Quarter Oscillating Feeder: A Graphical Analysis of its Performance for Feeding Spherical Components

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Abstract - *Automation of manufacturing industry has now become an integral part of industry as it is capable of delivering products in right quantity, quality and consistency. 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 [1][2]. There are many aspects of industrial automation depending upon the type of product and the industry. One such aspect is assembly line which streamlines the flow of product from one assembly station to the other in pre-decided cycle time to cater the needs of assembly line many a times discrete part feeding in required quantity and in desired orientation becomes indispensable. This task can successfully be done with the help of a suitable feeding mechanism.*

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 [3].

Quarter oscillating feeder used in the present study is a specialized feeder tailored to feed spherical components. The present study is aimed at analysing the performance of a Quarter oscillating feeder for different size of spherical balls. The desired outcome in this case is the feed rate and the various input parameters for the study are – Part Population, Part Size and Stroke frequency. A number of experiments have been conducted and the outcomes are graphically analysed to predict the performance behaviour of this feeder.

Key Words: *Automation, Feeder, Cycle time, Feed rate, Graphical Analysis.*

1. INTRODUCTION

With modern day industries moving towards automation to increase their rate of production, automated feeding of parts becomes an important accessory for them [4].Automation of contemporary manufacturing plants has been necessitated by a humongous increase in consumer demand and the failure of conventional plants to fulfill this demand [5]

A feeder is a machine or device which is used to feed or load any kind of material, chemical or product to the assembly line, manufacturing stations or wherever necessary. It is specifically used to feed material one by one at any desired rate and in the desired orientation. Process equipment manufacturers have developed a vast body expertise and a wide range of feed technology so as to efficiently meet the different requirements of feeding for different industries.

The feeder selection is a key in success related to achieve desired feeding. Hence, different types of Feeders have been made to cater to different kinds of feeding requirement which are:

1. Centrifugal Feeder
2. Vibratory Feeder
3. Linear Feeder
4. Flex Feeder
5. Oscillating Feeder
6. Step Feeder
7. Elevator Feeder

The feeder used during this experiment is Oscillating Feeder. It is an instrument that uses quarter rotation with the help of slider crank mechanism to feed material. It uses both gravity and quarter rotation motion to move materials. Gravity is used to keep them together and bringing back in front of wedge after getting a stroke and then with the help of quarter rotation, wedge is used to move the materials. They are mainly used to transport a large number of spherical objects. The feeder for the present study has been developed keeping in mind the kind of component which is steel ball in this case and can be useful for industries using balls, like bearing industry.

2. EXPERIMENTAL SETUP

The experimental setup used for conducting the experiments is shown in figure1. Setup is getting rotation from motor of 1440 rpm, this motion is transmitted to gear box using step cone pulley. The step cone pulley is varying the speed of slider, at the end 3 stroke rate were finalised for experiment, these were 16 stroke/minute, 27 stroke/minute and 48 stroke/minute respectively. The components selected for the experiments were spherical ball with 3 different sizes viz. 15mm, 18mm and 21mm respectively(see in figure 2). A number of trial experiments were conducted to identify important input parameters and their operating ranges. As shown in table1

Table -1: Input parameters and their operating limits

Parameters	Unit	Lower Limit	Upper Limit
SPEED	Stroke/minute	16	48
PART SIZE	Mm	15	21
PART POPULATION	No.	100	200

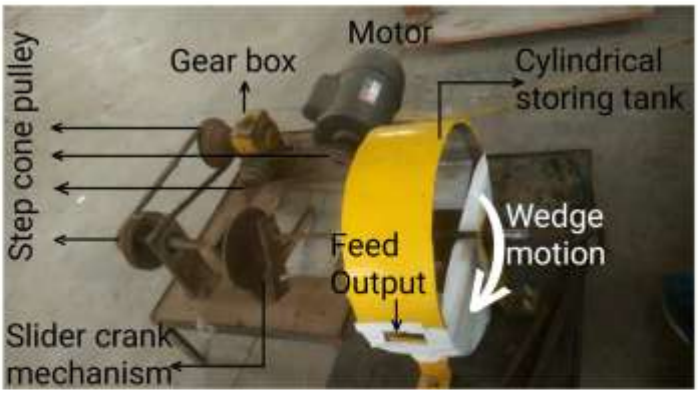


Figure -1: Experimental setup

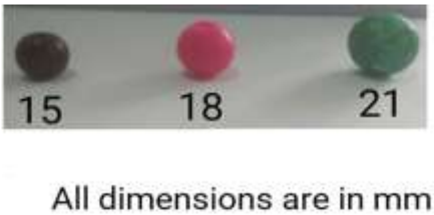


Figure -2: Specification of Spherical Balls

3. CONDUCTING THE EXPERIMENT

There were 3 parameters used and analysis was done by using OFAT (One factor at a time). Thus, by keeping 2 factors constant and by varying the third one readings were taken. Hence, all the 3 parameters were varied one by one and obtained a total of 27 readings. The experiments were conducted by using one factor at a time technique though the technique does not entertain the interaction effects among the parameters and hence limiting its applicability but still it can give an approximation of the performance behaviour of the unit and the study can be used as a preliminary stage to further conduct elaborated analysis on the unit. Experiments were conducted by varying only one parameter at a time keeping the other two parameters constant. Input parameters were varied at three levels namely lowest, intermediate and highest. Each observation was performed in three replicates totalling 27 observations. As shown in table 2

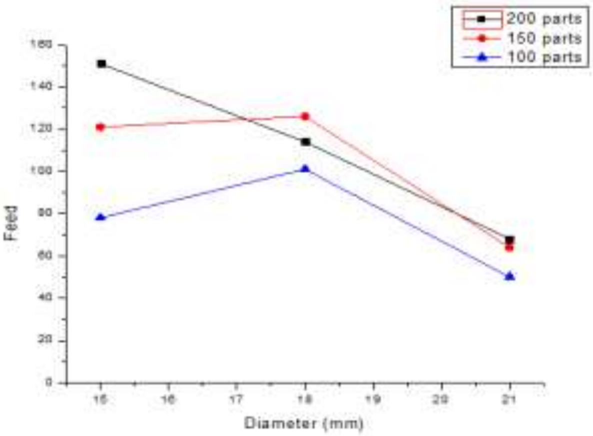
4. RESULTS AND THEIR ANALYSIS

Table 2

SPEED (stroke/min)	PART SIZE(mm)	PART POPULATION	FEED RATE (per min)			MEAN RATE
48	15	100	80	80	74	78
48	15	150	111	123	129	121
48	15	200	159	144	149	151
48	18	100	100	105	97	101
48	18	150	129	134	116	126
48	18	200	120	110	113	114
48	21	100	55	40	56	50
48	21	150	70	61	62	64
48	21	200	89	61	54	68
27	15	100	50	58	58	55
27	15	150	108	100	103	104
27	15	200	121	129	124	125
27	18	100	72	61	65	66
27	18	150	101	108	97	102
27	18	200	102	95	97	98
27	21	100	48	42	46	45
27	21	150	56	56	52	55
27	21	200	87	81	88	85

16	15	100	32	30	23	29
16	15	150	47	47	43	46
16	15	200	73	78	75	75
16	18	100	32	24	30	29
16	18	150	60	60	65	62
16	18	200	87	84	80	84
16	21	100	20	19	24	21
16	21	150	29	36	29	31
16	21	200	33	27	29	30

5. GRAPH AND IT'S ANALYSIS



Graph 1 : Feed at speed of 48 stroke/min

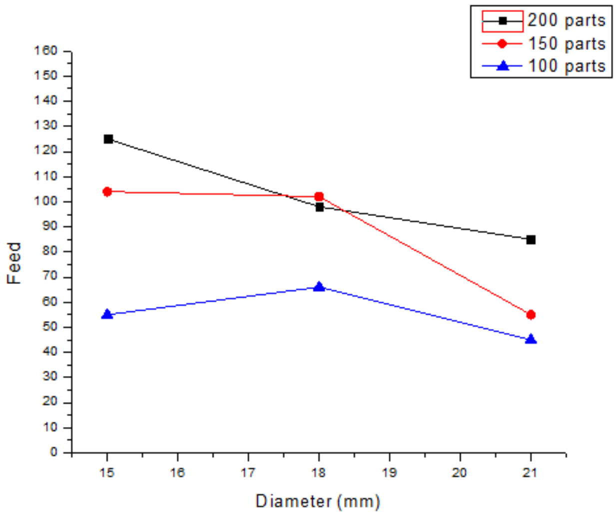
This graph shows the relation of FEED RATE PER MINUTE AND DIAMETER OF SPHERE in different part population (100,150 and 200 respectively)

- ➔ In part population of 100, graph linearly increase from 15mm to 18mm diameter. Then it decreases linearly from 18mm to 21 mm diameter.
- ➔ In part population of 150, graph show little increment from 15mm to 18mm diameter. Then it decreases from 18mm to 21 mm diameter.
- ➔ In part population of 200, graph linearly decrease from 15mm to 18mm diameter and again follow the same for 18mm to 21 mm dia.

The probable reason for this initial increase could be that, with increase in diameter the volume of ball will also increase and it will be easy for wedge to feed them.

Reason for linear downward slope in case of 200 part population could be the excess number of balls, there is a significant amount of interaction between them which affects the feed rate in a negative manner.

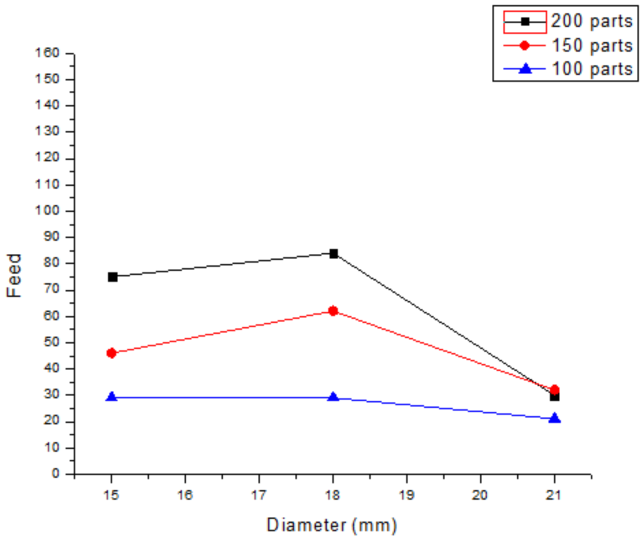
It can be see that in case of 21 mm diameter balls, feed is very low in all cases. This can be attributed to the fact that for shorter part size more parts can be accommodated on a single ledge as compared to bigger part size [6]



Graph 2 : Feed at speed of 27 stroke/min

Graph for 27 stroke/min is similar to Graph of 48 stroke/min, thus both are showing same characteristics, and reason is also the same.

Noticeable change in these two graph is feed is decreasing in 27 stroke/min as compared to 48 stroke/min, which is quite obvious. With maximum stroke/min, feed will be more.



Graph 3 : Feed at speed of 16 stroke/min

This graph shows the relation of FEED RATE PER MINUTE AND DIAMETER OF SPHERE in different part population (100,150 and 200 respectively)

- In part population of 100, graph show very small downward slope from 15mm to 18mm diameter. Then it decreases linearly from 18mm to 21 mm diameter.
- In part population of 150, graph show linear increase from 15mm to 18mm diameter. Then it decreases from 18mm to 21 mm diameter.
- In part population of 200,graph linearly increase from 15mm to 18mm dia and again follow the same for 18mm to 21 mm dia.

The probable reason for this initial increase could be that, with increase in diameter the volume of ball will also increase and it will be easy for wedge to feed them.

Reason for linear downward slope in case of 100 part population could be the fact that for shorter part size more parts can be accommodated on a single ledge as compared to bigger part size [6],as speed is very slow and part population is also low, at the time of feed ball may get slip down

CONCLUSIONS

The maximum feed rate obtained is 151 per min at speed = 48 stroke/min, part population =200 and part size =15 mm and

The minimum feed rate is 21 per min at speed = 16 stroke/min, part population = 100 and part size = 21 mm

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