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Development and Graphical Analysis of a Center Board Reciprocating Part Feeding System

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Abstract : Advanced industrial production systems require a high degree of automation for feeding and handling of small individual components. Small part feeding in automated assembly lines at desired rate and in desired orientation has now become the need of the hour [3]. This has led to the development of committed mechanized feeding systems which can be integrated with the assembly line to not only reduce the cycle time of the operation but also bring down the labor cost [2]. The current industrial setup consists of a wide variety of part feeding systems, but only a limited quality research has been conducted [2]. The present study deals with the design, fabrication and performance analysis of a reciprocating part feeding system for handling small cylindrical components during assembly operations. The system consists of a reciprocating mechanism which direct the components towards the chute in required orientation at a high feed rate. This work would prove to be of considerable importance for feeding similar industrial components on assembly lines where the feed rate has to be synchronized with the required rate of the process [4].

Keywords: Automation, Assembly line, Cycle time, Reciprocating Feeder, Chute.

1. INTRODUCTION

In the modern industrial scenario with increased consumer demand, the need for high production rate has risen. This has led to the development of automated assembly lines where the main aim is to keep the machine running to achieve a high rate of production. Feeder form a critical part of automated assembly lines [1] as it not only reduce human errors but also keep up with the production rate by feeding parts at desired pace and in desired orientation. The project aims in conducting a graphical analysis on performance of feeders. Tests are designed by carefully choosing different input parameters in an attempt to explore the relationship between the system inputs and unrestricted feed rate of the system.

1.1 Principal of Operation

A center board reciprocating type feeder is employed to feed cylindrical components (L>D) oriented along their length. The components stored randomly in the hopper are sent to the machine in a discrete manner. The system consists of a reciprocating inclined center board which is fed by two inclined surfaces. The center board executes a dwell at its topmost position, ensuring the transfer of components to the chute.

2. DESIGN AND FABRICATION

2.1 System Design

Design of system includes determining the geometrical parameters of the system by taking component type, desired feed rate, stroke length, etc. into consideration. Firstly, optimum inclination of the feeding platforms is determined under given constraints. These constraints include desired feed rate, dynamics of the components being fed, size of components, etc. The height of the center board is then defined and stroke length for slider crank mechanism is calculated. A schematic representation of the proposed design is as shown in Fig. 1.

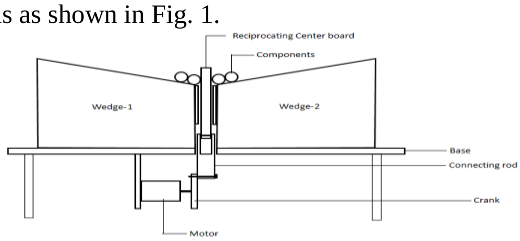


Figure 1: Schematic diagram of the system

Figure 2: Physical realization of the system

2.2 Experimental Setup

Considering the cost and overall inertia of the system, wood was selected as the material for general fabrication of system parts. The setup consists of two wedges, which are mounted on a rigid wooden base, upon which components are fed in random orientation. The physical realization of the system is as shown in Fig. 2. The components are fed gravimetrically to the center board which while being driven by a slider crank mechanism, reciprocates and directs them to the chute through a sliding path with appropriate diameter. Table-1 shows a detailed description of various parts of the feeder

Table 1: Description and specifications of parts
(*All dimensions are in mm unless specified)

S.No.	Part	Function	Specifications
1.	Wedge (2 nos.)	To direct the randomly oriented part towards the center board for feeding	Max Height: 270 Min Height: 120 Inclination: 25° Width: 250
2.	Center Board	To feed the components to the chute in the required orientation i.e. along the length of the cylinder	Path diameter: 14 Inclination: 10°
3.	Motor	To provide rotational motion to the crank	O/P Voltage: 12 V DC I/P Voltage: 220V AC
4.	Slider-Crank Mechanism	To convert rotational motion of the crank to reciprocation of center board	Stroke length: 100 Crank diameter: 120
5.	Components	Represent any cylindrical components for which L>D	Cylindrical Length: 25.4 Diameter: 6/8/10/12 Material: Plastic

2.3 Experimental Work

To propose a graphical analysis on performance of feeder, a series of experiments were conducted by varying the values of selected input parameters and recording the corresponding feed rate. Taking one minute as the reference time, feed rate was determined by carefully observing the number of components exiting the chute while maintaining the desired part population.

2.3.1 Selection of Paarameters

Different feed rates can be obtained by varying system parameters like Number of strokes per minute, part population, part size, inclination of center board or wedges, etc. However, the present study was carried out by taking the following three input parameters:

i. Diameter of the cylindrical component
ii. Number of strokes per minute
iii. Part population

The range for the above mentioned parameters were as mentioned in Table-2.

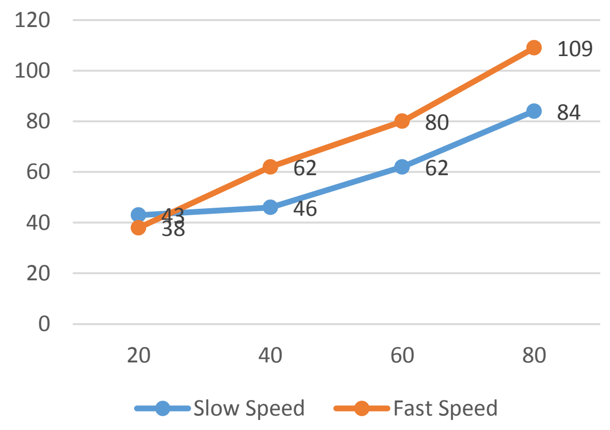
Table 2: Range of Input Parameters

S. No	Input Parameters	Min. Value	Max. Value	Class Interval
1.	Diameter (mm)	6	12	2
2.	No of Strokes/min.	50	70	20
3.	Part Population (nos.)	20	80	20

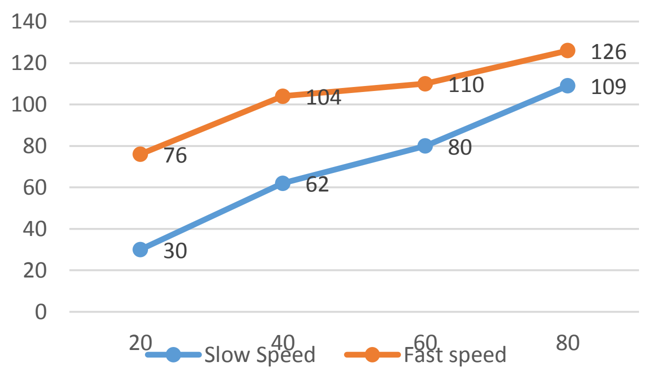
3. OBSERVATIONS

3.1 Variation in feed rate with part population

The following plots show the variation of unrestricted feed rate with part population at a given part size and no of strokes per minute.



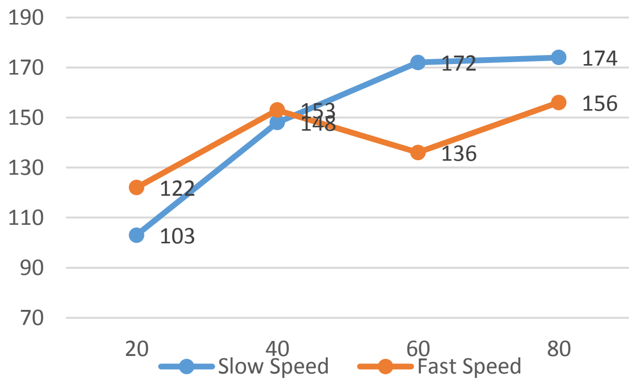
(a)



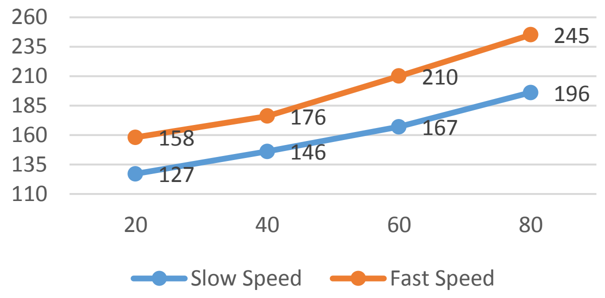
(b)

Figure 3: Variation in feed rate with part population for a) 6 mm and b) 8 mm diameter

- For 6 mm components, feed rate increases almost linearly with part population. Higher feed rates are observed at higher number of strokes per minute.
- For 8 mm components, feed rate increases with an increase in part population. However, in this case, higher feed rates are observed at lower number of strokes per minute.



(a)



(b)

Figure 4: Variation in feed rate for a) 10 mm and b) 12 mm diameter

- For 10 mm components, at lower number of strokes per minute, feed rate increases with part population upto a certain limit and becomes constant afterwards. A similar trend is observed at higher number of strokes. However, there is a discrepancy when the part population is 60 nos. where the feed rate is lower than expected.
- For 12 mm components, feed rate increases linearly with part population. Higher feed rates are observed at higher number of strokes per minute.

3.2 Variation in feed rate with part size

The following plots show the variation of unrestricted feed rate with part size at a given part population and no. of strokes per minute.

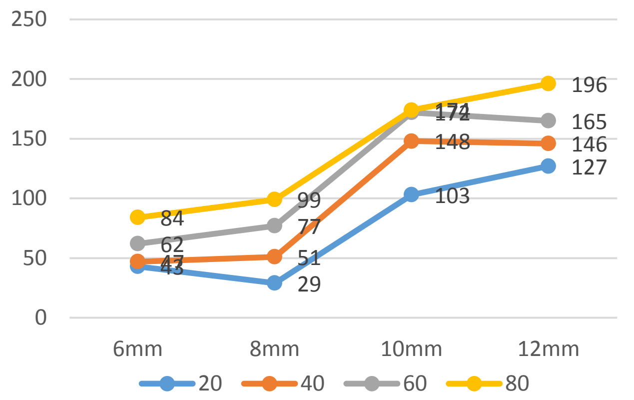


Figure 5: Variation in feed rate with part size at fast speed

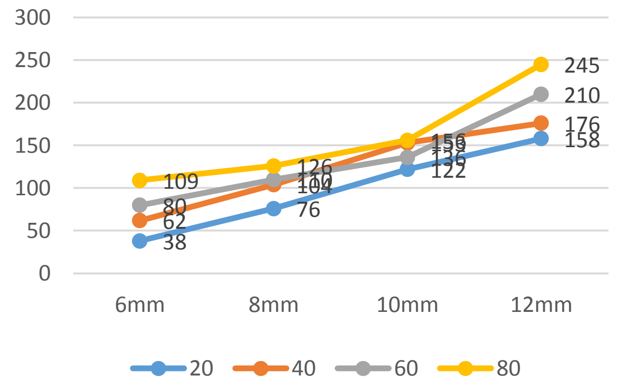


Figure 6: Variation in feed rate with part size at slow speed

- At faster speed, feed rate is almost constant initially. However, a steep increase is observed from 8 mm to 10 mm transition, after which the slope of the plot decreases. The feed rate is found to be higher for increased part population.
- At slower speeds, feed rate increases with increase in part size. However, the increase is not as steep as that observed at higher speed. The feed rate for higher part size is again higher as expected.

4. EXPERIMENTAL ANALYSIS

A. Effect of part population

The part population, at a given part size and reciprocation speed has a significant effect on feed rate. The feed rate increases with the increase in part population as the probability of components entering the centre board in every stroke increases. This tends to increase the feed rate of the system. However, the accumulation of components results in increased friction between surfaces which tends to reduce the feed rate. The combined effect leads to the increase in the feed rate with increasing part population. An inconsistency can be observed in the case of components with 10 mm diameter at a part population of 60, where the feed rate is found out to be lower than the expected value. In this scenario, the effect of friction overshadows the increase in components entering the centre board, thus, resulting to the fall in feed rate.

B. Effect of part size The part size at a given part population and no of strokes has a major effect on feed rate. The feed rate increases with an increase in part size i.e. diameter of the cylinder. However, differential slopes of the plot can be observed between different part sizes. This is due to the combined effect of following factors:

- With an increase in part size, weight of the component increases which results in an increase in driving force. This tends to increase the feed rate. However, as the weight increases, the normal reaction force also increases and hence the frictional force.
- The number of parts entering the center board per stroke increases with a decrease in part size. On one hand, it tends to increase the feed rate while on the other, the cohesive and adhesive forces also increase which tend to reduce it.

The combined effect of the aforementioned factors is that the feed rate undergoes a steep in rise for intermediate part sizes.

C. Effect of number of strokes per minute

As the number of strokes per minute increases, the feed rate tends to increase. However, with an increased reciprocating speed, the probability of the components to enter the centre board as well as the chute decreases, which opposes the former effect. In general, the feed rate for faster speeds are observed to be high, though in some cases, higher feed rates are observed at lower speed.

5. CONCLUSION

The proposed centre board reciprocating feeding system has been designed and fabricated. The system developed can successfully feed cylindrical components in desired orientation. An analysis on the effects of various operating parameters on its feed rate, to be used in industries to synchronize the feeder for various processes, is also presented. According to the present study, the best results are obtained for 12 mm diameter components at fast speed of reciprocation and part population of 80.

REFERENCES

[1] Hesse S., "Rationalisation of small workpiece feeding", Festo AG & Co., 2000

[2] Roberts A.W. "Design and application of feeders for the controlled loading of bulk solids onto conveyer belts"

[3] Pandey P., Varshneya K., Khanna P., ”Elevated Step Feeder-Design, Fabrication and Study of Effects of Operating Parameters on its Performance” International Journal of Engineering Technology, Management and Applied Sciences, January 2016, Volume 4, Issue 1, ISSN 2349-4476

[4] Raj S., Gupta S,, Khanna P., “ Development of a Magnetic Belt Type Feeder and Mathematical Analysis of Feed Rate of Tubular Components” International Journal of Computer & Mathematical Sciences IJCMS ISSN 2347 – 8527 Volume 5, Issue 1 January 2016

[5] Rajput A., Jain I., Gahlot N., Khanna P., “Design, Fabrication and Graphical Analysis of a Scoop Wheel Feeder” IJRMET Vol. 4, Issue 1, Nov 2013 - April 2014, ISSN : 2249-5762 (Online) | ISSN : 2249-5770 (Print)