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An Overview of Shrink Wrapping Machine for Wrapping of Cloth Peg

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Abstract: ***In order to handle most of the products like cloth peg, container, hanger, tooth brush, shaving blades, heavy 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, it is very convenient during transport also. Here an attempt is made to present a structured approach for design and development of shrink wrapping machine used for cloth peg wrapping. The main component of machine is rollers, chain drive, geared d.c.motor, heater, structure.***
Keywords: PVC material. Shrink wrapping machine, roller speed, chain drive

I. INTRODUCTION

Cloth pegs are used for holding cloths at a space when the cloths are kept for drying. They are made from plastic material. The use and sell of cloth pegs are huge i.e. around 10,000 kg annually from one plastic industry (each packet weighs 50 grams. Thus there is a sell of around 2 lakh packets annually). Each packet consist of 10 cloth pegs and the packaging i.e. shrink wrapping operation is made manually. Refer photofig.1. By providing shrink wrapping to cloth pegs it is convenient to handle, its appearance is good and glossy, the shrink wrap safeguard cloth-pegs from scratch. In this manual process of shrink wrapping, the operator used to pick up cloth-pegs inserted into PVC packet and then the packet is hold behind the dryer by giving gentle rotation of the dryer from top as well from bottom side. Because of heating, shrinkage of PVC film takes place and the film occupy volume of product. This manual process is repetitive and causes lot of fatigue to the operator. Hence an attempt is made here to develop a cost efficient mechanized system for shrink wrapping of cloth pegs and reduce drudgery of operator. Presently, by manual shrink wrapping operation production rate is around 2 to 3 thousand per day in 6 effective hours. With the introduction of shrink wrapping machine it is expected around 2 to 3 thousand packets can be sealed and wrapped in 1 hour. 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.[1],[2] When the film is stretched uni-axially oriented in one direction while it is heated then it is randomly twisted and inter twined molecules line up as shown in fig-2.

Fig-1: Manual shrink wrapping process of cloth peg packet

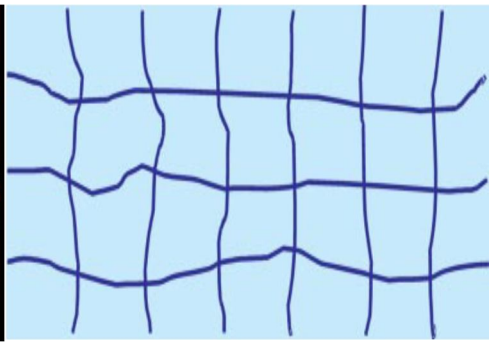

Fig-2: Polymer molecules in uni-axially oriented film

The advantage of using PVC material for shrink wrapping are as below:

1) Lowest Shrink temperature (65-70 ºC).
2) Excellent optical appearance
3) Controlled stiffness by plasticizer content control.
4) Lowest shrink force for wrapping fragile products.[3],[4],[5]

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The application of shrink wrapping process is very wide which are as below

a) Packaging of cloth pegs
b) Container
c) Glass jar
d) Hangers
e) Cartoons with tray.
f) Carbonated Soft drink bottles
g) Water bottles
h) Packaging of cashew nut, Vaults.
i) Packaging of apple, Tamarind pulp, cucumber, etc.
j) Packaging of tooth brush, shaving blades, etc.

Some of the applications are shown in fig.3 to 6

Fig-3: Shrink pack of cartoons

Fig-4: Shrink pack of glass jars

Fig-5: Shrink wrapped cartoons with tray

Fig-6: Shrink wrapped carbonated of soft drink

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II. OBJECTIVES

The objectives of developing shrink wrapping machine are as below:-

A. To carry out in-depth study of manual shrink wrapping process regarding production rate, quality of shrink wrap, drudgery of operator, inaccuracies due to fatigue, health problem to the operator due to repetitive work
B. To study in-depth on inputs, and those are to be taken into consideration while design of the system, given by one of a Plastic Industry namely-
1) Roller should not be overheated else it will melt shrink film and may damage products i.e. cloth pegs.
2) Sealed packets should not have sharp corners and those corners should also be sealed. If the corners are not pressed, then after packaging, it will tear other adjacent packets.
3) There should not be tearing of shrink wrapped sealed packets during heating.
4) The packets should be uniformly wrapped.
5) Appearance should be good and glossy.

C. To develop a mechanized system to fulfill the deliverables expected from the Plastic Industry namely -
1) Cost of the machine should be low
2) Production rate of the machine should be high i.e. around 2 to 3 thousand packets per hour
3) Packets should be shrink wrapped in one stroke
4) Uniform heat should be given to the packets from top as well as from bottom side
5) Electrical power consumption should be 1 to 1.5 unit per hour
6) Machine should have sufficiently long life (around 10 years)
7) The developed machine should be free from maintenance and should have very low maintenance cost
8) The developed machine should be robust, light weight, easy to operate and handle, occupy less space i.e. it should be compact
9) Machine should produce packets where the corners are also pressed, the quality of shrink wrapped packets should be good and glossy

D. To carry out in-depth analysis for selection of appropriate mechanism taking into consideration pros and cons of all possible mechanisms.
E. To carry out CAD modelling of shrink wrapping machine.
F. To carry out design and fabrication of shrink wrapping machine.
G. To conduct trials for observing the effect of heating on cloth peg packets, production rate, power consumption, flow rate of hot air, temperature of hot air etc.
H. To analyze quality of shrink wrapped cloth peg products.
I. To identify problems arrived in each fabricated system and overcome in next phase i.e. to carry out iterative process for development of mechanized system.
J. To carry out economic analysis and estimate pay-back period of the mechanized system.

III. PROBLEM IDENTIFICATION AND PROBLEM FORMULATION

A. During an industrial visit at the Plastic Industry the Proprietor of the firm pointed out their problems regarding -
B. Frequent non-availability of operator for shrink wrapping operation
C. Repetitive work of manual operation
D. Unable in fulfilment of market demand regarding cloth-peg packets during season i.e. during rainy and winter season
E. Poor quality of sealed packets
F. Low production rate from manual shrink wrapping operation
G. Their urgent requirement of low cost mechanized for shrink wrapping operation
H. Considering the above problems it is decided to work on the inputs given by the Proprietor so as to fulfill the deliverables expected from the Plastic Industry.

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While formulating a problem following factors are taken into consideration –

1) Identify and evaluate process force
2) Structured approach of synthesis of mechanism i.e. type synthesis, number synthesis and dimensional synthesis wherein it is decided to select chain drive with sprocket roller so that heat from heating coil can be utilized from top and bottom side of roller, degree of freedom of the system should be one, use of ball bearing in between roller and shaft in order to have low friction[6]
3) In order to have fine tuning, speed of geared d.c. motor, height of heating coil, speed of fan, temperature of heating coil should be adjustable

IV. RESEARCH METHODOLOGY

A. The steps of the Research Methodology are as given below –
B. Collect input data from client in terms of requirement of the mechanized system.
C. In-depth study of inputs.
D. Collect deliverables expected from the client.
E. Generalized hypothesis for converting manual operation into mechanization to reduce drudgery of operator and protect their health.
F. Carry out work on paper for synthesis of mechanism and select appropriate mechanism
G. Carry out CAD modelling and fabricate the mechanized system[7]
H. Conduct trials and experimentation
I. Identify various parameters i.e. speed of motor, height of heating coil, speed of fan, flow of hot air, temperature of hot air and observe the effect of these parameters on quality, rate of production, power consumption etc.
J. Use various instruments like tachometer, current meter, volt meter, thermocouple etc.to measure above parameters
K. Carry out cost analysis of system

V. STRUCTURED APPROACH FOR DESIGN AND DEVELOPMENT OF THE MACHINE

A general method which is developed for finding the optimum set of physical parameters of a mechanism in such a way that a certain physical characteristic of the system will best fit the desired physical characteristics in the operating range of the mechanism. This physical characteristic to be fitted is an angular velocity of gearised d.c.motor for rotating set of roller by chain drive, speed of fan of heater, distance of heating coil from product i.e. cloth peg, temperature of heating coil etc.

Initially synthesis of mechanism is carried out. For the type synthesis belt drive, chain drive and gear drive for roller is considered. But chain drive is selected as there is heating zones near coil.

Similarly, metallic conveyor belt, rollers are taken into consideration but considering the life factor, simple and robust rollers are taken into consideration. The length was estimated 600 mm for placing cloth peg packets, its travel through heater coil and its exits, hence it is decided to take roller of 25 mm diameter along with sprocket of 40 mm. Center to center distance between rollers is 40 mm.

On pipe in order to avoid overheating a pvc pipe coating is provided. A speed controller for gearised d.c. motor whose maximum speed is 100 rpm, is incorporated in order to obtain optimize result of shrink wrapping of the product. All the rollers are rotated by single chain drive.

From the in-depth study of a shrink film it is observed that at 65 to 70 deg, it wraps around the product, hence heating coil temperature of the heater is set at 80 deg. In order to have effective heating height of the coil is placed at a distance of 50 mm from the top surface of the product.

Similarly for better finish of product surface area of heating coil is considered as 250 x 250 mm. Speed of fan is 2500 rpm. These data is collected by carrying out experiment. Experiments and trials are carried out by taking 45 sample size of cloth peg packet and considering best quality of shrink wrap cloth peg packet as good appearance, glossy, uniformly shrink wrapped and pressed corners, independent parameters angular velocity, height of heating coil, temperature of coil, speed of fan are finalized. After selecting the optimized independent parameters, in order to avoid heat loss, the heaters are covered from bottom side so that power consumption can be reduced.[8],[9],[10],[11]

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Fig-7: Figure showing assembly of rollers

Fig-8: Figure showing heater with 100*250 size

Fig-9: Figure showing final shrink wrapping for cloth peg with 250*250mm heater

Table 1: Trails on Shrink Wrapping Machine for cloth peg

Sr. No.	No.of Packets	Time(in secs)	Speed of roller(in rpm)	Height of heating coil(in mm)	Surface area of heating coil(in mm)	Temperature of coil(in deg celsius)	Fan speed (in rpm)	Quality of wrapped product
1	45	55	40	60	100x250	80	2500	Improper shrink wrapping and heating in two passes
2	45	80	30	60	100x250	80	2500	Good quality but there is sharp corners and heating in two passes
3	45	110	20	60	100x250	80	2500	Tearing of packet and heating in two passes
4	45	80	30	50	100x250	80	2500	Good quality but there is a sharp corners and heating in two passes
5	45	80	30	40	100x250	80	2500	Product obstruct and heating in two passes
6	45	80	30	50	250x250	80	2500	Good quality with pressed corners and heating in one pass
7	45	80	30	50	250x250	70	2500	Improper shrink wrapping and heating in one pass
8	45	80	30	50	250x250	80	1500	Improper shrink wrapping and heating in one pass

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VI. CONCLUSION

A. Sealed packets do not having sharp corners and those corners get sealed.
B. There is no tearing of shrink wrapped sealed packets during heating.
C. The packets gets uniformly wrapped.
D. Appearance looks good and glossy.
E. Production rate of the machine is 2500 packets per hour
F. Packets get shrink wrapped in one pass
G. Electrical power consumption is 1.5 unit per hour
H. Machine life is expected of around 7 years
I. The developed machine requires less mantainance and is having low mantainance cost.
J. The developed machine is robust, light weight, easy to operate and handle, occupy less space.

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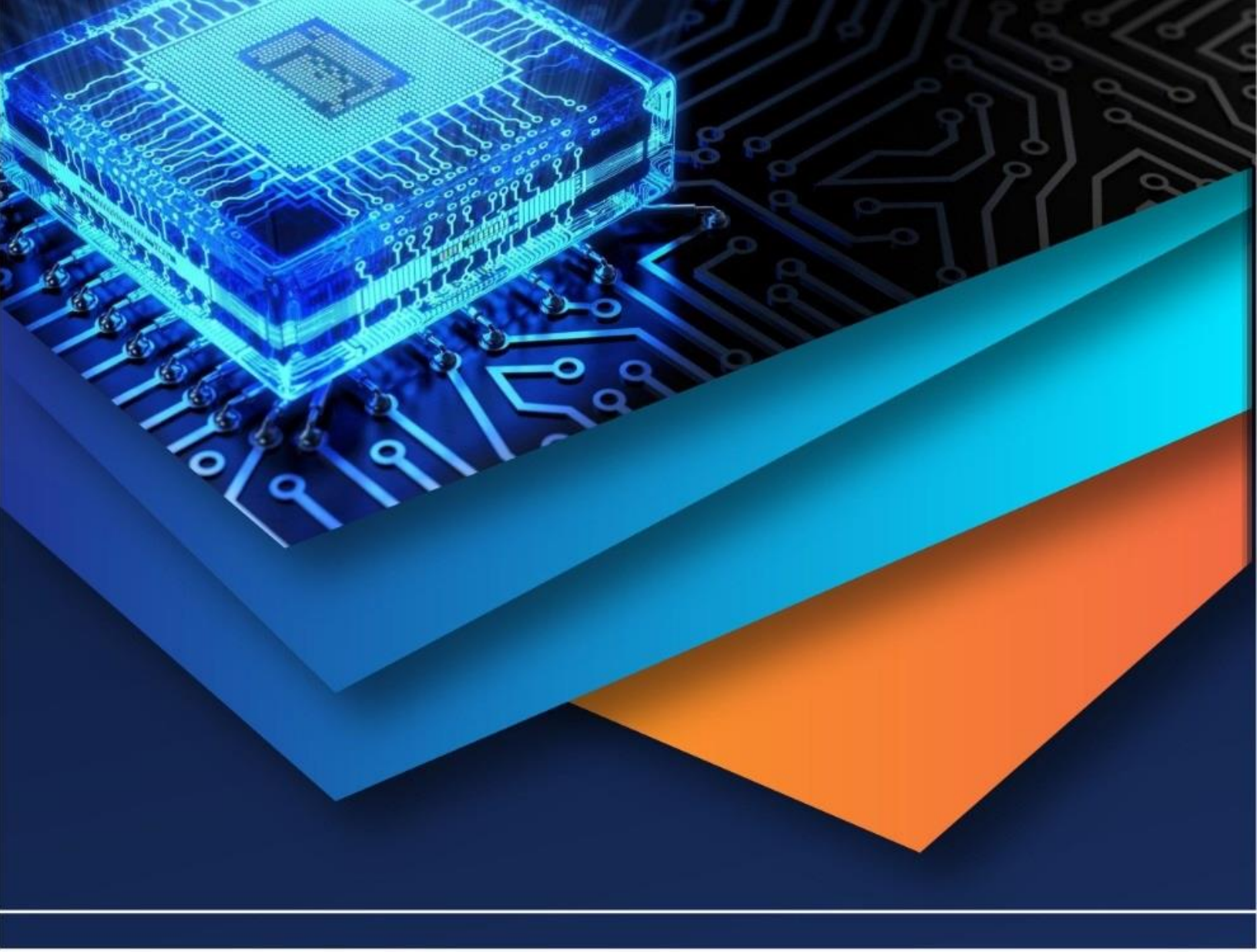

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