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Improvement in sealing and cutting mechanism of low density polyethylene bags for dry ice

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ABSTRACT

Temperature of Liquid CO2 varies between -16°C to -20°C and for the Dry ice it is -78.5°C. There is a chance of cold burn on the skin of the one who is in direct contact with these dry ice cubes. Even if we use hand gloves for the same, then gloves will adhere to the skin which is in contact with gloves. Also manual packing process is hazardous for the workers and is relatively slower than machine packing. So there must be a provision for automatic packing of these ice cubes [9]. SICGIL India Limited has an automatic packing machine for dry ice, but due to some sealing and cutting problems it is not in running condition. After replacing older data with newer one, obtained from trial and error method, the machine is working efficiently and problem of the cutting and sealing is solved & speed of packing is increased by 50% and cost benefits are increased by 18% & also the worker's good health & safety is assured

Keywords
Dry ice, Automatic packing machine, Health & Safety

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Introduction

SICGIL India Limited is the largest and the most preferred supplier of CO_2 and Dry ice all over and across India. The main product of SICGIL India Limited is Liquid CO_2 & Dry ice. Temperature of Liquid CO_2 varies between -16°C to 20°C and for the Dry ice it is -78.5°C.

Dry ice is available at the manufacturing sites located in India in the form of blocks, slices, nuggets and 3mm pellets.

There are four machines for dry ice production in which, each machine has two chambers which means, from a single machine two ice cubes will be produced. While dealing with these ice cubes, major problem occurs in handling the ice cubes due to their temperature. The temperature of dry ice is about -78.5˚C which is very low for the one to touch it with bare hands. Even with gloves it becomes hard to handle as gloves after some time adhere to the skin, which is in contact with gloves.

So it's necessary to provide the automatic packing machine for safety purpose. Total two conveyors are used, on both the sides of machine, it means each side has two machines and four chambers. Dry ice enters to the packing machine through in feed conveyor placed just before the packing machine. Produced ice cubes are then covered with paper and plastic polyethylene manually [1].

There are total 17 cylinders and 6 motors used in packing machine. Programmable logic controller (PLC) controls all the parameter of machine from top to bottom and left to right [9]. There are a number of sensors which sense the movement of dry ice at different stages.

The packing machine is fully pneumatic and runs without any mechanism of hydraulics. PLC and sensors require electric power. So power consumption is reduced by maintaining it.

Problem Statement

In an automatic packing machine, there is main problem with sealing and cutting of the plastic bag of dry ice. We use low density polyethylene bags for packing which has high strength and liability [1, 5, and 7]. We can recycle it after its usage [8]. The sealing and cutting mechanism is covered with the layer of Teflon tape [4]. Sealing of bags is done by the metal strips, which are heated at certain voltage for some time and Nichrome wire is used for the cutting of the bags by heating it; because of more liability [3].

Sealing and cutting takes place in 40% of portion, and another 60% of portion is not sealed and cut properly. So this machine is useless for packing. So we are working on this problem for better improvement of the company. A. The factors responsible for this problem are:

1. Wire material
2. Voltage of strip
3. Voltage of Nichrome wire
4. Sealing time
5. Cutting time
6. Insufficient air flow
7. Teflon tape layer
8. Overheating
9. Cooling pipe
10. Water pump
11. Sealing time

FIGURE 2.1- PROBLEM STATEMENT

[There are two jaws which have metal strip and Nichrome wire. Plastic comes between these jaws and heating and sealing takes place [8] but here it is not working. There is also a cooling system for temperature control.]

B.Disadvantages of problem

- More labor cost,
- Improper sealing and cutting,
- Can't get benefits of machine,
- More time consumption for packing,
- Can't get continuous production,
- Wastage of money,
- Space management,
- High maintenance,
- High break - even for the investment,
- High air compressor maintenance,
- Material corrosion etc.

Experimental Observation

From trial and error method, specification for better sealing and cutting mechanism is obtained as shown below.
We modified the voltage rating for sealing and cutting, time for horizontal and vertical sealing and cutting, proper cooling, Teflon layer, proper arrangement of sealing mechanism.

PARAMETER	MODIFIED	OLDER
Cutting Voltage	153 V	135 V
Sealing Voltage	123 V	135 V
Horizontal Voltage	97 V	90 V
Vertical Sealing Time	4 sec	3 sec
Teflon layer	3	1
Horizontal Sealing Time	1.5 sec	3 sec
Cooling medium	Air and water	Water
Nichrome rod position	Outward	Inward

TABLE 3.1 MODIFIED DATA

A. Flow rate andcylinderspecification of cutting and sealing

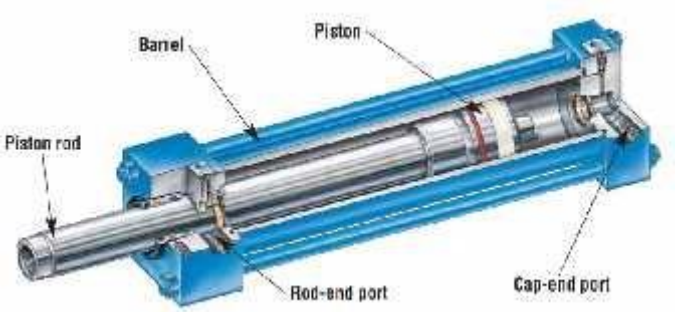

FIGURE 3.1- PNEUMATIC CYLINDER

[This is a pneumatic air cylinder contains inlet and outlet ports, piston and cylinder. This is a used for movement of the jaws.]

- Radius r = 1.2 cm = 0.12 m
- Stroke s = 35 cm = 0.35 m
- Cycles c = 2 per minute

Air flow rate includes, piston area
= 3.14 * 0.012*0.012
= 0.00045216 m^2
So air flow rate = a * s * c
= 0.00045216 * 0.35 * 2
= 0.000316512 m^3/min
= 0.000633024 m^3/min for both the stroke
(This much air flow requires to move the jaws for sealing and cutting)

B. Comparision for understanding purpose

BEFORE	AFTER
Nichrome wire is covered with Teflon layer	Nichrome wire is in direct contact of plastic polyethylene
Only one layer of Teflon on the strip	Modified by providing 3 layer of Teflon on the metal strip
Voltage for sealing =135 v	Voltage for sealing = 123 v

Voltage for cutting= 135 v	Voltage for cutting= 153 v
Sealing and cutting time = 3 sec	Sealing and cutting time = 4 sec
Cooling medium was water	Cooling medium is air & water
Nichrome rod position was inwards	Nichrome rod position is outwards

TABLE 3.2 COMPARISION

Summary And Conclusion

As compared with previous data, we examine that the previous data was for the specific batch quantity or some quantitative packing.
But our modification is for the mass production or for continuous production [11].
Because, by using multiple times, there is a chance of overheat and it leads to improper sealing and cutting of low density polyethylene bags containing dry ice of temperature -78.5 °C.
It has been observed, during the study and discussed with different industry representatives; the need of packing machine in the company is much needed due to safety purpose. Also the packing speed due to manual process is very slow.
Demand for packaging is expected to go up in the next four to five years and packing of dry ice will remain a main challenge for the industry.
To restrict the stated problems of the machine, some positive changes and necessary actions should must be taken. So to overcome all the existing issues in the Automatic Packing machine, we have done some mechanical & electrical changes in the machine as follows:

A.Mechanical changes in the machine:

- Nichrome wire is in direct contact of plastic polythene bag (by modifying the design). • Layer of Teflon is increased by 3 layer on the metal strip after a lot of trials.
- Nichrome rod position is outward.
- Cooling medium is modified by air & water.
- Maintenance of water pump for lifting water as a coolant.
- Installation of fan on the position of the jaws for pushing plastic inward.

FIGURE 4.1- CONCLUDED DESIGN

[This is the final image, after improvements are done in the machine by experiments and study. The new jaw design is in the figure and cooling is also modified.]

B.ELECTRICAL CHANGES IN THE MACHINE:

- Voltage for sealing is changed from 135 V to 123 V. • Voltage for cutting is changed from 135 V to 153 V. • Sealing and cutting time is changed from 3 Sec to 4 Sec. • Horizontal sealing time is changed from 3 Sec to 1.5 Sec.

C. IMPROVEMENT COST

The approximate expense during the whole project is given below:-

- Installation of blower fan
- Maintenance of pump
- Metal strip
- Teflon tape
- Fabrication for conveyor
- Air conveying pipe

Installation of blower fan:-
Specification - 12v, 70 * 70 * 25 mm
Blower for pushing the plastic:Cost = 240 rupees
Submersible pump: - Power = 20w, 190 v
Cost = 350 rupees
Air conveying pipe - From scrap of the company
Metal strips - From scrap
Teflon Tape - From scrap Fabrication for conveyor working:-
Done by company's welder
 So total approximate cost = **590 rupees** Now the machine is working completely.
Our main aim was to solve the cutting and sealing issues which done with modifying the data. The speed of packing is increased by 50% and cost benefits are increased by 18% &also the worker's good health & safety is assured.

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[11] Pseudomonas Species