© 2019 IJSRSET | Volume 6 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology
DOI : https://doi.org/10.32628/IJSRSET1962162

Study and Analysis of ENCON Opportunities in Automatic Tube Filling Machine

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ABSTRACT

In this paperentitled, "Study and analysis of ENCON opportunities in Automatic Tube Filling Machine," In this machine the plastic tubes gets sealed and aluminum tubes gets folded at open end. Wehave plannedto study and design mechanical cam based folding operation which will reduce the operating cost of the machine. We are going to study the folding operation in traditional Automatic tube filling machine. The traditional Automatic tube filling machine has pneumatically operated folding mechanism due to which operating cost of the machine increases. Using mechanical energy and cam principle we can operate the tube folding mechanism[4]. Simple modification in design will operates the tube folding mechanism without changing the main motor consumption.

Keywords : Automatic Tube Filling Machine, ENCON Opportunities, Folding Mechanism, Aluminum Tube

I. INTRODUCTION

Energy conservation is broader than energy efficiency in including active efforts to decrease energy consumption, for example through behavior, in addition to using energy more efficiently. Pharmaceutical industry is one of the fastest growing and energy consuming industry. Pharmaceutical packaging industry market values 65.55 billion USD and it will grownup up to 94.43 billion by 2021.Pharmaceutical manufacturing plants in the U.S. spend nearly $1 billion each year for the fuel and electricity they need to keep their facilities running[5]. The Mainly packaging machinery has requirement of compressed air, Heating, mechanical equipment consumption etc.

In pharmaceutical and cosmetic industry tube and jar filling machines plays important role as many products are reach up to the customer in the form of folded aluminum tubes, jar or sealed tubes[3]. The automatic or semi automatic tube filling machines needs for sealing of plastic tubes and closing of the filled aluminum tubes as the aluminum tube will not able to sealed properly Automatic tube filling machine has ability of filling the empty aluminum tubes and the filled tube will get 1st fold and then 2nd fold. The tube will get lifted under each station through the lifting cams which are installed on the common shaft and the indexing turret will rotates the tube from one station to another. In traditional machines the folding operation occurs with the help of pneumatic pressure which will utilized the maximum pneumatic energy of compressor assign for that specific machine.

II. GENREAL OVERVIEW OF THE MACHINE

The automatic tube filling machine is use for filling & closing for metal & Aluminum tubes. The lami or plastic tube gets sealed. In general plastic tube filling

operation tube is get sealed at open end while for aluminum tube folding is done to close the open end of the tube. This machine is use for filling product inside the tubes[1]. Tube holders are designed as per tube diameter.

The standard stainless steel jacketed hopper with stirrer unit is provided to load the product. Level sensor maintains the product level. Empty tubes feed manually in the tube holder.

After loading the tubes, tube passes through the tube presence sensor for maintain proper orientation of the machine.

If tube is not present inside the tube holder product is not get filled.

The piston dosing pump, consisting of piston placed in S.S. cylinder carries out the dosing. Two set of piston pump (depending on material characteristic) is provided for the product dosing. The dosing is cam based operating assembly. The tube will pass under the orientation station and gets oriented. After orientation and filling occur the tube will pass through closing assembly where 1st folding is done through the crimping jaw then tube will pass through 2nd folding station and then ejected through cam base lifting ejection pin.

Sequence of Operation For Aluminum Tube Filling And Closing Machine[1]:

A. Drive mechanism
B. Indexer
C. Tube level assembly
D. Tube Orientation assembly
E. Dosing assembly
F. Tube first folding assembly
G. Tube second folding assembly
H. Tube batch coding assembly (optional)
I. Tube ejection assembly

III. AIMS AND OBJECTIVE

The main purpose and objective of this is to study and achieve the energy conservation opportunity in automatic or semi-automatic tube filling machine. The Parle Kovai Machinery Pvt. Ltd is having the standard traditional pneumatic based design for the machine on which tube folding is achieved.

The compressed air required in Aluminum Tube Filling Machine for below purpose

- To operate folding unit
- To operate sealing unit
- To shut off for nozzle
- To heat the plastic tube open end for sealing

The compressed air consumption for folding unit and sealing is generally high as compare to filling shut off operation. It means compressor has to major work for folding and sealing operation which actuates per minute if the speed of the machine is around 50 to 60 tubes per minute[2].

With the help of systematic approach, the electric consumption for the folding operation can be reduced by reducing compressor work. In current/traditional tube filling sealing and folding operation of tube filling machine, the folding unit is actuated through pneumatic cylinder which will be replaced by the cam base mechanical folding by adding the cam assembly on the same driven shaft

The pneumatic power is simply used to actuate the crimping jaws of the folding unit. Generally the minimum requirement is 3cfm pressure required to actuate the folding unit when it is operated on pneumatic folding unit. Although there is a used of small part of compressed air around 1cfm for shutoff nozzle. Pneumatic folding unit consume major part of the pneumatic energy. While other units like orientation, ejection is carried out by the lifting cam on same driven shaft.

There are many machines manufactured as per customer orders and continuous in house trials are going before dispatch to customer. Each machine consumes the compressed air up to 7 cfm for that compressor will operate to maintain the compressed air pressure for 8 to 10 hrs. If we reduced the load on the compressor by doing simple modification in

folding mechanism then there is a chance of energy conservation by reducing the compressor work.

A systematic study shows that the addition of operated cam for actuation of crimping jaws and to achieve that actuation grooved cam on driven shaft and will serve the same purpose and also we achieve the smooth folding with no use of compressed air.

IV. RESEARCH METHODOLOGY

In this research we are going to compare and study principle of cam operated assembly with pneumatic based operated assembly of the folding unit. The base of the research is on cam principle and its applications. As the pneumatic energy is costly this will increase the operating cost of the machine at in house and overheads at customer site.

There is and another problem with current pneumatic operated folding assembly is that due to the sudden actuation of jaws or prompt actuation of cylinder there is an impression on the close tube profile.

The pharmaceutical and cosmetic industry is very sensitive about their product aesthetics and overall quality of the container/tube. These types of impact impressions are not generally accepted in the industry. Therefore design team of Parle Kovai Machinery Pvt. Ltd has taken the initiative in direction of smooth folding and after thinking of alternative source the cam base folding concept is designed.The cam base design is having two sections one is folding assembly cam and another is folding cams mechanism lifting assembly which is also cam based.

Figure 1 : Pneumatic base Folding Unit

Operational Sequence:

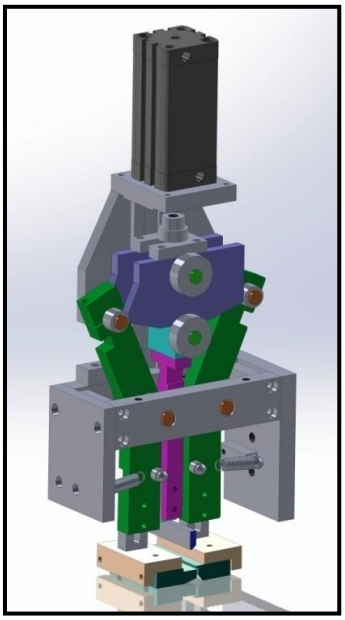

Figure 2 : Pneumatic base Folding Unit

The first crimping unit consists of two jaws with cam for performing the first crimping operation. The tube gets hold or is locked in between the two jaws. Meanwhile the cam becomes active and folds the tube which is called as first crimping. The tube is released after the crimping process is over.

The second crimping unit is similar with the first crimping; the unit consists of two jaws for performing the second crimping. The tube with first crimp is hold or is locked in between the two jaws of the second crimping jaw. Meanwhile the cam becomes active and folds the tube as per the setting done in the cam. The tube is released after the crimping process is over

The both unit requires the approximately 6 cfm pressure to actuate the folding unit.

Tube Folding with Cam based Folding Unit:

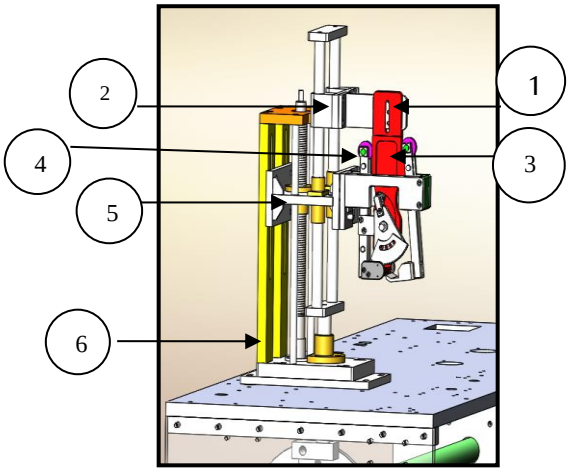

Figure 3 : Cam based Folding Unit Assembly in Semi-Automatic tube Folding Machine

Table 01 : Major Part List for Cam based Folding Unit

Part No	Part Name
1	Operating Cam
2	Follower
3	Lever
4	Geared lever
5	Sliding lever

There are two sections of cams are utilized for following operations:

1. Operating cam for folding operation
2. Grooved cam for lifting folding assembly

The operating cam consist of cam, roller follower, lever with folding jaws, geared lever for folding, sliding rod connected to the groove cam

The grooved cam rotates for three positions;

- Dwell rest position
- Rise position
- Rest position

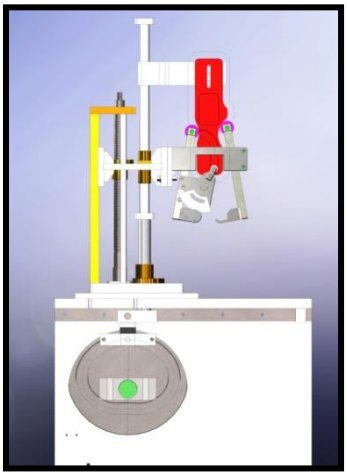

Figure 4 : Dwell Rest Position

During dwell rest position of the cam, sliding rod at the bottom position and follower of the operating cam is also at lower section of the cam profile. So the both folding jaws are open and folder pinion is at open position

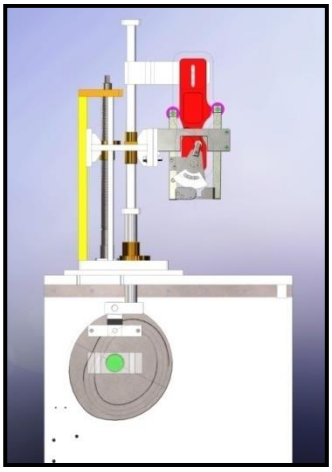

Figure 5 : Rise Position

During rise position of the grooved cam, sliding rod at up position and follower of the operating cam is also at rise profile of the operating cam. So the both folding jaws connected to lever are come closer and hold the tube and geared lever folding will turns the folder pinion to closed position which will folds the tube. Here tube will get 1st fold.

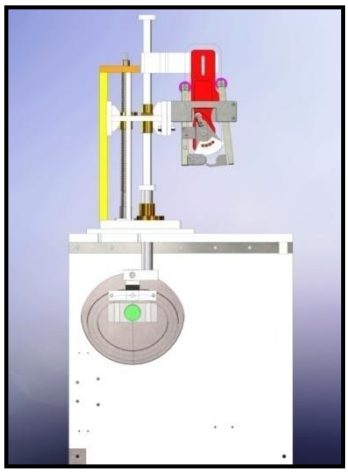

Figure 6 : Rest Position

During rest position of the grooved cam, sliding rod at middle position and follower of the operating cam is crossed the rise profile of the operating cam. So the both folding jaws connected to lever are released. folded holder containing folded tube will travel towards 2nd folding unit. Geared lever folding will turns backwards and the folder pinion will open[1].

Operational Sequence:

As machine is getting started when grooved cam is on rise position then rise position of the grooved cam tends to lift the sliding rods to upper position. At the same time follower of the operating cam will travel on the rise profile due to which both folding jaws connected to the lever will come closer and hold the tube tightly. The gear lever connected follower will travel the rise position in tapped profile and actuate the open folder pinion to closed position and the tube is get 1st fold.

Now grooved cam starts moving to rest position so with the rest position of the grooved cam tends to down the sliding rods to bottom position. At a same time follower will leave the rise profile and comes down due to which both folding jaws connected to the lever will released the folded tube. The gear lever connected follower will travel to rest position in tapped profile and actuate the closed folder pinion to open position. Now folded tube holder will travel towards 2nd folding

2nd folding operation:

The 2nd folding unit is work same as the 1st folding unit only the folded tube gets second fold. Rest of the operation sequence is same as 1st folding.

Advantages of Cam based folding:

- Successfully installed with same main motor rating:
  The current main drive motor is remaining same even after addition of the lifting grooved cam on the main shaft. So we are achieving the cam base folding operation within same motor rating
- Smooth folding:
  Another advantage of folding in pharmacy point of view is smooth folding. In pneumatic folding due to high impacting force the folding profile may have line or sharp end. This may not be acceptable as per QC guidelines of the pharmaceutical standard. While in cam based folding tube is smoothly hold as per uniformly rise position of the grooved cam and the folding pinion will fold the tube end.
- Reduction in compressor work:
  As major part of the compressed air is consumed in folding operation which is running continuously 8 hrs, the operating cost of compressor is high. As the same unit is replaced by the cam based unit the compressor work will reduced.
- Operating cost of the machine is reduced:
  The overall operating cost of the machine is the combination of electrical consumption of machine and electrical consumption per cfm pressure generated by compressor. After replacing of the cam based folding unit and other accessories the cfm consumption of pressure will reduced which ultimately reduced the operating cost of the machine.

V. EXPECTED OUTCOME

Each and every industry whether it is small scale, medium scale or large scale needs to the reduced

overheads on power consumption for their end product. The minimum cost of production can be achieved by the systematic process study of the process and by finding the parallel alternative for specific process in the sustainable development. The overall efficiency of the plant is mainly depends upon the energy consumption.

The aluminum tube filling machine manufacturing plant mainly requires the energy in the form of electricity and compressed pneumatic air. The major part of the energy consumption is consumed in continuous running of the fully assembled machines for trials before dispatch to the customer. To run the machine we required the electricity and to run the different operations compressed pneumatic air up to 7 bar is required.

The study is elaborated that the folding operations consumes major part of the compressed air for doing folding operation. The generation and maintain of 7bar pressure for continuous 8 working hours will consumes more electrical units than any other utility.
With the help of the above modification we can effectively reduce the operating cost of the machine as well as utility.
While systematic studying each and every process in terms of product quality and economical cost, the alternative is derived for tradition pneumatic base folding operation. The cam base folding unit will serve the purpose with the more effective folding quality and at reduced operating cost. The detail calculation, expected results along with various design calculations, expected results along with various design parameters that were derived at conception stage and it gives the ENCON resulted in terms of the conservation of electrical unit for numbers of manufacturing machine with cam based folding.
Also study and alternative for other operations which are having pneumatic consumption like shut off of filling also reduces the electric consumption for each machine
As pneumatic consumption in terms of electrical unit is high thane the cam base as this unit will run on same main motor rating, no external energy is required to drive the cam base folding unit.
Generally we can calculate the energy conservation in such a way that;
The total cfm consumption of the machine with traditional components like pneumatic folding, pneumatic shutoff.
After modification cfm Consumption For same machine at same compressor rating
Convert the cfm to equivalent kW and then kWh.
This achieved difference is throughout for the machine whether it is at manufacturing unit or at customer place.
The detailed calculation and case study for recent month will give the expected result

VI. CALCULATIONS

The central compressor ratings are as follows,
Compressor Make: Chicago Pneumatic

7.5 HP, 5.5KW with air delivery is 16cfm.

For pneumatic base folding unit;
As per FESTO datasheet, cfm consumption for 1st folding cylinder= 4.11cfm
For 2nd folding cylinder= 4.11 cfm
Total air consumption for folding operation= 8.22cfm
So KW consumption for both folding can be,
As per compressor rating,
16cfm air generated on consumption of 5.5 KW
∴ 8.22 cfm air generated on consumption of x KW

$$\frac{5.5}{x} = \frac{16}{8.22}$$

By solving above equation we get x=2.825 KW
As general working condition the working hours considered as 10 hrs.
So the electrical power consumption per hours can be calculated as,
2.825KW×10working hours= 28.25KWhours
=28.25KWh
As per Maharashtra state electricity board the rate per KWH varies as per day work load
∴Considering minimum rate per day is 7.56 Rs. Per day

The KWh per day for on machine is calculated as;
28.25KWh× 7.56 Rupees = 213.57 Rupees per Day.
As per general working conditions Considering the 25 Days working done per month
∴ 213.57× 25Days = 5339.25 Rupees per Month
Therefore the cost of electrical unit consumption on folding operation per year can be calculated as;
=5339.25Rupees per Month× 12Months,
= 64,071 Rupees per year.
Therefore the yearly operating cost of the pneumatic folding operation for one machine is 64,071 Rupees
If the same operation is replaced by the mechanically cam based operated mechanism then the above operating cost of folding operation can be conserved per year

VII.CONCLUSIONS

From above calculation it is observed that the , if we replaced the pneumatic based folding unit with mechanical cam based folding unit then the electrical power consumption of the machine is reduces which will reduced the operating cost per KW consumption of the machine.
As per the Energy Conservation opportunity basic principle (which also stated in Bureau of Energy Efficiency general guidelines),
'THE SAVING OF ONE ELECTRICAL UNIT IS EQUIVALENT TO GENERATION OF TWO UNITS OF ELECTRICITY.'
From the calculation we can conclude that by the simple approach of changing the operational methodology we achieved the ENCON Opportunities in Automatic Tube Filling Machine.

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Cite this article as :

Sushrut Madhav Patankar, Clifford Edward, "Study and Analysis of ENCON Opportunities in Automatic Tube Filling Machine", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 6 Issue 2, pp. 612-618, March-April 2019. Available at doi : https://doi.org/10.32628/IJSRSET1962162
Journal URL : http://ijsrset.com/IJSRSET1962162