DEVELOPMENT OF A FLEXIBLE ELEVATED GRAVIMETRIC PART FEEDING SYSTEM WITH PERFORMANCE ANALYSIS

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ABSTRACT

*The successful assembly lines in mass production require performance based part feeding systems. However, the lack of flexible programmable part positioners, facilitating the handling of smart sized parts, restricts the efficiency of a production unit. So, a flexible feeder in batch production is indeed important**[1]**.*

*Flexible assembly lines can be rapidly configured to handle new parts. This can dramatically reduce the time needed to bring new products to market and permit cost of assembly lines to be used for various products **[2]**. Considering the problem of development of traditional feeders for orienting small industrial parts, this project aims to develop a flexible elevated-gravimetric feeder with the help of a prototype for the same**[3]**. The system consists of a conveyor belt, a series of flanges (assisting in mainly elevation), integrated hopper for staging the parts in random manner, chute mainly orienting the parts, along with a motor to drive the conveyor through a pulley. The speed of conveyor belt and the part orientation may be changed as per convenience with small adjustments. To study the performance of the system, rectangular sheets are used as flanges and simple cuboidal small rods are used for the experiment purpose. The system features of an integrated hopper designed in such a way to promote self-feeding of parts of any cross-section (circular, hexagonal, octagonal, cuboidal, etc.) on account of weight of the part, this illustrates the flexible nature of system.*

Keywords- Assembly Line, Flexible, Gravimetric, Integrated Hopper, Self-feeding

I INTRODUCTION

The predominant approach today to introduce factory automated technology into manufacturing is to selectively apply automation and create islands of automation. The phrase "islands of automation" has been used to describe the transition from conventional or mechanical manufacturingto the automated factory **[4]**. Automated flexible assembly systems (FAS) are capable of being programmed to assemble several different products on a single assembly line with minimal equipment changes. For manufacturers who produce several different products in volumes too small to justify the expense of having a separate assembly line for each product, FASs are more economical than traditional manual or dedicated automated production methods. FASs allow a manufacturer to produce several different products in limited volumes with essentially the same amount of equipment that would be necessary to produce a single product in high production volumes. Flexible assembly systems are also advantageous over dedicated automated systems because when a product is updated or redesigned, a FAS typically can be modified to produce the new, redesigned product with minimal or no equipment changes**[5]**. Considering the current industrial setup, only a limited amount of quality research has been done on the feeder systems **[6]**.

In accordance with the above described characteristics, FASs require parts feeding systems which can feed a variety of different parts on command in proper orientation; the following project aims at proposing a prototype for solving the above said utility. A typical parts feeding system comprises numerous components. First, a storage means, such as a bulk supply hopper or bin is used to store a plurality of parts. A conveyor or other feeder device transfers the parts from the storage means to a parts feeder, where separation and orientation of the parts typically occurs. After the conveyor over the flanged ledges, its goes towards the mouth of the feeding chute, this is again tilted at an arbitrary angle to enable the parts through the chute under their own weight. Though the presented system offers flexibility in the shape of the parts being oriented, its flexibility may get limited by the length of the parts with flanges taking a part with length comparable to its own as well as the mouth of the chute, while can offer great variation in crossection of the prismatic components and even very small size components. The given mechanism is equipped with a long length chute which helps to ensure the orientation of the parts, where the parts flow over the delivery chute under their own weight and even by a push from the other parts. The given system is independent of the environment in which the parts may be given to the hopper, like even if the parts are lubricated, the mechanism can perform similarly.

Now the study even includes a study on the performance of the gravimetric belt feeders, where in the hopper is loaded with a given constant load of parts and a constant controllable belt speed is checked by a motor to determine its performance. This approach of study is employed because the flow of solid on a belt is uncontrolled and the load on the constant speed belt is measured as an indication of the solid flow rate **[7]**.

II OBJECTIVE

The study can be divided into two illustrative categories: -

1. Fabrication and Designing of storage hopperand chute for feeding solid steel cuboidal parts.
2. Analysis of operating parameters governing the feedrate of the setup.

2.1 Design and Mechanism

Fig. 1 - Working Mechanism of Part Feeding System

2.2 Parts

1. **Conveyor Belt-**An endless belt made of a strip of PVC with stitched ends. Dimensions of the belt: $1110*70*2mm^3$.
2. **Selector Flanges-**Inclined projections GI sheets(28 gauge no.) to collect components. They are attached to the belt with helpof split pin rivets. Dimensions: $80*20mm^2$, Inclination angle: 28.5˚.
3. **Pulley-**The upper and the lower pulleys of mild steel pipes and mounted upon an axle with roller bearings.
4. **Hopper-**The hopper is that part of the feeder where parts are stored in bulk. The hopper has an inclined shape like a parabola; this facilitates continuous feeding of parts as the feeder picks up parts from the bottom of the arc. One of the walls has a slot with which is slightly greater than the conveyor belt to allow for the components to be picked up by the ledges. A baffle which acts as a supporting wall to prevent the component from sliding down the ledge is also attached to thehopper.Dimensions: 750*(120-40) *1500(mm^3).
5. **Delivery Chute-**It is a long U-shaped channel which transfers the part from the feeder ledge to the workstation. It was made up of sheet metal and inclined at an angle of 70 degrees with the vertical plane. Dimensions: 760*50*20(mm^3)
6. **Motor-**A DC motor with rated maximum RPM of 30, Voltage rating of 30V was used to drive the pulley.
7. **Power Source-**A constant current DC power source was used to supply variable voltage to the motor to drive it at different speeds. Input: 220V AC, Output: 0-30V DC.

III EXPERIMENTAL WORK

3.1 Analysis

In order to utilize the feeder for various industrial based applications it is important to calibrate the feeder in response to different operating factors. The present work is based on graphical analysis of the performance of an elevated feeder. 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: -

- **Part Size : -** It refers to the size or length of the solid cuboidal component.
- **Part Population: -** It refers to the number of parts that were placed in the hopper during the analysis.
- **Motor Speed : -** It refers to the speed of DC motor in RPM.

3.2 Range of parameters

- **Part size/length (mm) : 30, 40, 50, 60.**
- **Part population : 20, 40, 60, 80.**
- **Motor Speed (RPM) : 12, 16, 20, 24.**

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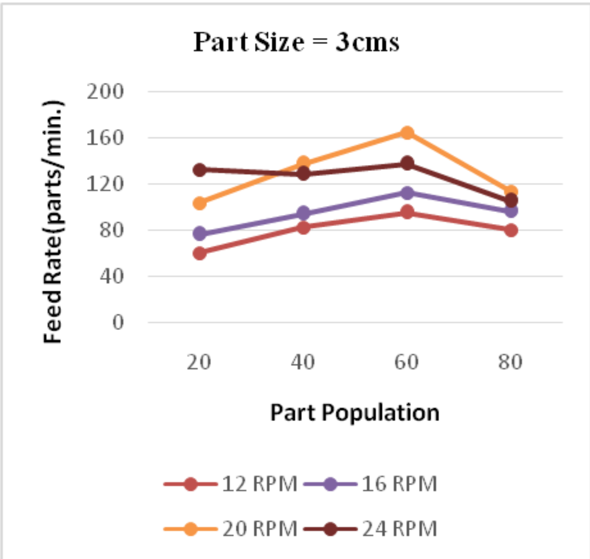
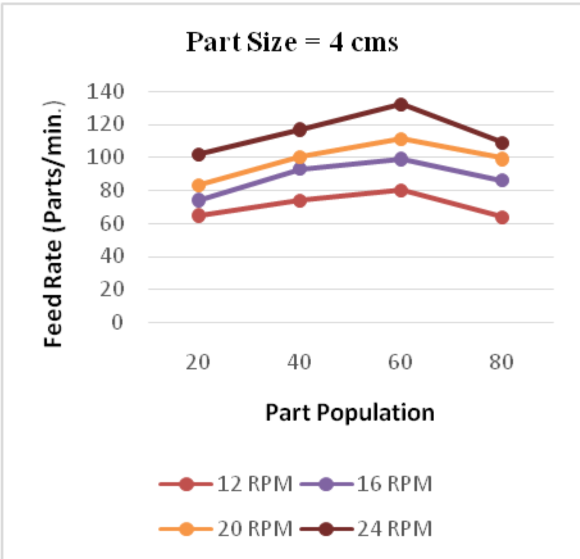
The experiment was carried out by utilizing the one factor at a time technique, which involves varying one of the parameters while keeping the other governing parameters constant. The feed rate was obtained for each set of operating conditions. Three readings corresponding to each combination of conditions were taken over a span of three minutes; an average of these readings was then represented graphically in order to keep errors out of the equation.

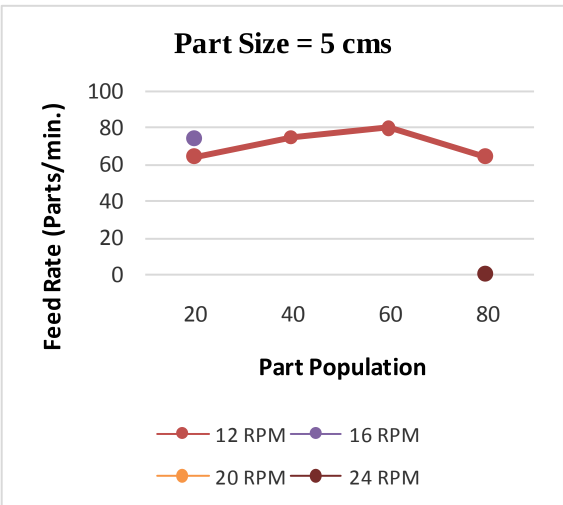
IV GRAPHICAL ANALYSIS

This section provides the graphical analysis which depicts the variation of feed rate with changes in various operating parameters. The graphs plotted show the variation of feed rate by changing two of the parameters while the last parameter is kept constant.

4.1 Feed rate variation v/s part population and motor rpm, keeping the part size constant







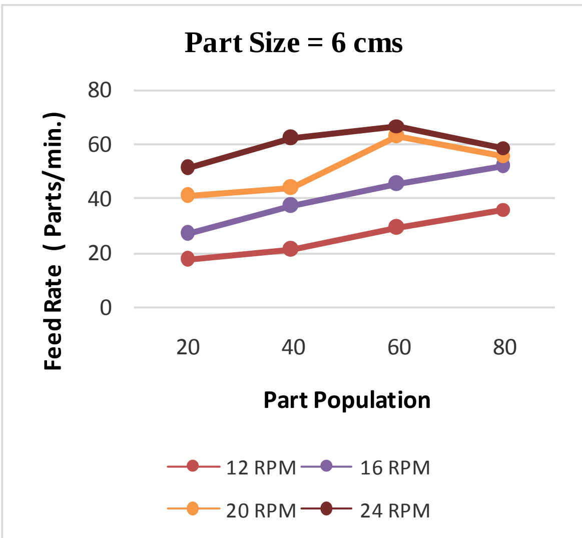


Fig. 2

4.2 Variation in feed rate v/s motor rpm and part size keeping the part population constant

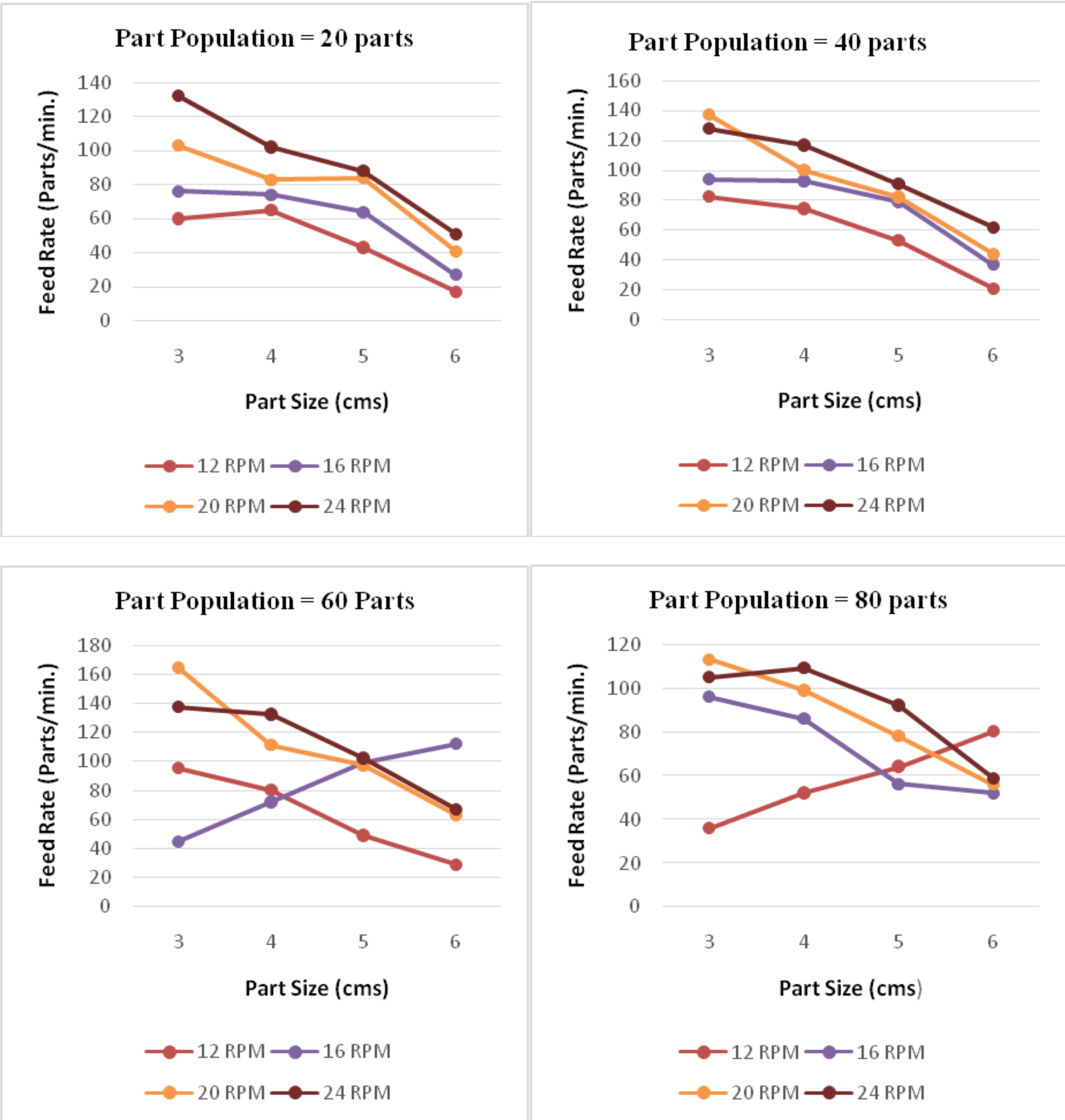


Fig. 3

4.3 Analysis of the Graphical Results

The result inferred from the above shown graphs can be summarised as: -

1. Effect of Part Population on the Feed Rate

From the graph shown in **Fig.2**, for any particular part size, the parts fed per minute increases initially starting from the lowermost point i.e. 20 and then it starts decreasing after a certain limit. The inferred characteristic can be attributed to the fact that initially as we increase the load, the flanges lift more number of components , as much as they are capable of, but after a certain limit, the feed rate reduces due to each component obstructing other's way through the flanges. Even they may get into places where flanges and the hopper design aren't able to feed them. At such great part population, strength of flanges as well as the flexibility of the conveyor belt greatly alters the feed rate which are highly influenced by the weight of the parts and their part density within the hopper, changing the orientation of the flanges. So at such densities, the mechanism becomes unpredictable.

2. Effect of Part Size on Feed Rate

From the graph shown in **Fig.3**, for a constant part population in the hopper being maintained, we infer that with increases part size, the feed rate decreases, which is due to the fact that, as part size increases, lesser number of parts can be taken up by the flanges to the chute.

3. Effect of Motor Speed on Feed Rate

Again from **Fig. 3**, we can even infer that with increasing motor speed, the feed rate increases linearly, as the frequency of the flanges through the hopper increases, so does the feed rate increases,which is also upto the given rating of the driving motor.

V CONCLUSION

An effort has been made to present an overview to an elevated gravimetric feeder in order to optimise its use in the industry in order to optimise its use in industry requiring small sized industrial components at given rate and orientation to encourage quality and uniform production rate.Results from the above graphs show that the designed system functions optimally at motor speed of 20RPM with part population of 60 of corresponding size of 30mm, giving a feed rate of 164parts/min. However, the future work is required to show the simulation of results on actual feeders.

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