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Development of a Reciprocatory Tube-funnel Feeder and Graphical Analysis of its Performance

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Abstract

Rapid industrialisation and technological advancements in assembly processes and the demand for feeding the components in assembly lines has grown significantly [1]. It, therefore, becomes essential to optimize the assembly process. Automated or mechanized assembly can be achieved by the use of feeders. This paper describes the design and development of a mechanical reciprocatory tube funnel feeder which is suitable for use in any manufacturing system requiring discrete feeding of cylindrical parts. The developed system facilitates feeding of randomly placed heap of parts in a desired orientation and at the desired feed rate.

Keywords: *Reciprocatory tube, Feeder*

I. INTRODUCTION

With modern day industries moving towards automation to increase their rate of production, automated feeding of parts become an important accessory for them [2]. In automated assembly systems, part feeders play a very important role as they are responsible for supplying the machine continuously segregated parts at a specific flow rate and orientation. In such automated feeder systems part feed rate is as important as the orientation because at the point of assembly the critical requirement is that the part must be available in the correct orientation that further necessitates designing of a special delivery chute which is part geometry specific. Part feeders are used to orient and deliver parts like nuts, bolts, capsules, tablets, pins and other small components at a specific feed rate to desired locations usually on a conveyer belt or machine [3].

1.1 General requirements of part feeders:

The following are some of the general considerations that must be followed while designing a part feeder.

1) In a mechanized assembly, the output of parts from the feeder is always restricted by the machine being fed. The machine will generally use parts at a strictly uniform rate and this may be referred to as the machine rate. In the design and testing of part feeders, it is often convenient to observe the feed rate when the feeder is not connected to a machine. The feed rate under this circumstance is referred to as the unrestricted feed rate which must be greater than the machine rate.

2) With part feeders suitable for automatic machines it is necessary that all the parts be presented to the machine in the same orientation. Some feeders are able to feed and orient many types of parts whilst others are only able to handle a very limited range of part shapes.

3) A part feeder should be reliable i.e. it should be designed so that the possibility of parts jamming in the feeder is minimised or eliminated.

4) Some part feeders are noisy in operation and some tend to damage certain types of parts. [4]

This paper deals with the study of the reciprocating tube funnel feeder.

2. COMPONENTS AND DESIGN

The developed feeder consists of various components and sub-assemblies which are mentioned in Table 1 given below.

Table 1: List of Components

S. No.	Components	Specifications
1.	Tube	Mild Steel, length= 19.6-18 cm, diameter= 15 mm
2.	Funnel	Galvanised Iron, length= 20 cm, top diameter= 16.5 cm bottom diameter= 2 cm
3.	Crank Mechanism	Length of shaft= 12 cm
4.	Reduction	Ratio = 70

	Gearbox	
5.	Motor	1440 rpm, 220 V, 3 A
6.	Stepped pulley	4 steps, 89 mm
7.	Belts	Motor to gearbox -> A30 Gearbox to shaft -> A38

3. EXPERIMENTAL SETUP

The setup (as shown in Figure 1) consists of a tube oscillating inside the spout of a funnel. The tube is sectioned diagonally from the top (as shown in Figure 2) so that it can easily penetrate the accumulated cylindrical components. Inclination of the sloping walls of the funnel ensures equal feeding probability of the parts.

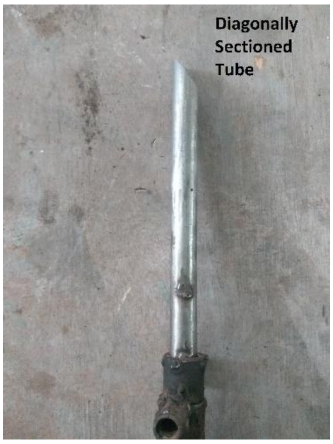

Figure 2 Diagonally sectioned tube

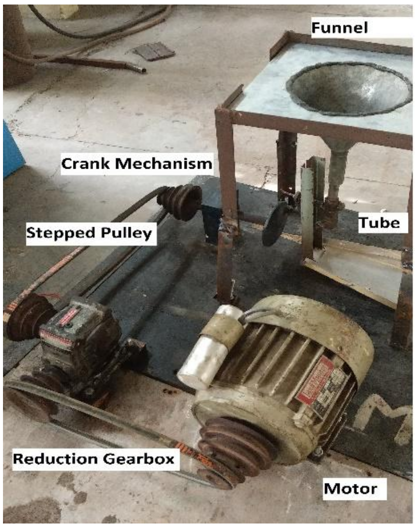

Figure 1 Experimental Setup

An AC induction motor is coupled with a reduction gearbox used to rotate the stepped pulley mounted on the driver shaft. The driven shaft of the gearbox is coupled with the shaft of the crank mechanism via another set of stepped pulleys. This causes the rotation of the shaft and hence the crank mechanism. The rotary motion of the shaft is translated into linear oscillations of the tube whilst the components slide into the tube and are simultaneously fed. Solid cylindrical aluminium components are used to carry out the experiment. Sufficient clearance is provided between the components and walls of the tube to allow smooth movements of the components along the tube.

4. WORKING ANALYSIS

In order to utilise the feeder for various industrial based applications, it is important to calibrate the feeder in response to different operating factors. A systematic analysis of the part feed rate of the feeder was carried out under different operating conditions. A series of experiments was carried out by varying these parameters. The various parameters which were involved in the analysis are:-

Table: 1

PARAMETER	SPECIFICATIONS
1. Part Length	15 mm, 20 mm, 25 mm
2. Part Population	50, 100, 150, 200
3. Strokes per minute	1 stroke = 1 upward + 1 downward movement of the tube

Case 1: Speed= 22 spm; Part Length=15 mm; Part Population varied.

Table 2 Variation of feed rate with part population

S. No.	Part Population	Feed Rate (ppm)			Mean feed rate
1.	50	158	137	128	141
2.	100	141	138	150	143
3.	150	152	141	145	146
4.	200	162	164	175	167

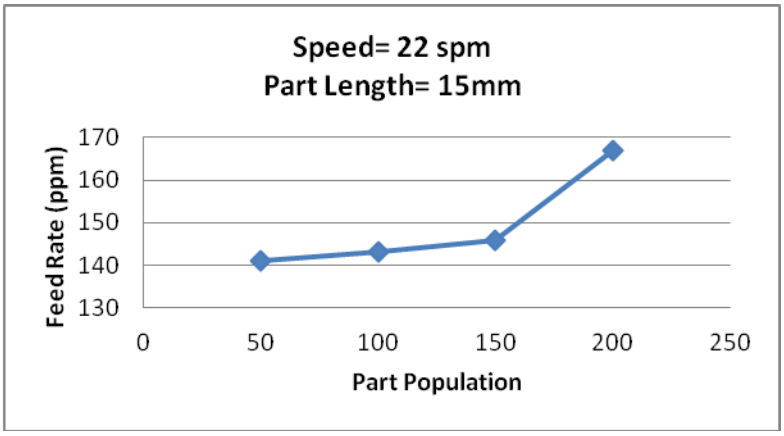

Figure 2. Effect of part population on feed rate.

Case 2: Speed= 22 spm; Part Length varied; Part Population =100.

Table 2. Variation of feed rate with part length.

S. No.	Part Length (mm)	Feed Rate (ppm)			Mean feed rate
1.	15	141	138	150	143
2.	20	73	51	83	69
3.	25	48	49	44	47

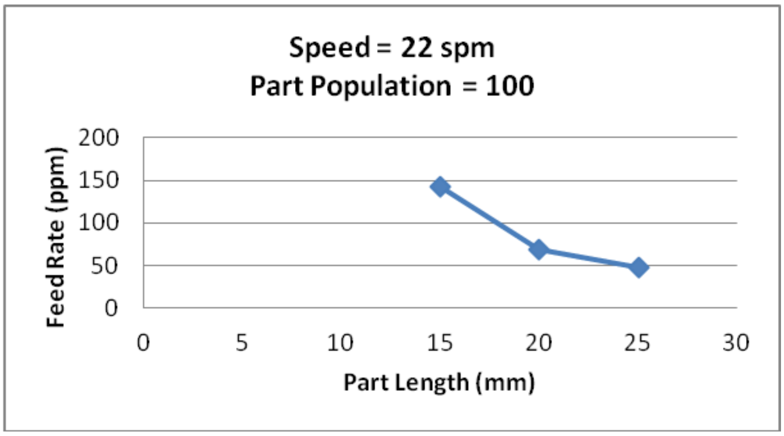

Figure 3. Effect of part length on feed rate.

Case 3: Speed varied; Part Length= 15 mm; Part Population =100

Table 3 Variation of feed rate with strokes per minute

S. No.	Strokes per minute (spm)	Feed Rate (ppm)			Mean feed rate
1.	16	107	116	131	118
2.	22	141	138	150	143
3.	28	152	154	162	156

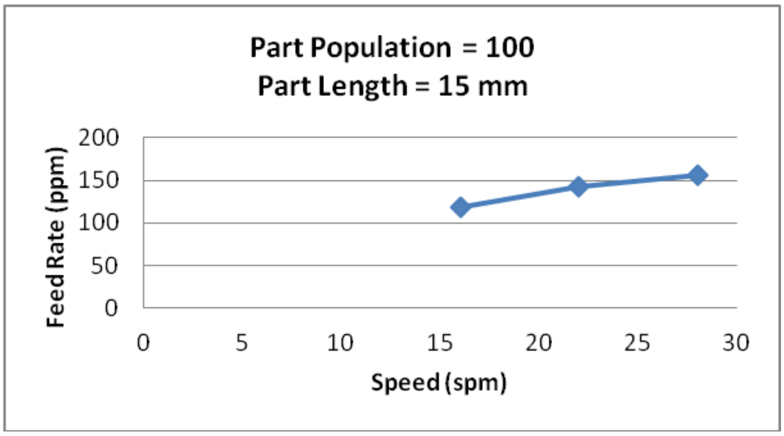

Figure 3 Effect of strokes per minute on feed rate

5. CONCLUSIONS

It is observed that:

- The feed rate increases proportionately with part population between 50 and 200 components. At less than 50 the feed rate becomes erratic due to unfavourable placement of components. At more than 200, feed rate again becomes erratic due to excessive interaction among the components themselves.
- The feed rate decreases proportionately with part lengths between 15 mm and 25 mm. For part length less than 15 mm, the parts may orient themselves lengthwise inside the tube. For lengths more than 25 mm the feed rate falls drastically due to excessive interference between the parts.
- The feed rate increases with strokes per minute. But as the number of strokes is increased further (i.e.

more than 28 spm) there is so much turbulence and interactions among the parts that their tendency to slide into the tube decreases.

It is observed that maximum feed rate is achieved when:

1) Speed = 28 spm
2) Part Population = 200
3) Part Length = 15 mm

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