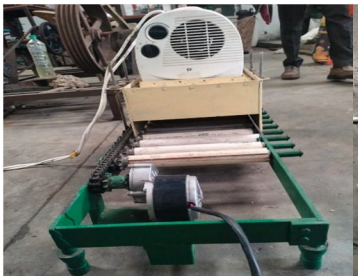

Fig No. 4 : Front View

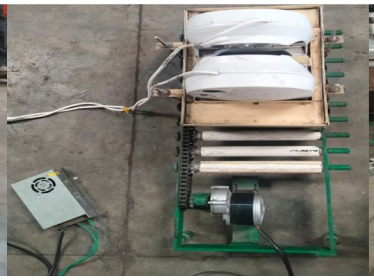

Fig No.5 : Top View

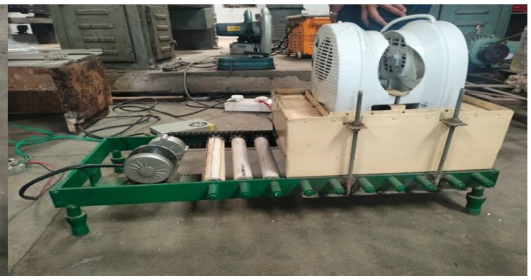

Fig No.6 : Side View

VI. FOLLOWING PLASTICS FILMS ARE COMMONLY USED FOR SHRINK AND STRETCH WRAPPING

1) Polyethylene • Used almost exclusively or as a combination of LDPE + co-polymers EVA (ethylene vinyl acetate) or EEA (ethylene ethyl acrylate).
2) Copolymer Modification: LDPE is sometimes modified by addition of EVA and EEA (up to 8%). EVA is approved by US-FDA for direct contact with food. EEA is approved up to 7% for direct contact with food. However, Vinyl Acetate (VA) or Ethyl Acrylate (EA) content is normally restricted to 3-4%.
3) Irradiated polyethylene film containing EVA, shrinks strongly in boiling water and is generally used for wrapping chickens.
4) Used for foodstuffs (e.g. meat and vegetables). Both are also used for non-food applications, where increased transparency and gloss justify the increased price in comparison with LDPE.

VII. CONCLUSION

After determining dimension by carrying out design of various components, the shrink wrapping machine is fabricated.
Trials and testing is carried out in order to make the machine refined.

1) The System Process Force Is 1200N.
2) Tooth Load (Ft) N = 3.35 Kn.
3) Total Chain Length = 122*Pitch 1525 Mm.
4) Total Electrical Power Consuomption Is 3 Unit Per Hour By Heater.

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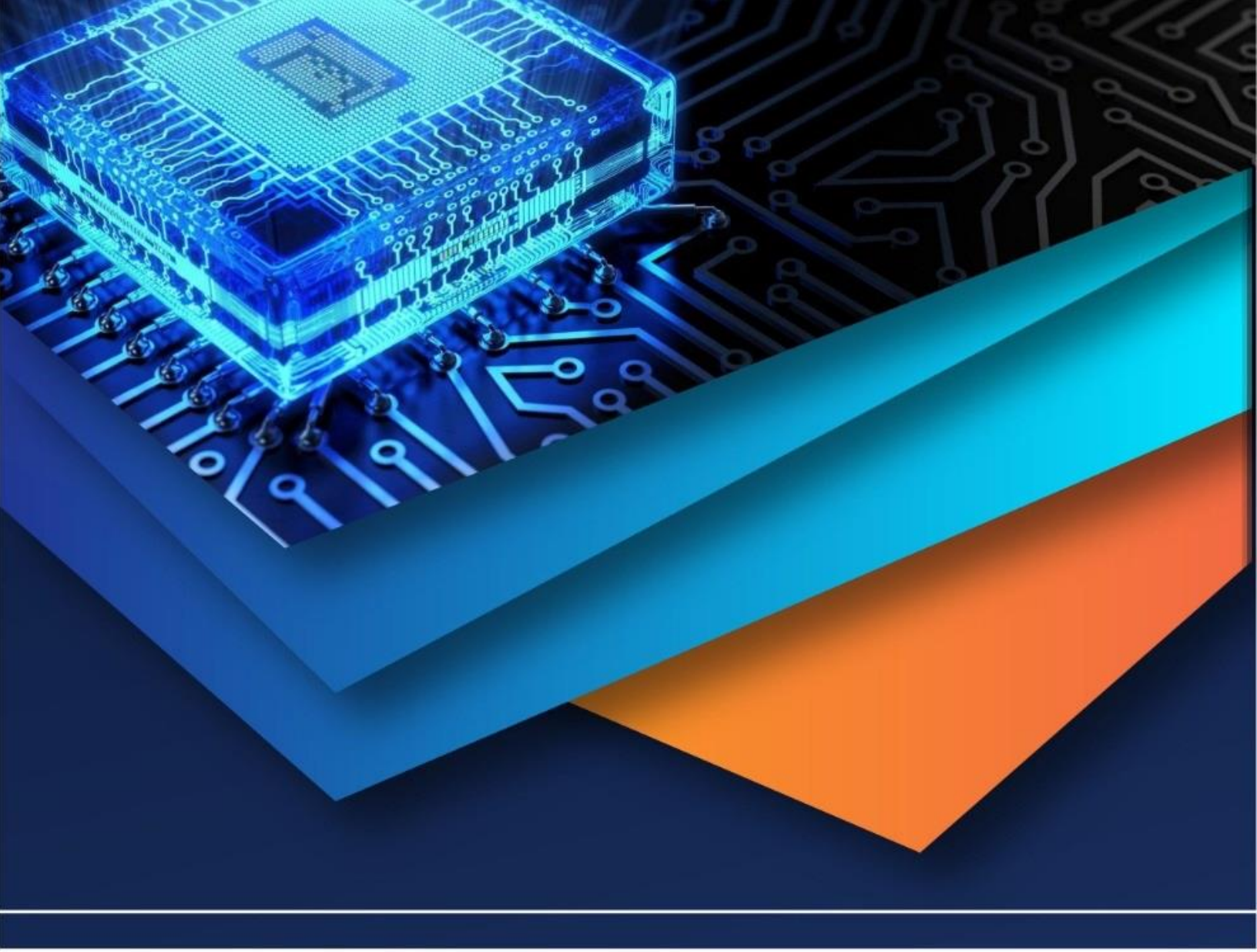

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