International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-7 Issue-5, June 2018

Design and Fabrication of Tablet Strips Counter and Shifter Machine

I. I. Sayyad, Gonjare Pranav Pramod, Joshi Shaunak Nitin, Dongare Varun Sanjay, Galdhar Rohit Dilip

Abstract: ***The applications of conveyor are increasing day by day in the manufacturing industries due to its flexibility and accuracy in material handling. Industries like packaging and food processing uses conveyor for the rapid production and less power utilization in material handling. In general, only a single type of object likes tablets, bottles or trays are monitored and controlled on a single conveyor in pharmaceutical industries. The trays or boxes on the conveyor are to be stopped at the required station and material to be filled in the trays on conveyor. This can be done using the induction type proximity sensors and counters placed at different positions in the system. In given system, we have done the design and fabrication of semi-automatic tablet counting and shifting mechanism in belt conveyor used in the packaging and transportation system in tablet packaging for pharmaceutical industries. The number of trays/boxes to be filled by tablets can be transfer by using arrangements of proximity sensors and pneumatic locking along with counting system. The output packaging fixed can be easily altered in between the process.***

Keywords: Tablets, Packaging, Counter, Pneumatic, Sensors, Belt Conveyor.

I. INTRODUCTION

The machine is consisting of mainly belt conveyor and pneumatic tablet locking system. Initially tablets strips are flows from the belt conveyor and slide down from conveyor to final end destination. The belt conveyor is having belt drive system. When tablet search to final end destination it passes through proximity switch which locks and counts number of tablet strips. Initially pneumatic locking arrangement of tablet counter gets OFF and when 10 tablets are counted it signal is passes to solenoid valve, so that the compressed air is flows through the solenoid valve to double acting cylinders to unlock the arrangements and counted strips fall on boxes on another secondary conveyor.

Manuscript published on 30 June 2018.
***** Correspondence Author (s)
I. I. Sayyad, Department of Mechanical Engineering, Sanjivani College of Engineering Savitribai Phule, Pune University, Pune (Maharashtra), India. E-mail: sayyadimrani@gmail.com
Gonjare Pranav Pramod, U.G. Student, Department of Mechanical Engineering, Sanjivani College of Engineering Savitribai Phule, Pune University, Pune (Maharashtra), India. E-mail: pranavgonjare20@gmail.com
Joshi Shaunak Nitin, U.G. Student, Department of Mechanical Engineering, Sanjivani College of Engineering Savitribai Phule, Pune University, Pune (Maharashtra), India. E-mail: shaunakjoshi1995@gmail.com
Dongare Varun Sanjay, U.G. Student, Department of Mechanical Engineering, Sanjivani College of Engineering Savitribai Phule, Pune University, Pune (Maharashtra), India.
Galdhar Rohit Dilip, U.G. Student, Department of Mechanical Engineering, Sanjivani College of Engineering Savitribai Phule, Pune University, Pune (Maharashtra), India.

That procedure is repeated continuously to manage packaging time. A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyor systems are commonly used in many industries, including the automotive, agricultural, computer, electronic, Food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most common include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand. Some individual areas that are helpful to consider are the required conveyor operations, such as transportation, accumulation and sorting, the material sizes, weights and shapes and where the loading and pickup points need. Conveyor provides one of the most versatile and economical means of moving product conveyor can quickly move large quantities of items in virtually any direction with a minimum of effort and expense. They can use in both permanent and portable applications. The statement of project is “Design and fabrication of tablet strips counter and shifter machine.” used in packaging industry. In existing system for material handling in tablet packaging and transportation there are time requirement and manpower involves more problems due to manual handling and packaging in small scale pharmaceutical industries. There is only belt conveyor having automation operating by using electronics system but it does not have any provision for counting and box packing arrangements for tablets. So, to overcome this problem we can implement the automatic tablet counting and shifting mechanism in belt conveyor with automation in starting and stopping system.

1.1. OBJECTIVES:

The main objective is to suggest suitable system for belt conveyor for material handling. The following are important points regarding this objective of study-

1. To reduce the effort and power consumption during counting
2. To maintain the accuracy in packaging.
3. To make a machine at low cost, low maintenance, low capital investment in less space.

II. THEORY

2.1. Overview of Material Handling

Material handling (MH) involves "short-distance movement that usually takes place within the confines of a building such as a plant or a warehouse and between a building and a transportation agency."
1 It can be used to create "time and place utility" through the handling, storage, and control of material, as distinct from manufacturing (i.e., fabrication and assembly operations), which creates "form utility" by changing the shape, form, and makeup of material. It is often said that MH only adds to the cost of a product, it does not add to the value of a product. Although MH does not provide a product with form utility, the time and place utility provided by MH can add real value to a product, i.e., the value of a product can increase after MH has taken place; for example:

- The value (to the customer) added by the overnight delivery of a package (e.g., Federal Express) is greater than or equal to the additional cost of the service as compared to regular mail service otherwise regular mail would have been used.
- The value added by having parts stored next to a bottleneck machine is the savings associated with the increase in machine utilization minus the cost of storing the parts at the machine.

2.2. Types of Conveyors

i) Belt conveyor: -A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward

Fig.1 Belt Conveyor

ii) Roller conveyor belt:

Fig.2 Roller conveyor

2.3. Conveyors

Conveyors are essential to productivity, from light-duty package-handling roller conveyors in distribution centers to overhead and towline chain conveyors carrying automobiles through assembly to massive ore-handling belt conveyors. To avert production stoppages due to conveyor failure, progressive companies use predictive condition monitoring technologies to monitor those assets. The objective is to detect impending failures before they occur, and take corrective action during scheduled production shutdowns. One of those technologies is thermo graph, or IR Imaging. Thermal imagers capture two dimensional images representing the apparent surface temperatures of conveyor components, and are excellent tools for monitoring conveyors.

- Conveyors are able to safely transport materials from one level to another, which when done by human labor would be strenuous and expensive.
- They can be installed almost anywhere, and are much safer than using a forklift or other machine to move materials.
- They can move loads of all shapes, sizes and weights. Also, many have advanced safety features that help prevent accidents.

There are a variety of options available for running conveying systems, including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs. Conveyor systems are commonly used in many industries, including the automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most common include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand. Some individual areas that are helpful to consider are the required conveyor operations, such as transportation, accumulation and sorting, the material sizes, weights and shapes and where the loading and pickup.

III. CONSTRUCTIONS AND WORKING

3.1. Construction

A) Proximity sensor:-

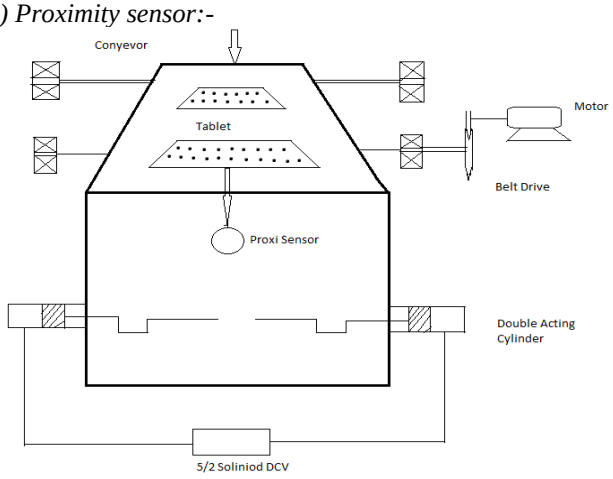

Fig.3 Schematic Diagram of Tablet strips Counter and Shifter Machine

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Proximity sensors are inherently non contact detection devices. Proximity sensors are designed to provide accurate and repeatable operation under high speed conditions. Performing at speeds as high as 5,000 Hz, these sensors can easily accommodate the demands of many fast-paced industrial applications. Proximity sensors offer the precision necessary to maintain efficient, effective production. Sensors typically available with multiple IP ratings, which range from relatively clean environment to those wash-down conditions or temperature extremes.

B) Double-Acting Cylinder:-

This cylinder has ports at the head and rod ends. Pumping air into head end moves piston to extend a rod while any air in the rod end pushed out and return to reservoir. The flow from direction to and from a double acting directional valve or by actuating a control of a reversible pump.

C) 5/2 Solenoid Direction Control Valve:-

This Valve regulates the flow of fluid by opening and closing or partially obstructing passage ways. A 5/2 way directional valve from the name itself has 5 ports equally spaced and 2 flow positions. It can also be used to isolate and simultaneously bypass a passage way for the fluid which should retract or extend double acting cylinder.

D) Compressor:-

A compressor of appropriate capacity is used to meet compressed air requirements. The compressor increases the pressure, and corresponding temperature to high enough level.

3.2. Working

Fig.4 Actual Model of Semi-Automatic Tablet Strips Counter and Shifter Machine

As shown in fig. the machine is consisting of mainly belt conveyer and pneumatic tablet locking system. Initially tablets strips are flows from the belt conveyer and slide down from conveyor to final end destination. The belt conveyer is having belt drive system. When Tablet search to final end destination it passes through proximity switch which locks and counts number of tablet strips. Initially pneumatic locking arrangement of tablet counter gets OFF and when 10 tablets are counted it signal is passes to solenoid valve, so that the compressed air is flows through the solenoid valve to double acting cylinders to unlock the arrangements and counted strips fall on boxes on another secondary conveyer. That procedure is repeated continuously to manage packaging time.

A) Pneumatic Systems Introduction:-

Pneumatic systems form the most primitive and distinct class of mechanical control engineering. They are classified under the term 'Fluid Power Control', which describes any process or device that converts, transmits, distributes or controls power through the use of pressurized gas or liquid. In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. Pneumatic systems are well suited for the automation of a simple repetitive task. The working fluid is abundant in nature and hence the running and maintenance cost of these systems are exceptionally low. All fluids have the ability to translate and transfigure and hence pneumatic systems permit variety of power conversion with minimal mechanical hardware.

The major components of the pneumatic systems are:

1. A compressor of appropriate capacity to meet the compressed air requirements.
2. A receiver to store the compressed air.
3. Air distribution lines to distribute the air to various components of the system.
4. Filter lubricator regulator (FLR) unit for conditioning of air and regulation of pressure.
5. Pneumatic control valves to regulate control and monitor the air energy.
6. Pneumatic actuators and Air driers.

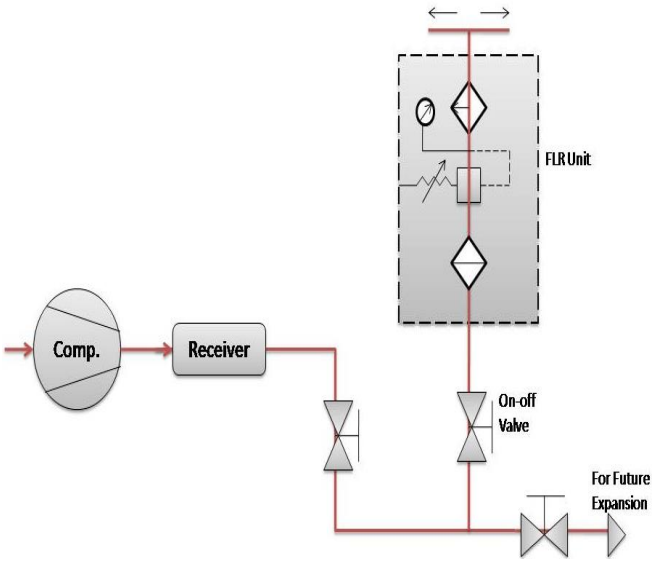

Fig.5 Basic Pneumatic System

B) Double acting cylinder:-

Here we have used double acting cylinder. It is the pneumatic actuator, which is actuated using compressed air. The Force exerted by the compressed air moves the piston in two directions in a double acting cylinder. In principle, the stroke length is unlimited, although buckling and bending must be considered before we select a particular size of piston diameter, rod length and stroke length.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

The double acting cylinder consists of 1) Cylinder tube2) Piston unit 3) Double cup packing on piston, rod packing of O-rings4) Bronze rod guide, Piston rod 6) End covers (flanges) 7) Port connection 8) Cushion assembly.

The cylinder is manufactured from aluminum solid bar with central bore on lathe machine. It is then made smooth internally using method of honing and lapping. It contains piston and piston rod, which reciprocates to and fro with the application of high pressure air. The piston is fitted with the piston ring which is made of Teflon rubber to make perfect compression of the air. The material used for various parts differs for different types of cylinders depending upon applications.

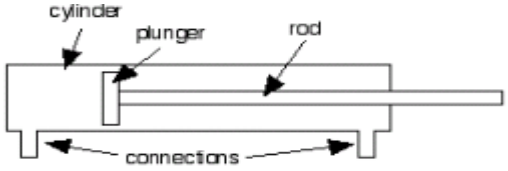

Fig.6 Double Acting Cylinder

C) 5/2 Direction Control Foot Operated Valve:

Its basic symbol is as shown To control the to and fro motion of a pneumatic cylinder, the air energy has to be regulated, controlled, and reversed with a predetermined sequence in a pneumatic system. Similarly one has to control the quantity of pressure and flow rate to generate desired level of force and speed of actuation. To achieve these functions, valves are used to-(i) start and stop pneumatic energy, (ii) control the direction of flow of compressed air, (iii) control the flow rate of the compressed air and (iv) control the pressure rating of the compressed air. A direction control valve has two or three working positions generally. They are:

1) Neutral or zero position
2) Working position.

The positions are mostly numbered as 0, 1, and 2. Direction control valves are designated to indicate both the number of ways as well as the number of working positions such as 4/2, 3/2, 5/2 means 5 ways / 2positions. Here we have used 5/2 direction control valve. In this design of direction control valve, 5 openings are provided. This ensures easy exhausting of the valve along with the two positions i.e. ON and OFF. Here the spool slides inside the main bore and according that the spool position is made ON or OFF due to the fact that the spool gets connected to the open side or the closed side of the air opening.

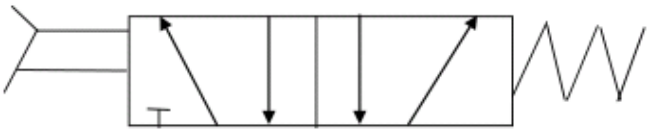

Fig.7 5/2 Direction Control Valve

IV. SYSTEM DESIGN

System design mainly concerns with various physical constrains, deciding basic working principle, space requirements, arrangements of various components etc. Following parameters are looked upon in system design. Selection of system based on physical constraints. The mechanical design has direct norms with the system design hence system is designed such that distinctions and dimensions thus obtained in mechanical design can be well fitted in to it .Arrangement of various components made simple to utilize every possible space .Ease of maintenance and servicing achieved by means of simplified layout that enables quick decision assembly of components Scope of future improvement.

DESIGN

Motor Selection:

Thus selecting a motor of the following specifications

- Single phase AC motor
- Power = 1/15hp=50 watt
- Speed= 60 rpm

Motor Torque:-

$$P = \frac{2 \Pi N T}{60}$$

$$T = \frac{60 \times 50}{2 \Pi \times 60}$$

T = 7.96N-m

Power is transmitted from the motor shaft to the input shaft by means of an open belt drive,
Motor pulley diameter = 20 mm
IP _ shaft pulley diameter = 60 mm
Reduction ratio = 3
IP shaft speed = 60/3 = 20 rpm
Torque at IP rear shaft = 3 x 7.96= 23.88 Nm
Design of belt Drive:-
Motor pulley diameter d = 20 mm
IP _ shaft pulley diameter D = 60 mm
Coefficient of friction = 0.23
Let,
Thickness of belt = 5 mm
Width of belt = 6 mm
Mass of belt per unit length is given by;
Error! Reference source not found.= density of belt material = 950 kg/m3
m= 0.0285 kg/m
Velocity of belt is given by;
V=**Error! Reference source not found.**
V=**Error! Reference source not found.**
V= 0.078 m/s Linear velocity
To find out tension in the belt is;
P= **Error! Reference source not found.**
50 X 10-3 = **Error! Reference source not found.**
Error! Reference source not found. = 636.619 N ---------- (1)
Center distance between two pullies of motor and pullies output C=200mm.
α = sin-1**Error! Reference source not found.**
α = sin-1**Error! Reference source not found.**
α = 5.7390 (In Degrees)
α =5.739 X (**Error! Reference source not found.** /180)
α =0.10c (In Radians)
θ = Angle of lap of belt.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

θ = **Error! Reference source not found.** – 2 α
= **Error! Reference source not found.** – [2 X 0.10]
θ = 2.94c (In Radians)
θ = 168.54O (In Degrees)

Now **Error! Reference source not found.** = e^**Error! Reference source not found.**
Error! Reference source not found. = e^**Error! Reference source not found.**
Error! Reference source not found. = 7.97

F1= 7.97 F2 ---------- (2)

Put Eq. (2) in Eq. (1)

F1- F2 = 636.619
7.97 F2 - F2 = 636.619
6.972 F2 = 636.619
F2 = 91.3N
Put in Eq. (3)
F1 = 727.69N
Centrifugal force in belt is given by,
Fc = mV2
=0.0285 X (0.078)2
Fc = 1.73 N
Shaft design:-
To find diameter of shaft by ASME code
For commercial steel shaft, Actual shear stress τact = 55N/mm2
T = (/16 x τact xd3
(τact=**Error! Reference source not found.**
7.763 =**Error! Reference source not found.**
d3=737.089
d=9.033mm select d=20mm
Bearing selection:-
As shaft dia. – is 20mm so we have selection a pedestal bearing having shaft outer dia. – 20mm.
Selection of shaft ball bearing:-
In selection of ball bearing the main governing factor is the system design of the drive i.e.; the size of the ball bearing is of major importance; hence we shall first select an appropriate ball bearing. Taking into consideration convenience of mounting of ball bearing.
As shaft diameter is 20mm to it and selected a pedestal ball bearing having shaft outer dia-20mm ball bearing to support the shaft of 20mm.
Total radial load on bearings are = Weight of belt + weight of roller shaft.
Assume = 30 N
Radial load on each bearing for front transmission side,
Fr = 30/2
Fr= 15 N.
Equivalent dynamic load
Pe = V.Fa.Ka
= 1 X 15 X 1.5
Pe = 22.5 N
Bearing life is,
L10 =**Error! Reference source not found.**
Lh10 from graph 4.6 PSG Design data book for 16000 rpm maximum speed of ball bearing is 315000 Hours.
L10 =**Error! Reference source not found.**
L10 = 8127 millions of revolutions.
L10 = **Error! Reference source not found.**
C =**Error! Reference source not found.** X Pe
C =**Error! Reference source not found.** X 22.5
C = 335.09 KN.
PSG Design data book P. No. 4.13.
Design of Pneumatic Cylinder:-

NOTE: if we increase the pressure of air as per formula pressure is directly proportional to the force.
If, P F

Design of Pneumatic Cylinder:-
Clavarino's equation for closed end cylinder at both ends. For ductile material use to determine the thickness of cylinder.
Let,
Material of the cylinder is Aluminum.

$$t = r_i \left[\sqrt{\frac{\sigma t + (1 - 2\mu) P}{\sigma t - (1 + \mu) P}} - 1 \right]$$

Sut =Ultimate tensile strength = 200N/mm2
μ = Poisson's Ratio for the cylinder material =0.29 (standard)
di = Inner diameter of cylinder =25mm
Consider,
Double acting cylinder Ø25X 80 (Diameter X Stroke)
ri =12.5mm
By assuming pressure in working cylinder is, P = 3 bar =0.3 N/mm2
So according to Clavarino's equation,
For closed end cylinder at both ends to determine the thickness of cylinder.

Assume,
p = 3 bar = 0.3 N/mm2
μ = 0.29
ri= 12.5mm.

$$t = r_i \left[\sqrt{\frac{\sigma t + (1 - 2\mu) P}{\sigma t - (1 + \mu) P}} - 1 \right]$$

$$t = 12.5 \times \left[\sqrt{\frac{200.784}{199.808}} - 1 \right]$$

t = 0.03049 mm.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

By considering Factor of safety FOS =1.5
t=1.5 x0.03049 mm. =0.0457mm.
Available thickness, t = 1.05mm
Piston diameter- = 25mm
Stroke diameter- = 80mm
Piston rod diameter- = 10mm.
Let,
A= Force area of cross-section of piston.
A= **Error! Reference source not found.** (D2) mm2
A= **Error! Reference source not found.** (252) mm2
A= 490.87 mm2
APR= Force area of cross-section of piston on rod side.
APR= **Error! Reference source not found.** (D2 – d2) mm2
APR= **Error! Reference source not found.** (252 – 102) mm2
APR= 412.334 mm2

Required to complete stroke is 2 second.
Linear velocity of piston V= **Error! Reference source not found.**
V = **Error! Reference source not found.**
V = 40 mm/sec.
Piston force acting during forward stroke
Fa= P X **Error! Reference source not found.** (D2)
= 0.1 X 490.87
Fa = 49.087 N.

Piston force acting during return stroke.
FR= P X **Error! Reference source not found.** (D2 – d2)
= 0.1 X 412.33
FR = 41.233 N.

A. Advantages

- System can work on the low power and time consumption as compare to the old methods.
- The operation of the new machine is well controlled, well balanced system.
- It increases the efficiency of old packaging methods in low cost application machine.
- Machine packaging time will be less.
- Only simple support structures are required design and fabrication is easy.
- It is a faster process.
- More accurate and economical in mass production packaging.
- It minimizes misalignment and less floor space is required.
- The operation of the new machine is well controlled, well balanced system.
- It increases the safety and working condition during tablet packaging.

B. Limitations

- Initial investment is high.
- Pressure, speed and forces required cannot be controlled easily.
- It decreases the safety and working condition during tablet packaging.
- Filter, Regulator and Lubricator (FRL) unit is required as it works on pneumatic system.

C. Applications

- Packaging Industry.
- Pharmaceutical Industry.
- Bottle Processing Industry.

V.CONCLUSIONS

The model develop by us fulfill the required objectives that it reduce human efforts and time in packaging operations. Similarly it maintains the accuracy in packaging process. It performed the most rigid operation with high speed packaging in any types of products. By using this Machine we can conclude that it can measure- 40 Tablets in 1 minute, After some modifications in this machine any one can develop automation unit for the packaging so that machine can easily be adopted in today's automated plants.

REFARANCES

1. Tasnim F. Ariff, Muhd Fahmi B. Jusosh, Malek Parnin and Mohd. Hanif Azenan.., "Design improvements and Fabrication of Conveyor belt cleaner and washing system" International Journal of Education and Research. [Vol.1, Issue No.10, page no.(1-15),(2013)]
2. Imran S. Khan, Prof. Ravichandra Gandhi, "Study and Analysis of Roller Conveyor in Material handling" [Vol.4, Issue No.8, page no. (724-728), (August, 2015)]
3. Mr.Amol B Kharage, Prof. Balaji Nelge, Prof. Dhumal Ketan, "Analysis and optimization of Gravity Roller Conveyor Using ANSYS". [Vol.4, Issue No.4, page no. (296-301), (April, 2015)]
4. Yogesh Tanajirao Padwal, Mr. Satish M. Rajmane, Swapnil S. Kulkarni, "Design and Analysis of a Roller Conveyor for Weight Optimization and Material Saving". [Vol.2, Issueno.7, page no. (138-140), (July, 2013)]
5. Konkalla Naga Sri Ananth, Vaitla Rakesh, Potham settee Kasi Visweswarao, "Design and Selection of the Proper Conveyor-belt". [Vol.3, Issueno.9, page no. (43-49), (August 2014)]
6. Rohini N. Sangolkar, Vidhya dhar P. Kshirsagar, "Modelling And Analysis of Industrial Belt Conveyor Or System Using Creo-Parametric And ANSYS Software."[Vol.3, Issueno.4, pageno. (178-181), (July-August 2015)]
7. Vijay M. Patil, Nitesh kumar A .Vidya, Roshan L. Katkar, Piyush S. Pande, "Type of Conveyor System Used in the Machine."[Vol.2, Issueno.12, page no. (305-307), (July, 2015)]
8. R. K. Bhoyar, Dr. C .C. Handa, "Design Consideration of Adjustable Height and Radial Belt Conveyor System."[Vol.4, Issueno.10, page no. (4377-4382), (October, 2013)]
9. Alhande A. Algitta, Mustafa S, Ibrahim F, Abdalruof N, Yousef M, "Automated Packaging Machine Using PLC."[Vol.2, Issueno.5, page no. (282-287), (May, 2015)]

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)