Journal of Science and Technology
ISSN: 2456-5660 Volume 06,Special Issue 01, August 2021,

www.jst.org.in *DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp586-596*

Design and Analysis of Automated Packaging Machine for IndustrialApplications

Vinod M. Bansode[1], Abhilash A. Giram [2], Omkar K. Kamble [3], Vinod A. Gite [4]

[1](*Department of Mechanical Engineering, NBN Sinhgad School of Engineering Pune, India)*
Corresponding Author: omikashikar31@gmail.com

To Cite this Article
Vinod M. Bansode, Omkar N. Kashikar, Abhilash A. Giram, Omkar K. Kamble, Vinod A. Gite, "Design and Analysis of Automated Bottle Packing Machine for Industrial Applications" Journal of Science and Technology, Vol. 06, Special Issue 01, August 2021, pp586-596: .

Article Info
Received: 15.07.2021 Revised: 24.07.2021 Accepted:10.08.2021 Published: 16.08.2021

Abstract: *The main aim of our project is to pack bottles automatically. This project will automatically pack the tonic bottles with the help of Geneva wheel. The components which are used in the project are decided. The components are electric motor, Pneumatic cylinder, Geneva wheel, conveying system. The force will be exerted by the pneumatic cylinder on the bottles so it will go inside the box and it will get packed. This system is invented for the human convenience. The 3D model will be drawn with the help of CATIA software. The experimental testing will be carried out and then the result & conclusion will be drawn.*

Key Word*: Automated Packaging Machine, Packaging Machine, Automation of Bottling*

I. Introduction

In small industries bottle packing operation is done manually. The manual packing process has many short comings as it will require more time to pack the bottles. This problem faced by small industries so to overcome this problem we are developing this bottle packing machine. Our project is meant for small industries. It aims to eliminate problem faced by small scale bottle packing system. With this system that operates automatically, every process can be smooth and the process of repacking can reduce workers cost and operation time. The system operates by the program that designed to do the operation. Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale, and use. Packaging also refers to the process of designing, evaluating, and producing packages. Packaging can be described as a coordinated system of preparing goods for transport, warehousing, logistics, sale, and end use. Packaging contains, protects, preserves, transports, informs, and sells. In many countries it is fully integrated into government, business and institutional, industrial, and personal use. In industries plastic packaging is available which works on the principle of vacuum extraction process.

Description of the Industrial Process

Currently, in the industrial process of packaging and bottling of bottles, only Zone 1 (in which no single operator is needed for manufacturing. All manufacturing and work is done by fully automated robots.) and Zone 2(in which one or two operators are needed to supervise the process of manufacturing but all the work is done by robots or automatic machines) are fully automated process, Zone 3(in which less than 50% of processing or manufacturing is done by robots and other work is done by using man power), needing at least 12 operators. To increase productivity and decrease costs in this area, we observed the need to develop a project to streamline packaging by complete automation. It is required to be achieved by reconfiguring the master cases are transferred to the introduction in the final packaging and palletizing packs.

Given the above, the following requirements have been defined design:

- Transfer the boxes is automated packaging equipment
- The transfer is automatic storage boxes
- Sealing is automatic of boxes
- Transfer the pallets are automatically palletizing area
- Transfer storage boxes, packaged and sealed, is automatic.
- Palletizing is done automatically.

Nowadays, automation in the industry becomes the global trend in manufacturing The Automatic packaging machines are fully automatic mono-head packaging machine. The machine is used for packing water bottles, pharmacy bottles, leaker bottles and coffee industry. It can wrap the product in 10 grams to 10 of kilogram of boxes. It fills the product in the box and den seal the product centrally. It is based on draw bar mechanism or belt draw down mechanism.

Automation is certainly the necessity as today's manufacturers face razor-thin profit margins. Companies must automate in order to deliver what today's customer is demanding when he wants it and at the price he wants to pay. The increase in manufacturing is led by the automation as well as low wages, customization, mass production, flexibility and information.

The entire packaging process is done with the help of electro pneumatics and motors. The control for the hardware is to be process by the programmable logic controller via the computer. The whole system executes the following processes:

- Automation using the microcontroller
- Filling of material into the bag
- Packaging
- Sealing

The automatic weighing and packaging machines provide a wide array of applications for different industries. The greatest asset of the packaging and weighing machines that are manufactured in the market is that they are advanced and they provide effective coordination with the other processes of production in the best possible manner. It is important for the food industry to stick to the market standards in a position that will make sure their brand value and also attach to the industry quality standards in the best possible manner. It is necessary to note that the customized solutions provided by packing machines for food products in India are modified today to meet a particular set of items in the process.

Problem Statement

Many small and medium scale food production business owners have to do the process of weighing and packaging manually. This process is time consuming and it limits their business and production. The cheapest machine available in India costs around Rs. 1.25 lakhs INR which is not affordable to small and medium scale businesses. The greatest asset of the packaging and weighing machines that are manufactured in the market is that they are advanced and they provide effective coordination with the other processes of production in the best possible manner.

Objective

The objective is to pass the packing process from a manually operated Single Station Manned Cell to a semi-automated Single Station Manned Cell or to a Single Station Automated Cell. It means the task of operator passes from do manually the operation to supervise the process.

Methodology

Step 1: Started the work of this project with literature survey. Collected many research papers which are relevant to this topic. After going through these papers, we learnt about Bottle Packing machine.

Step2: After that the components which are required for my project are decided.

Step 3: After deciding the components, the 3 D Model and drafting will be done with the help of CATIA software.

Step 4: The components will be manufactured and then assembled together.

Step 5: The testing will be carried out and then the result and conclusion will be drawn.

II. Literature Survey

"The Design and Research on Automatic Packaging Machine of the Strains**."**Qiuxiao Yang a, Kaibao Wang b, Mingzhu Zhang c, Li Zhao d, Su Hang and Ming Meng 2015. The strains packaging is mainly completed by hand in mushroom planting industry. In order to improve the low efficiency, an automatic packaging machine of the strains was designed. The machine involves the auger delivery, heat-sealing and cutting mechanism. Theoretical calculation and numerical simulation was applied for the auger delivery unit. This packaging machine can meet the demand of the relative technical requirements, and suitable for promotion in the medium and small farmers. Chinese packaging industry begin to grow in the 1980s. There was a scanty few of mushroom strains packaging machine applied in China, and lower efficiency than developed countries due to the lower starting point and smaller scale. Improving the degree of automation is the main tendency for the development of the packaging industry in the world. So the design of mushroom strains packaging machine is presented. [1]

"Study and Optimization of Box Packing Machine**."**D. Ashraf Ul Alam 2014 Optimizing helps business to run like a well-oiled machine. Efficiency in operations directly translates positively in the company's bottom line. The need for ever-changing process innovations is persistently fuelled by rapid technology advancements and demands on organizations to improve their bottom-line. Installation of new machine or hiring more people doesn't help the improvement always, but to align and streamlining the resources together is also very important. The research area belongs to manufacturing processes development and topic is study and optimization of automatic packaging machine. Primary objective of this research is to study and find the development areas in the flow production department of the case company, to find out performance boosters and suggest implementation process for the changes. Secondary objective is to provide the improved structure of flow production department in the greenhouse sector. In a nutshell, the research was a successful project for me and for FamifarmOy. The company has decided to do some of the modifications to the machine as I suggested. The modification will help the company to achieve their targeted benefit. [2]

"Automation of Packing Process." Cortés Mora, Felipe Zia, Muhammad Irfan 2014 the design work that precedes the automation of a process is not an easy job. Each one of the variables and possible risks involved in process must be carefully considered before implement the final design as well the requirements in performance and cost. However automate a dangerous, inefficient or just uncomfortable task entails many benefits that make up for the long period of design process. A well automated line will benefit the production with quality, productivity and capacity among other profits. In this project the immediate objective is to automate the "SANDFLEX Hacksaw blades" packaging process in the plant that SNAEuropeowns in Lidköping. Actually the packing is completely manual. One operator packs the blades into the boxes meanwhile one more operator loads and unloads the packing station with empty and full boxes respectively. The task is both, tiring and uncomfortable for the operators as well inefficient for the company since the production rate is limited. Analyzing and observing carefully product and process, different theories and strategies to achieve the goal were developed. Three are the possible solutions to solve the problem, with different levels of automation and technologies. The robotic solution uses an articulated robot to perform all the tasks; the hybrid solution uses pneumatic devices to pack the blades and an articulated robot to support the station loading and unloading the boxes. Finally the pneumatic solution uses only pneumatic devices, which hold, open and close, push box and blades using airpower; a few sensors detect positions and states, since a PLC coordinates and controls all process. [3]

III. Construction and Working

Journal of Science and Technology
ISSN: 2456-5660 Volume 06,Special Issue 01, August 2021,

www.jst.org.in *DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp586-596*

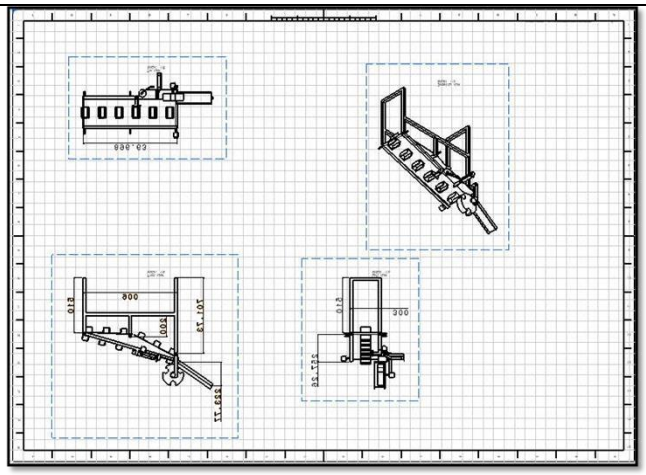


Figure 1: Set up

Bearing:

Friction is bound to occur between the rotating shaft and the part that supports the rotation. Bearings are used between these two components. The bearings serve to reduce friction and allow for smoother rotation. This cuts down on the amount of energy consumption.

Conveyor belt:

One of the basic tools in material handling industry, belt conveyors are most commonly used in transportation of bulk materials (grain, salt, coal, ore, sand, etc.). Belt conveyor systems consist of two or more pulleys (a.k.a. drums). An endless loop of carrying medium the conveyor belt rotates about them.

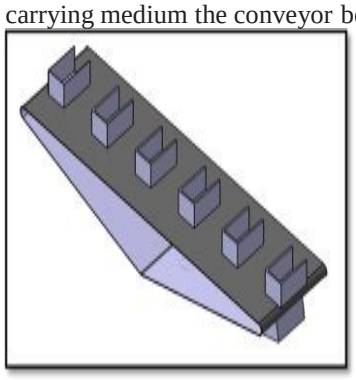


Figure 2

Frame:

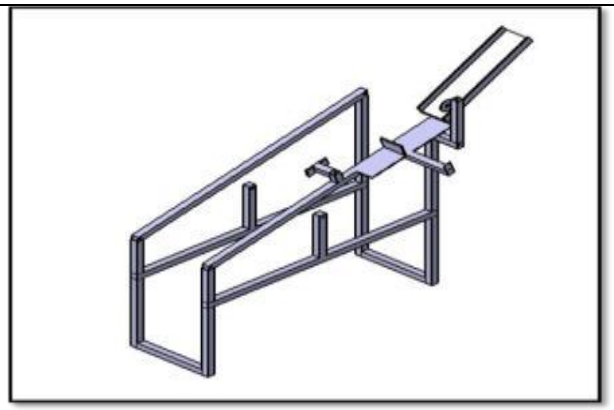


Figure 3

Geneva wheel:

In watches, the "drive" wheel is the one that winds up the spring, and the Geneva wheel with four or five spokes and one closed slot prevents over winding (and also complete unwinding) of the spring. This so- called Geneva stop or "Geneva stop work" was the invention of 17th or 18th century watchmakers.

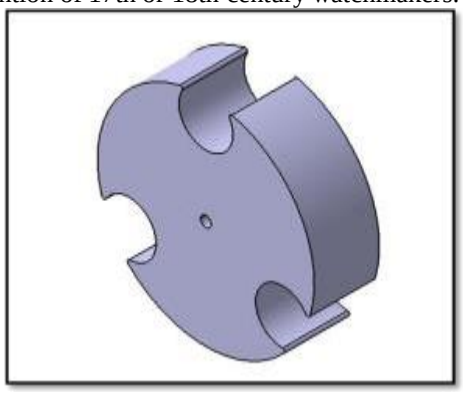


Figure 4

Motor:

DC motors are suitable for many applications – including conveyors, turntables and others for which

Adjustable speed and constant or low-speed torque are required. They also work well in dynamic braking and reversing applications, which are common in many industrial machines

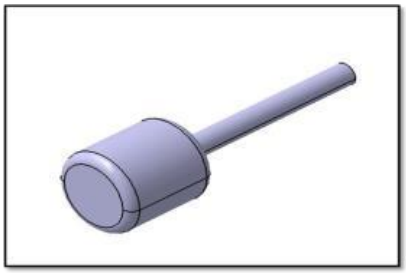


Figure 5

Pneumatic cylinder:

Pneumatic cylinders, also known as pneumatic actuators, are the products used to provide linear or rotary motion and force to automated systems, machines and processes, for example in industrial applications.

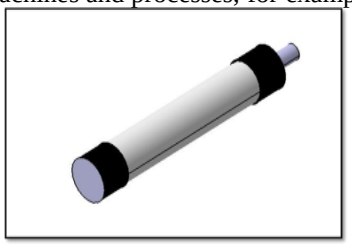


Figure 6

Working Principal

In this setup we are using IR blaster, UNO Arduino circuit. As the bottle is fed from the rack to the conveyor belt the conveyor belt carries the bottle forward till the bottle got sense by the IR blaster, when the bottle is sense by the IR blaster the conveyor stops and the bottle is fed into the box through pneumatic cylinder. And further the box is packed by the mechanism of applying the tape of the box flap.

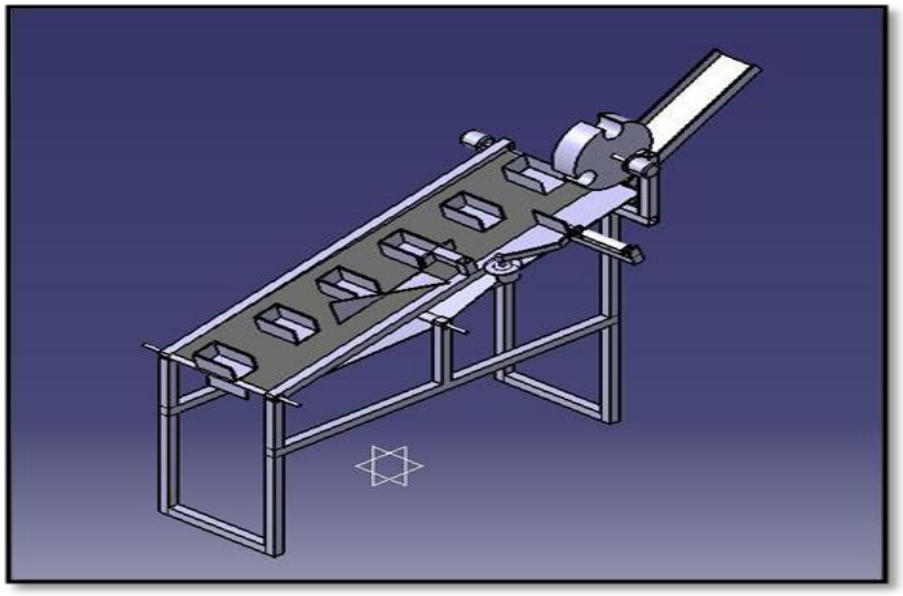


Figure 7

Journal of Science and Technology
ISSN: 2456-5660 Volume 06,Special Issue 01, August 2021,

www.jst.org.in *DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp586-596*

IV. Design and Experimental Analysis

4.1.1 Motor Selection:

Consider weight of the consumable = 10kg (approximately)
So the force applied is equal to = 10x9.81
F= 98.1 N
Hence, the torque required = 98.1x 850 mm
= 83.385 N-m
So we have to select a motor having considerably similar torque as calculated.

4.1.2 Frame Specifications:

We have used 3mm thickness of M.S. sheet
The frame is of 914 x 600 mm

4.2.1 Design of belt conveyor-

For the design of conveyor we are considering some data,
1. We are designing the belt conveyor for light utility, so we took its material as Rubber.
2. Density of rubber=1522kg/m3
3. Minimum thickness of belt=1.5mm
4. Distance between two rollers (L)=2.5 feet=762mm
5. Mass of the belt= mass of belt + Mass of the boxes = 1.7396+2= 3.7396kg
6. Coefficient of friction between bottom surface of the belt and top surface of the rollers having length 200 mm (u)=0.4 (Empirical experimental value)
7. RPM of the rollers (N)=20
8. Mass of the bottles placed on conveyor=10kg.
9. Diameter of roller = 50mm

Now,
The linear speed of belt conveyor is calculated as, (Here take N=20rpm)
$V=\pi D N/60$
V=0.0524 m/s
Now total vertical force applied by packages on belt conveyor
F= (Total mass on the belt)*(Acceleration due to gravity)
=(10)*(9.81)
F1= 98.1 N
Total weight of the belt=(Mass of belt)*(Acceleration due to gravity)
F2= (3.7396)*(9.81)
F2= 36.69 N
Total belt pull=[(Total weight of all packages)+(Total weight of the belt)]*(Coefficient of friction between belt and rollers)
=[(98.1)+(36.69)]*(0.4)
F = 53.916 N
Now the total required power to move the conveyor belt is calculated as,

P=2.825 w P=(Belt pull)*(Belt speed)
=53.916*0.0524 N-m/s
Now we have to give more power than A to move the belt, so select the drive accordingly.

4.2.2 Belt Length:

www.jst.org.in *DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp586-596*

The length of the belt is dependent on the diameters of both pulleys and the distance between their centers D1, D2, D3:
D1= 438mm
D2= 485mm
D3= 905mm
D= 905+485+438mm= 1828mm
As we know roller we are using are of same diameter
So, d1=d2=d= 50mm
$L = (d_1 * \pi / 2) + (d_2 * \pi / 2) + 2D + ((d_1 - d_2)^2 / 4D)$
L = 78.55 + 78.55 + (2 X 1828) + 0
L= 3813mm

Journal of Science and Technology
ISSN: 2456-5660 Volume 06,Special Issue 01, August 2021,

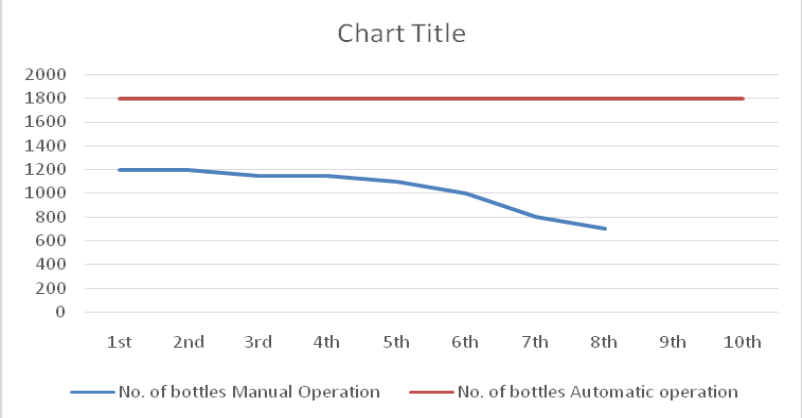
www.jst.org.in *DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp586-596*

V. Result & Conclusion

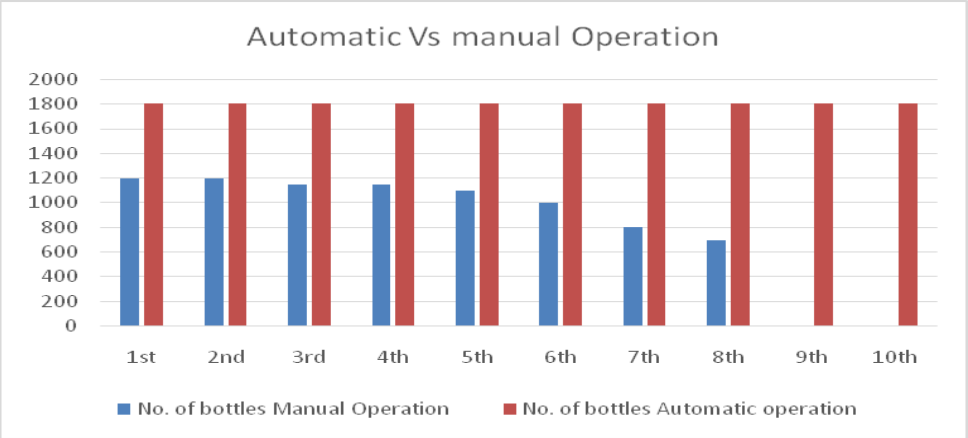
By comparing manual operation of packing and automatic operation of packing bottles we can say that the new automatic system will reduce cost of labor and increases production rate.

Table 2 Production Rate

	Hours	No. of bottles	
		Manual Operation	Automatic operation
	1st	1200	1800
	2nd	1200	1800
	3rd	1150	1800
	4th	1150	1800
	5th	1100	1800
	6th	1000	1800
	7th	800	1800
	8th	700	1800
	9th		1800
	10th		1800
total	10Hrs	8300	14400



Graph 1 Counting of bottles



www.jst.org.in *DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp586-596*

Graph 2 Automatic vs manual opration

In this machine or setup, bottles are being wrapped inside the box. The packaging process of bottle will be done in three steps, firstly the bottle are fed from the wheel mechanism one by one. After that the bottle is restricted by the plate for packaging, as the box and the bottle comes in line with each other, the conveyor moment is stopped for the process of bottle filling inside the box. As the box is filled by the bottle the conveyor starts rotating again. At the end or at the third step box get packed. Due to this process of bottle packing the labor requirement for packaging the bottle is reduced.

VI. Future Scope

Depending on the size, shape and Weight of the bottles packing operation can be done. The machines are specially used for packing soft drinks and water bottles of any kind. As we have developed a machine which can pack the bottle into box one by one at a time, so in future for improving the packing time we can optimize the system to do multiple bottles at the same time or we can pack the bottles of any size. Now we are considering respective the prototype for medicine bottles only. Also we can aesthetically make it more robust.

References

[1]. Qiuxiao Yang a, Kaibao Wang b, Mingzhu Zhang c, Li Zhao d, Su Hang and Ming Meng, "The Design and Research on Automatic Packaging Machine of the Strains", Jilin 132021 Volume03, Year2015
[2]. MD.ASHRAF UL ALAM,"Study & Optimization of Automatic Box Making Machine", Published in theseus.fi Volume04,Year2014
[3]. Cortés Mora, Felipe Zia, Muhammad Irfan, "Automation of Packaging Process" published on diva-portalVolume09,Year2008,
[4]. Prajakta Hambir, Nimish Joshi, Pranav Karande, Amol Kolhe, "Automatic Weighing and Packaging Machine" Published in Internation research journal of engineering and technology Volume06,Year2019,
[5]. Boca, M. L., Kovač, P., Savković, B., "Model Approch of Automation of Bottling and Packaging for Industrial Process of Bottles" Published in research gate Volume02,Year2017