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Graphical Analysis of a Vibratory Bowl Feeder for Clip shaped Components

Ujjwal Jindal[1], Shrey Jain[2], Piyush[3], Pradeep Khanna[4]

[1]Netaji Subhas Institute of Technology, Dwarka, Delhi-110078, India
[2]Netaji Subhas Institute of Technology, Dwarka, Delhi-110078, India
[3]Netaji Subhas Institute of Technology, Dwarka, Delhi-110078, India
[4]Netaji Subhas Institute of Technology, Dwarka, Delhi-110078, India

Abstract

Automation is the most important aspect of the industrial process in today's fast moving world. Automation facilitates production to meet the high demands of the consumers [1]. It not only reduces human efforts and time required in the production process but also improves the quality of the product with maximum efficiency. Mechanical feeders are used to feed components in a particular orientation one-by-one at desired frequency from a randomly distributed lot. The objective of this paper is to design, fabricate and analyze the performance of a modified path for a vibratory bowl feeder for feeding flat components like paper clips. The existing path of the feeder was modified to restrict multiple feeding of clips and take care of their orientation. The feed rate was studied experimentally by varying the input parameters such as part population, frequency of vibration and length of clips. Results obtained from the experiments were studied and conclusions were drawn about the effects of various parameters on the feed rate.

Keywords – automation, mechanical feeders, vibratory bowl feeder, flat components

I. Introduction

The way assembly lines operate in industries across the globe, has seen a major upheaval as a result of unprecedented industrial growth and technological advancements [2][3]. Small part feeding in automated assembly lines at desired rate and in desired orientation has now become the need of the hour. This has led to the development of specialized small part feeding systems which can be integrated with the assembly line to not only reduce the cycle time of the components being made but also bring down the labour costs as well. Compared to the wide utility of feeders in the current industrial setup, only a small amount of quality research has actually been put in the area [4].

Working Principle

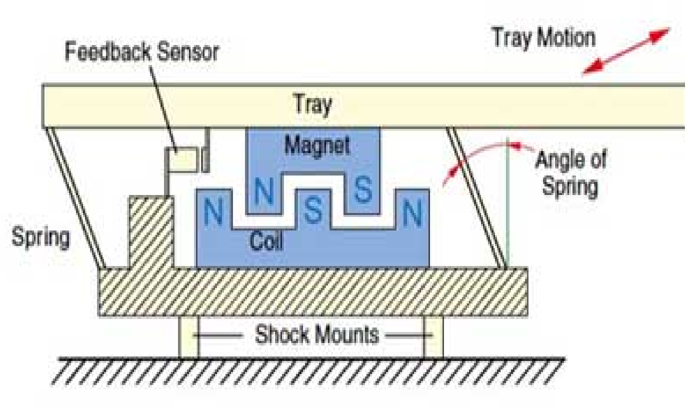
Vibratory Bowl Feeders are used for feeding of components to various Machines. The actuation / Vibrations take place by electromagnets. The Vibratory Bowl Feeder is a device that converts Electro-magnetically produced vibrations into mechanical vibrations. These mechanical vibrations are utilised for movement of the work piece along the track of the Bowl Feeder. Magnetic coil, which is fixed to the counter mass, is energised with supply of electric current, producing a force, which in turn attracts and releases the magnet armature. As the magnet is rigidly fixed to the top spring holder and bowl feeder, the vibrations are transferred to the spiral-conveying track of the bowl. **Depending on the angle of gradient of the leaf springs and lead angle of the helix of conveying track, the work pieces move with every vibration above the track in small jumps.**

Construction

A vibratory bowl feeder consists of a bowl mounted on a base by three or four inclined leaf springs or packs of springs. The springs constrain the bowl so that it travels vertically. As the components move up an inclined track along the edge of the bowl, the tooling in the bowl orients the components into the required orientation or rejects the misaligned parts into the centre of the bowl where they begin their travel up the track again. One to six electromagnets, mounted on the lower counter weight / heavy base, generates the force to drive the bowl feeder. The Counter weight rests on rubber feet, which serve to isolate the vibration of the Vibratory feeder [5].

The components are conveyed in the bowl by one of two modes: sliding or hopping. In the sliding mode, motion is produced from friction between the part and the bowl. As the bowl rises and turns, the friction between the track and the part pushes the part forward with the track. When the track descends and turns backward, the force of friction is smaller and the part slides forward relative to the bowl. In the hopping mode, the part moves forward with the bowl as it rises and turns, but it experiences freefall when the bowl's downward acceleration exceeds the acceleration of gravity.

During free-fall, forward motion is created as the bowl moves backward relative to the part.



II. Procedure to find center of mass

1. Place a white paper on a wall and fix it with a nail.
2. Tie a thread on that nail and let it hang under its own weight. For more accurate reading we can also tie a small mass onto the free end of the thread so that there is no swinging of the thread.
3. Hang the clip through one of its corner on the same nail. Trace the thread through the clip.
4. Again hang the clip through other corner and repeat the above procedure.
5. The point where two lines intersect is the centre of mass of the object.

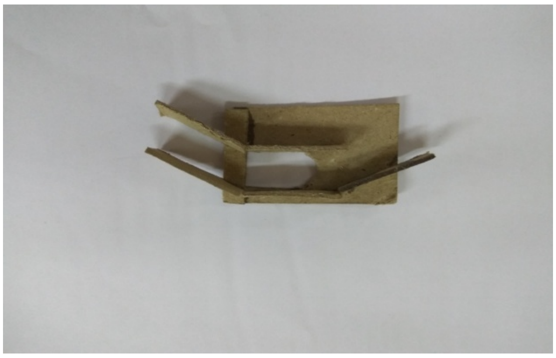
III. Experimental Setup

The existing path was modified to take care of the orientation of the clips. Centre of mass of the clips was used to sort the disoriented ones.

A cardboard setup consisting of a cut mark of the shape of the clip was designed with calculated cuts so as to sort the disoriented clips. Cardboard material was chosen so as to minimize the effect of vibrations that could fail the setup.

Guiding paths were designed upto the cut mark and further beyond it in a proper manner to avoid jamming of the clips.

Further a simple chute was constructed to allow the clips to feed one at a time. Width of the chute was slightly greater than the width of the clips.



IV. Performance analysis

The types of parts used for experimentation were paper clips. Although the performance of the feeder depends on many parameters like material of clips, size of hopper, width of the path, inclination of the path, part population, frequency of operation and length of parts, experimentation has been carried out on the following three: The variable parameters were:-

A. Part Population in the Feeder

It is defined as the number of parts in the feeder bowl at any given time. The different populations used were 25, 50, 75 and 100.

B. Frequency of Operation

The various operating frequencies (Hz) were; 55, 60, 65 and 70.

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C. Length of Parts

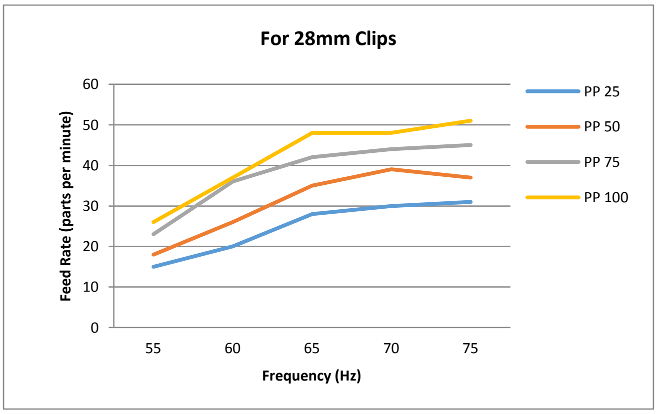
The different part lengths, in our case clip lengths, were 28 mm, 33 mm and 50 mm.

The graphical analysis has been carried out by using one factor at a time technique.

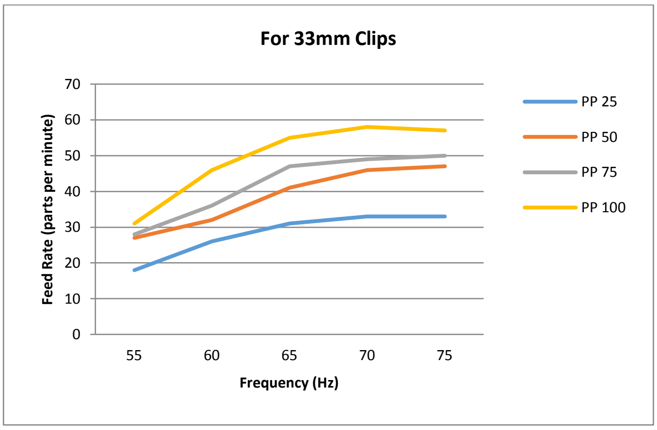
V. Experimental Setup

Parametric analysis was done by keeping any two of the parameters, namely, part population, frequency and length of parts, unchanged while varying one. The part population was kept constant with respect to the frequency and the number of parts coming out of the feeder in one minute was recorded. This was repeated for two readings and their average was taken to get the final feed rate. Subsequently, for the same number of parts the frequency was varied and the same procedure was repeated. The above steps were repeated for different clip lengths and the readings were tabulated. For a particular clip length, the feed rates vs. frequency graphs were plotted for varying part populations. Then, for a particular part population, the feed rate vs. frequency graphs were plotted for varying clip lengths.

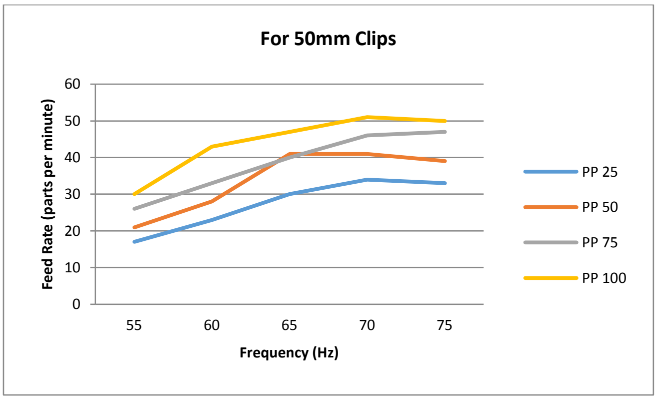
VI. Graphs



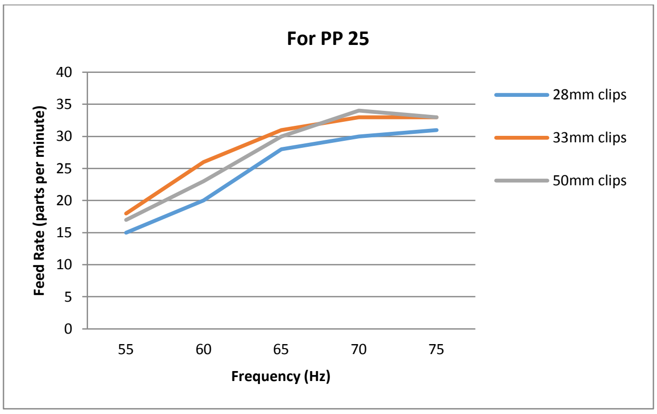
Graph 1: Variation of feed rate with frequency for 28 mm clips and different part population



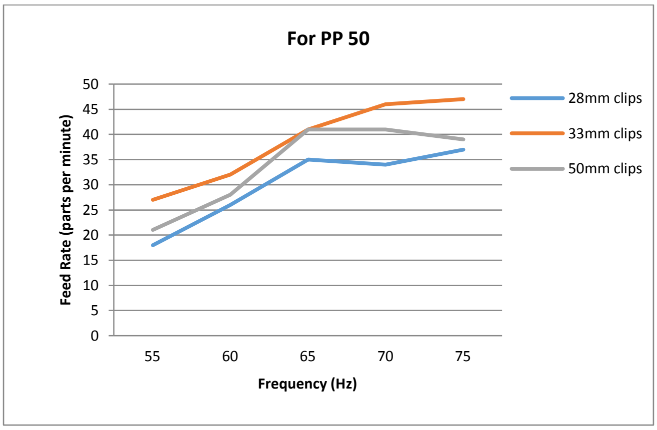
Graph 2: Variation of feed rate with frequency for 33 mm clips and different part population



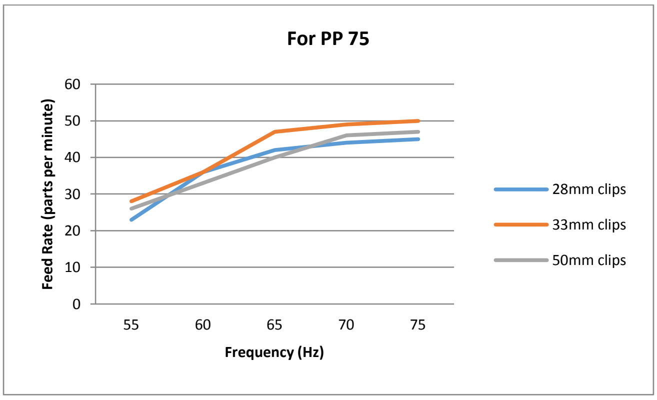
Graph 3: Variation of feed rate with frequency for 50 mm clips and different part population



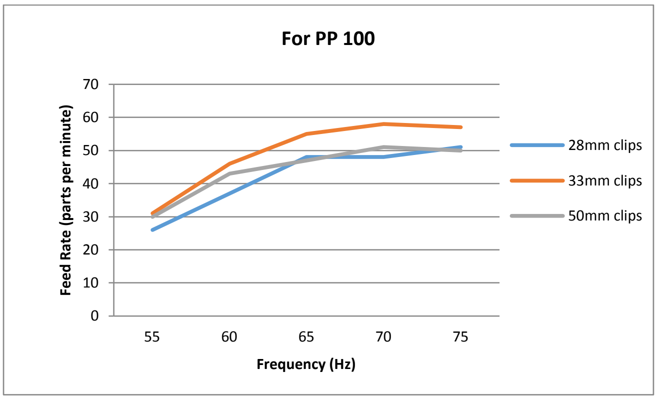
Graph 4: Variation of feed rate with frequency for part population 25 and different length of clips



Graph 5: Variation of feed rate with frequency for part population 50 and different length of clips



Graph 6: Variation of feed rate with frequency for part population 75 and different length of clips



Graph 7: Variation of feed rate with frequency for part population 100 and different length of clips

VI. Conclusion

A. Frequency

All the graphs obtained from the experiment showed that with the increase in frequency, initially there was an increase in feed rate and after certain frequency, the feed rate levelled off and in some cases, decreased. The reason to such an observation is that at lower frequencies (<55 Hz) the parts did not move due to inertia. When the frequency was increased slightly, the parts showed movement and the feed rate increased. But after a critical frequency, the increase in feed rate was minor and after 75 Hz (in some cases earlier) there was excessive turbulence due to which the clips bounced and fell off the track, thereby decreasing the feed rate.

B. Part Population

As can be seen from the graphs, the feed rate increased with the increase in part population. The reason to such an observation is increased push and interaction between the clips.

C. Length of Clips

The clips of length 33 mm showed the maximum feed rate followed by 50 mm and 28 mm clips respectively. The reason for it could be attributed to the fact that 28 mm clips had very less mass and the frequency range 55-75 Hz caused many of the clips to fall off the path frequently before reaching the modified path. 50 mm clips had more inertia than 28 mm clips and showed increased feed rate overall but their feed rate was still less than that of 33 mm clips because being longer in length (than 33 mm clips) they were not able to follow the curvature of the path as accurately as 33 mm clips and hence, fell off the track more frequently than 33 mm clips. Therefore 33 mm sized clip is found to be the optimum size for maximum feed rate.

VII. Summary

Path of the existing vibratory feeder was altered to feed paper clips of different sizes. A study was conducted through experimental analysis to optimize the 3 parameters namely frequency of operation, part population and length of clips to acquire the maximum feed rate. According to our observations, ***the maximum feed rate is obtained for a part population of 100, length of clips 33 mm and frequency of 70 Hz.***

VIII. Acknowledgement

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IX. References

1. Sheetal Bhagat, Tanushi Pandey, Vishesh Garg, Pradeep Khanna, Design, Fabrication and Analysis of Vibratory Feeder, IJRMET Vol. 4, Issue 1, Nov 2013 - April 2014
2. Mikell P. Groover, “Automation, ProductionSystems, and Computer-integrated Manufacturing”Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Boothroyd Geoffery, “Assembly Automation and Product Design” Taylor and Francis Group.
4. Roberts A.W. “Design and application of feeders for the controlled loading of bulk solids onto conveyer belts”
5. [Online] Available: http://blog.elscintautomation.com/post/WHAT-IS-A-VIBRATORY-BOWL-FEEDER-ITS-USES-AND-WORKING.aspx