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# Vacuum based Silicon Filling Machine

Yogesh Fatangade<sup>1</sup>, Rohan Kulkarni<sup>2</sup>, Ashwini Rao<sup>3</sup>, Anuj Raut<sup>4</sup>

<sup>1</sup>Professor, <sup>2,3,4</sup>Student, Department of Mechanical engineering, RMD Sinhgad School of Engineering, Pune, India

**Abstract:** Now-a-days there are so many machines are available in market which can fill the viscous paste of any material in to various size components but these machine have major disadvantage that after the filling of paste into the component there is presence of air and which is totally undesirable. So as to avoid this we have developed a machine which is able to fill the viscous paste without allowing air to be in the component by using vacuumization before and after the filling of paste. It will increase the overall performance of the filled component. Also this machine can fill five small components at a time which will increase the rate of production and lead to profit to the organization.

**Keywords:** Silicon, Semi-automatic machine, Mass production, Vacuumization.

## I. INTRODUCTION

The process of filling of silicon viscous paste into the tubes or any other components is carried out conventionally by the machines without using vacuumization during the filling process; but in our research we found out that due to absence of vacuumization process there are so many flaws such as ineffectiveness of silicon paste as it becomes solid after few days in the tube or component, loss of its heat carrying capacity due to porosity. When silicon filled component is being used to obtain highly precise and accurate results then in that case presence of air content is highly inconvenient. It will affect the performance of the component to extreme, hence it becomes necessary to use the vacuumization during filling of silicon viscous paste.

Table 1 Specifications

1	Fluid	Silicon
2	Density of fluid	3 gm/ml
3	Quantity	0.45-0.49 gm
4	Viscosity	42-43 pa
5	No. of components to be tested at a time	05
6	No. of stations	06

## II. METHODOLOGY

In this project we started with understanding the existing silicon filling machine through a series of line observation in various companies, on internet, informal interviews with workers in production and assembly line and data collection at study area. The next stage was to analyze the existing performance by analyzing the data collected. Then plan for improvement was executed based on the calculation of demand, number of components required to be filled in one complete cycle. The vacuum based silicon filling machine was designed by using Alibre software. Place the cassette at station one manually Then press start push button. Presence of O-ring into the brass body will be sensed by the proximity sensor. Component will be locked and cassette will be rotated in 60 degrees to transfer the component to station 2. Lid of 1st vacuum chamber will be closed. Vacuum chamber will be evacuated to preset level by vacuum pump and simultaneously filling needle will come down. Once required vacuum is reached, then gun will automatically insert into the filling port. Preset amount of fluid will be filled into the component under vacuum condition and filling needle will move in upward direction. Once preset amount is filled, pinching arrangement is provided to stop the dripping Gun will move to its original position and lid will be moved up. Cassette will be rotate in 60 degrees to transfer the cassette to station 3. Level of heat sink compound into the brass body will be sensed at station 3. If heat sink compound is not filled to the proper level then component will be rejected and rejected component will be lifted and transfer to the rejection chute by using pick & place mechanism Cassette will be rotated in 60 degrees and moves to station 4 Then manually coupler will be inserted inside the brass body. Cassette will be rotated in 60 degrees and moves to station 5 Coupler presence will be sensed using proximity

sensor. Again lid of the 2nd vacuum chamber at station 5 will be closed. Once the lid is closed, gripper will come down through servo motor and will grip the coupler and lift it up by 1mm. Vacuum chamber will be evacuated at preset level by vacuum pump. Once the preset level of vacuum is generated, coupler will be inserted again fully into the brass body. Coupler will get ungripped and both the lid and grip will be moved in upward direction simultaneously. Cassette will rotate to 60 degrees and will come to station 6 which is idle station. Again cassette will rotate and come to home position i.e. station 1 and cassette will be unloaded manually.

### III. GRAPHICAL STUDY

The machine is used to fill the silicon into the brass cartridges and these brass cartridges are further used as temperature sensors in the vehicles. During the filling process air can enter into the brass component and due to this the accuracy of the temperature sensor is reduces. To avoid the air from entering into the filling chamber it is necessary to design perfect vacuumed chamber. Hence we have designed and conducted some trials to check if the vaccumizing is achieved properly or not and at the same time what time is it taking to complete the whole process.

#### A. Time effectiveness trial

The fully automatic machines are mostly used for filling of paste of silicon into the tubes, time taken by the machine for the complete process including various stations of work is shown below with the help of chart.

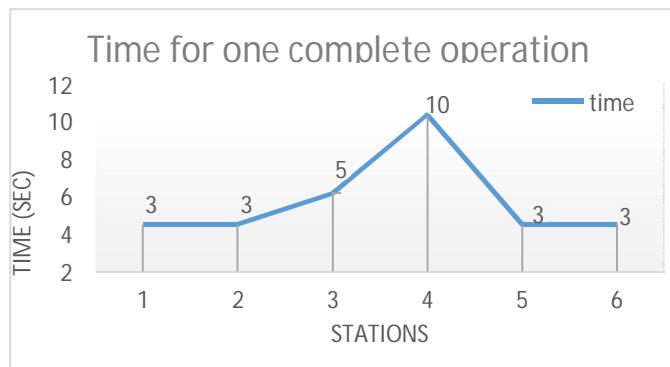


Fig. 1. Time required for conventional machine to fill one component

From the graph it is clear that the machine will take 27 seconds to fill one component with the silicon; which is much more than that of time taken by our machine. We have to achieve 750 mili bar of vacuum in the filling chamber for the perfect filling of component in the least possible time; hence it is very important for us to remove all the leakages of air from the chamber. So to obtain the readings of used Digital pressure switch using which we can get the exact readings of the obtained vacuum in the chamber, and if the required vacuum is not obtained up to our requirement then we have to check for the possibilities of leakage of air and avoid it by some means.

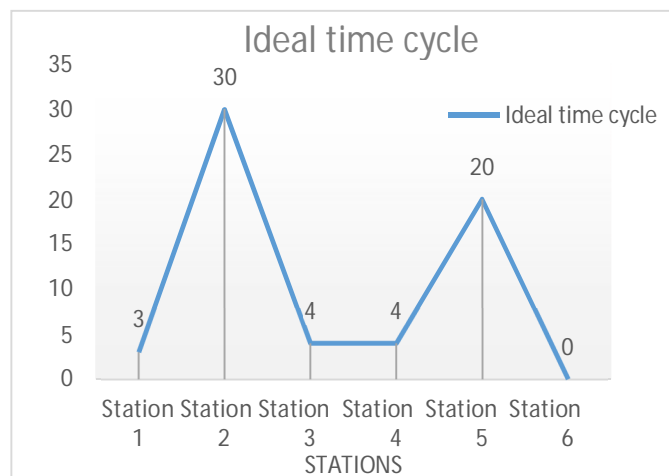


Fig. 2. Trial required for VBSFM to fill five components

Fig.2 will show us that, time required for station two and station five is more as compared to other working stations because the process of filling of silicon viscous paste is done in the second station. Filling process is carried out in a vacuumed place and due to the time required to obtain perfect vacuum in the chamber overall time of the station increases. By the comparative study with the conventional filling machines it is very clear that our machine can fill five brass cartridge at a time in 61 seconds and conventional machine will take almost 135 seconds to fill same amount of components. Using the Vacuum based silicon filling machine will reduce more than 70 seconds for the one complete cycle. Hence the time taken for creating vacuumed place is totally justified.

**B. Weight Measurement**

Amount of silicon paste is being filled into the brass component plays very important role in the overall performance of its temperature sensing ability and for filling exact amount of silicon the stroke of the dispensing gun is controlled with servomotor. Weight of the component is carried out before and after the filling process and after this it is found out that few of the components are exceeding and below the range. The required range is between 0.300-0.500 gm differences in weight.

The dispensing gun is controlled by using servomotor even though there are few components which have weight of silicon content is higher than required that we can see in the below graph, this because of drooling and dripping phenomena.

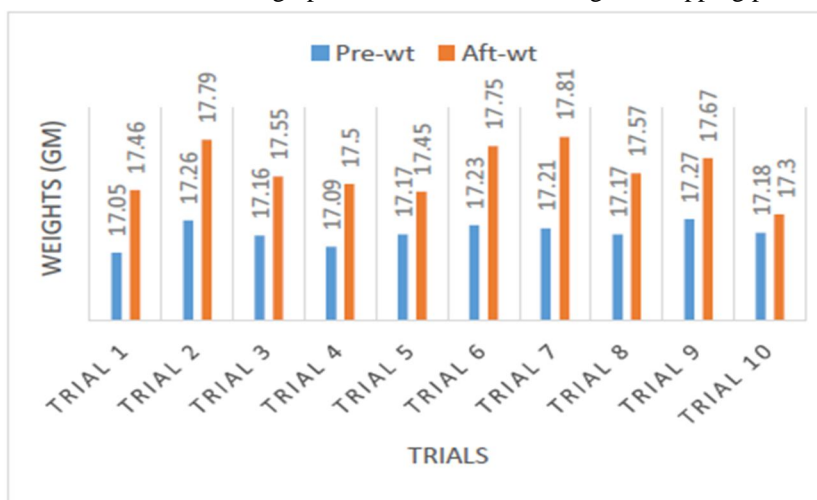


Fig. 3. Weight measurements initially

Due to drooling, some amount of extra silicon is being filled into the component and hence weight of silicon is increased into component, which is undesirable for the accurate and precise temperature sensing. Hence due to improper vacuuming there were some air gaps. This caused drooling and porosity in the silicon dispensing gun. The air was trapped between the silicon and the piston arrangement in the silicon dispensing gun. So when the piston pushed the silicon the trapped air try to escape (caused due to porosity). As a result the amount of silicon dispensed was less. To overcome these problems, we drilled the piston throughout its length which resulted in leading the air directly to the atmosphere. Due to improper vacuuming air is escaping into the filling chamber so as to avoid this we have replaced the push in fitting with the push on fitting.

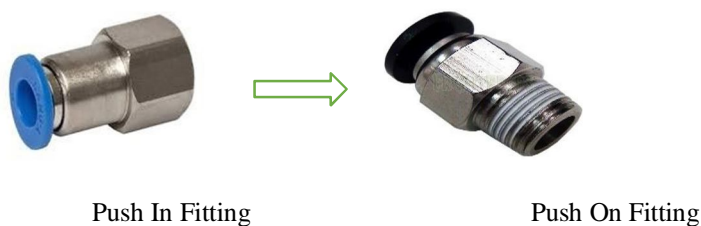


Fig. 4. Types of fitting used before and after

There are chances that the air can enter from bottom of the chamber as it have a longitudinal motion before and after filling so to avoid the air from entering into chamber we have used rubber platform to obtain perfect vacuumed place in the filling chamber. After these changes the readings we got were in line with the proposed weight of the component.



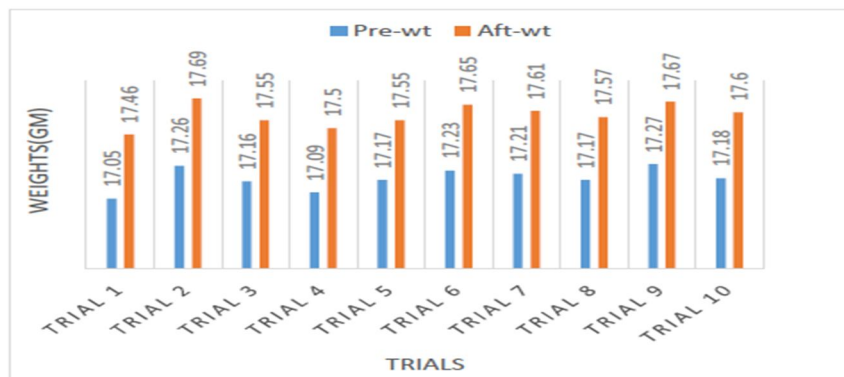


Fig.5. Weight measurements after corrective actions

#### IV. RESULTS AND DISCUSSION

From the above study we can say that using vacuum based silicon filling machine is very convenient for the mass production as this machine could save more than 70 seconds per cycle and even a smallest reduction in time can give big amount of profit. Vacuumization process is introduced during filling of paste which is very difficult to achieve but due to this very accurate and precise readings can be expected from the end component. Below we can see some of pictures of actual machine.

#### V. CONCLUSION

This paper is based on how the vacuum based silicon filling machine is used to fill the viscous paste of silicon into any small component with vacuumization before and after the filling process. At the same time the machine can fill five components, hence it gives very high production rate. The time required to fill is very low and machine can fill exact amount of viscous paste into component so it will lead to reduction in requirement of excess material to be filled and due to this precise filling operation cost is reduced to great extent. As the required amount of paste is being filled in it will simultaneously reduce the rework and the rate of production is increased very high. This machine is best suitable for mass production plant.

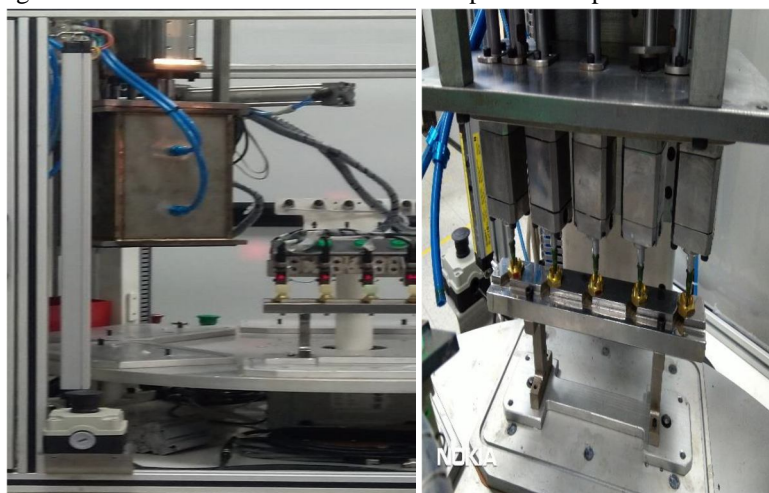


Fig. 6. (a) Vacuum chamber

(b) five dispensing guns

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