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Design and Development of Vertical and Horizontal Sealing Die of Multi Track Machine

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Abstract: ***This paper deals with the peculiar features of vertical form fill seal type packaging machine which has its major application in food and beverage industry. A multi-track machine is one of the diversity in this type of packaging machine where it could produce number of pouches at a stroke depending upon the number of tracks available. A four sided seal on a pouch is obtained by two dies mainly horizontal seal and vertical seal. The purpose of design and development of vertical and horizontal sealing dies into single piece is to increase pouches per minute of Multi-Track packaging machine. A combination assembly is developed by combining the two single assemblies which leads to reduction of cost of assembly. The ultimate usage of the technique, by value engineering, has resulted in increase in production rate along with cost optimization.***
Keywords: Sealing die, Multi track machine, Vertical form seal machine, Four side seal, Cost optimization, etc.

I. INTRODUCTION

A vertical form fill sealing machine, invented by Walter Zwoyer patented his idea for in 1936 when he was working with the company named Henry Heide Candy. The machine construction consists of pouches coming out of roll of film and also a simultaneous action of filling the pouch and sealing the filled pouch.[1]

The vertical form sealing machine also abbreviated as VFFS machines play a vital role in packaging industry which are engaged in forming packing of material, filling in it and sealing of packages. Due to its nature of increased speed of filling which is one of the major concerns in food and beverage industry as they need to cope up with the high demand rate along with increasing operational cost. These machines are used in almost all industries due to its ease in installation and compatibly.[2] These automated heavy machinery can also be customized according to the production line and on the basis of need of product. The choice of installing it directly in production line or in different section makes the machine flexible in nature. The process involved in this machinery consists of form packaging, filling the package with product intended and then seal it for the shipment to different outlet. The sealing machine occupies less floor area in plant than its horizontal counter parts. VFFS machines are can handle both solid and liquid products such as grains, chips, water and other types of food. The increased demand of the machine in this industry is due its feature of packing product in dust, moisture and contamination free environment.[3]

The variant in this type is Multi track machine. The machine construct of multi lines which improved the productivity of the machine along with reduction in time and cost required to produce a sealed packet.[4] The four sided seal packet can be produced in this machine by the two sealing dies mainly horizontal sealing die and vertical sealing die.

For this sealing operations required dedicated assemblies to carry out their individual operation due to this production time increases. The machine becomes bulky with these two assemblies. Cost required for extra sealing assembly is considerably high and also productivity of the machine reduces due to addition of extra work station (sealing jaw assembly). The initial and working cost of the machine increases. A basic anatomy of the four side seal is as shown in the fig. 1.

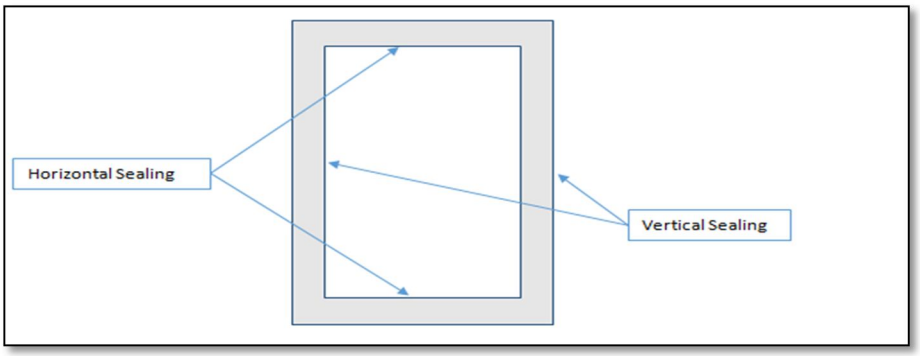

Fig. 1: Four side seal pouch

II. METHODOLOGY

As discussed above a multi track VFFS machine was to be redesigned to get the required improvement than the existing model available. After studying the technical specifications of the machine like its electronic components, fabrication parts, assembly, feeding parts, supporting parts, material used for manufacturing and the type of production line, it was found to have three solutions for better performance. The three solutions had the advantages as follows:

1) Using single mechanism for the motion of both the dies
a) This helps to eliminate the usage of two different assemblies for the dies
b) This also reduced the running cost of the machine
2) The unnecessary gap between the two dies is reduced
a) This reduced the size of the system thereby reducing the floor space area
3) Modification in the dies and combining them as single die unit
a) This makes the system more compact
b) It reduces the running cost of the machine
c) It reduces the two different assemblies to single assembly
d) It also reduces the initial manufacturing cost of machine

Due to the above mentioned advantages the third solution was found to be more feasible out of all. The development in design using the third modification required less capital to work and also is comparatively simpler than the rest of the modifications. The study of technical specifications further provided the scope to improve some critical sections like changing the whole fabricated holding structure of the system, provision of equalize heating for the increased surface area of the die which is to be installed.

The original die was improvised by the adding the horizontal sealing die at the lower end of the existing vertical sealing die. The further study on the type of product, thickness required and the number of tracks available gave a detail outlook for drafting 2D model and then the 3D model.

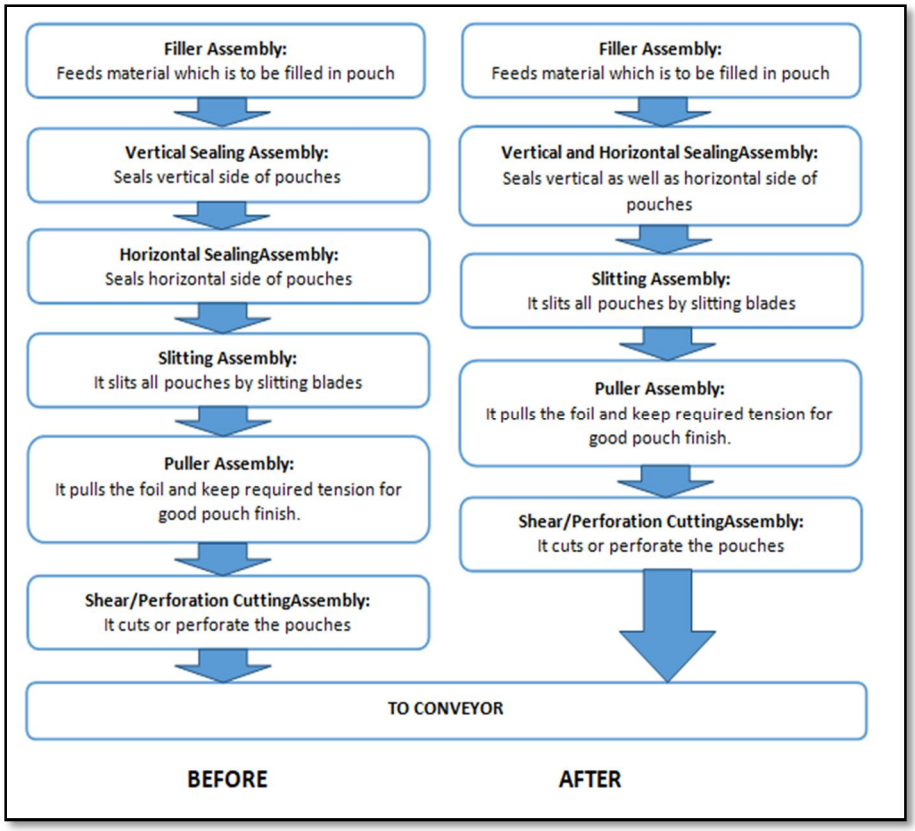

Fig. 2: Comparative study of singular and combined seal dies assembly

The figure shows flow due to elimination of horizontal sealing assembly and combines this assembly into vertical sealing assembly and the detailed methodology to be followed.

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III. DEVELOPMENT USING 3D MODELING

A. Independent Vertical And Horizontal Seal

The Figure shows vertical sealing die which will perform vertical sealing and horizontal sealing die which will perform horizontal sealing. The foil drops down from the tension mechanism into the multi tracked seal the multi track divide the foil into number of open end pouches. The two side open end pouches travel to the horizontal seal die where the pouches are closed and split vertically from the remaining foil.

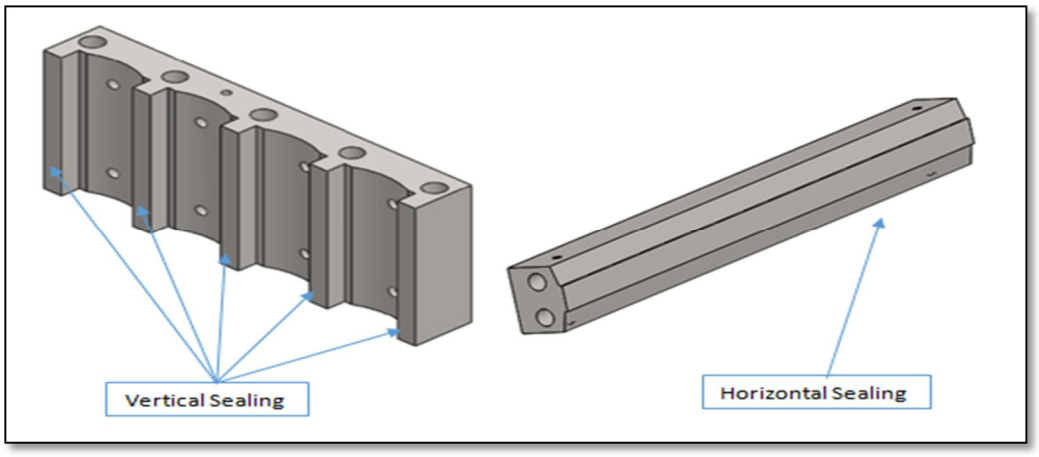

Fig.3: Independent dies (vertical and horizontal)

Due to this the travel of the foil increases and also takes more time to seal the pouches. The foil is heated up to 150^0C to obtain proper sealing. The dies are mounted on plates whose travel motion is controlled by pneumatic cylinders. The sealing obtained is air tight and is also free from contamination.

B. Combination Of Vertical And Horizontal Sealing

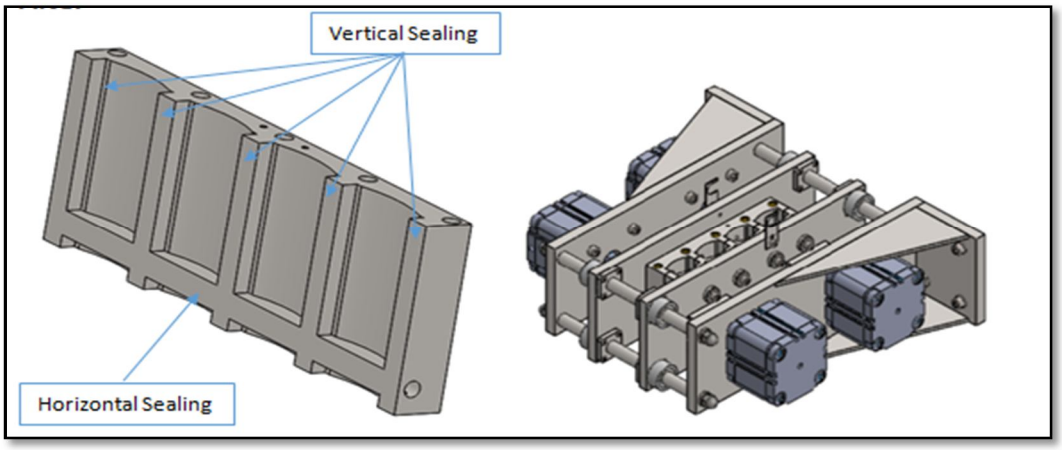

Fig. 4: Sealing die and assembly

The left side of the figure shows combination of vertical and horizontal sealing operations in single sealing die called Vertical and Horizontal Sealing Die. The right side of the figure also shows Vertical and Horizontal Sealing assembly, it shows that the similar assembly is eliminated which will directly reduce the machine manufacturing cost.

Due to addition of horizontal strip, it may lead to uneven heating of die surface which leads to faulty packaging. An extra brass cartridge heating element is added to the strip with an input of 500kW power to equalize heating. The material was so chosen so as to have good conductance of heat throughout. The component like shaft was made up of hard chrome steel and the die to be used had following specifications as shown in table.1.

Table1: Material Specification

Sealing Die Specification:	
Material of Construction:	EN-8T-Condition
Finish:	Blackodizing (Anti-rust coating)
Sealing Pattern:	Straight, Square, Knurling

IV. RESULT

It can be seen through the cost detail study that a huge cost saving can be done due to development of combined sealing die assembly. The cost is subjected to vary according to the type of product but an approximate cost saving can be seen through the below mentioned table. The table describes the cost cutting obtained due to elimination of the usage of independent dies.

TABLE 2: Cost Analysis

Sr. no.	Components	Quantity	Unit Cost (Rs.)	Amount (Rs.)
1	Pneumatic cylinder	4	3000	12000
2	Mounting plate	2	4000	8000
3	Bracket for mounting plate	2	8000	16000
4	Hard chrome shaft	4	1500	6000
5	Sealing jaws	2	5000	10000
6	Rod heater	4	300	1200
Total Cost Saving				52000

V. CONCLUSION

The vertical and horizontal sealing is done at single station which eliminated second horizontal sealing jaw assembly so due to this foil travel distance is reduced and pouches per minute increase. Productivity increases with reducing the machine initial cost. The efficiency of machine is also increased by eliminating a stroke per package. The efficiency of the machine is increased without the expense of complexity in design. The paper gives the scope of further development of the machine by using value engineering.

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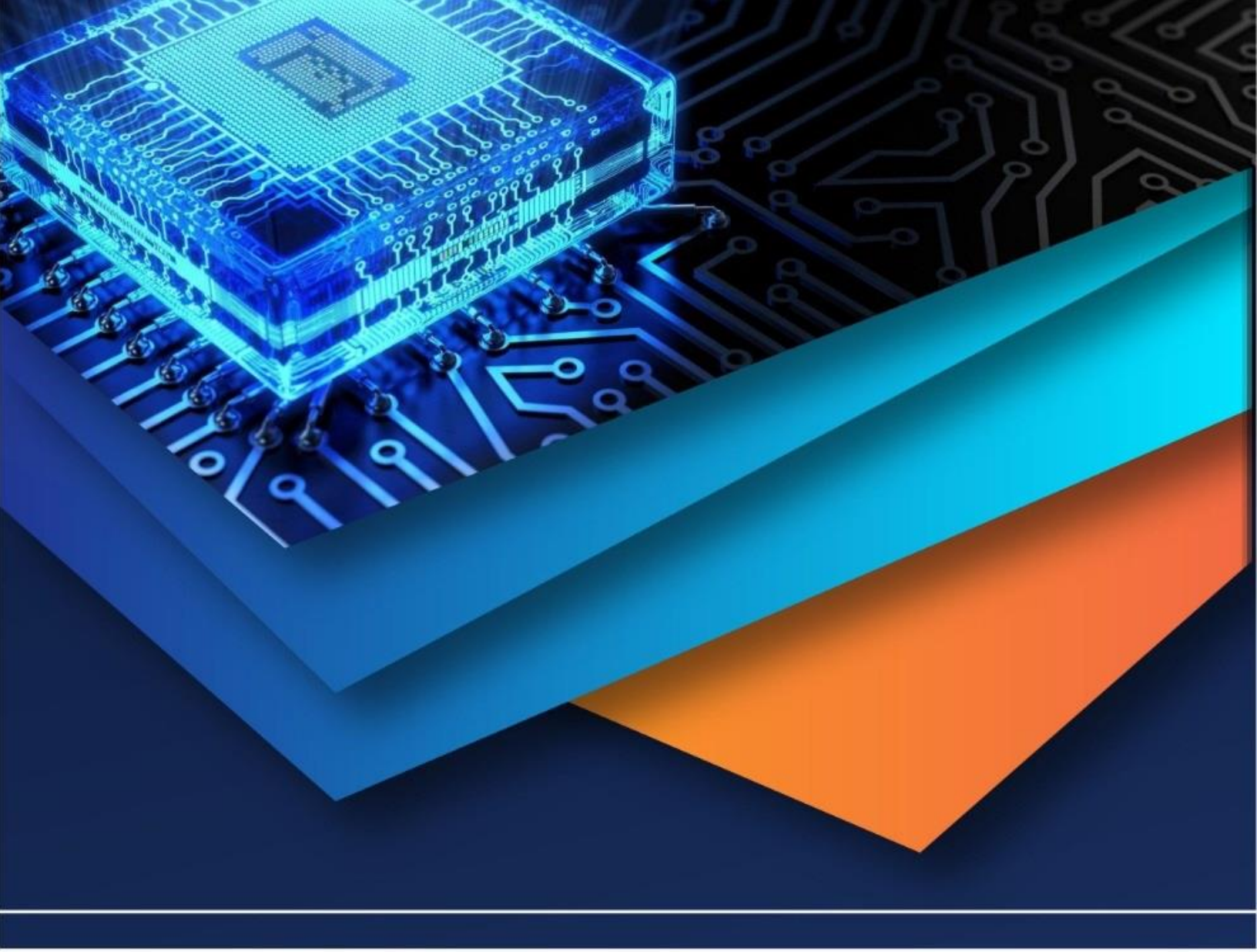

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