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Development of a Magnetic Belt Type Feeder and Graphical Analysis of Feed Rate of Tubular Components

Sanjit Raj[1], Shubham Gupta[2], Ankita Verma[3], Pradeep Khanna[4]

[1,2,3,4]*Division of MPAE, Netaji Subhas Institute of Technology, New Delhi*
[1]*sanjitraj1994@yahoo.com*

Abstract: *The unprecedented industrial growth and technological advancements observed during past two decades have revolutionized the way assembly lines operate. Small part feeding at desired rate and in desired orientation being an integral part of assembly lines, also needs to go hand in hand. This has led to the development of specialized small part feeding systems to be used along with the assembly line. These systems not only reduce the cycle time but also bring down labor cost. Though a wide variety of feeders are available in various industrial setups, the authors feel that only limited amount of structured research work has been carried out so far. The present study describes the development of a Magnetic Belt Type Feeder[1] and further analyzes its delivery pattern graphically. Cylindrical Sleeve type components were used for the analysis and the experiment was carried out by varying four operating parameters, namely- part length, part population, number of magnet pick-ups and speed of motor. This work would prove to be of significant importance for feeding similar industrial components on assembly lines where the feed rate has to be synchronized with the required rate of the process, ensuring correct orientation as well.*

Keywords: *Assembly line, part population, feed rate, cycle time*

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 [3]. In automated assembly lines where the main aim is to keep the machine running to achieve a high rate of production, delivery of semi finished products to machines for further operation at a desired rate becomes very important. This task is taken care of by automated part feeders. These feeders not only reduce human errors but also keep up with the production rate by feeding parts at desired pace and in desired orientation. The design of feeder should ensure the correct orientation of parts, thus eliminating any human interference. The part feeders are cost effective and efficient substitutes for human labor thus saving a lot of valuable handling time and labor cost. The magnetic belt type feeder isan active feeder [4][5] used to feed ferromagnetic parts. The parts are stored in bulk and are sent to the machine by the feeder in a discrete manner.

WORKING PRINCIPLE OF MAGNETIC BELT FEEDER [1]

The magnetic belt type feeder is an active feeder [4][5] i.e. it picks parts from bulk in any orientation and retains it tillthe specially designed chute where this randomly grasped part is made to reorient in the desired manner and fed to the machine subsequently.

2. FEEDER HARDWARE

The feeder has been fabricated by utilizing the in house facilities available in institute and has following hardware components

- Conveyor rollers: ϕ73mmx220mm
- Conveyor belt: 1372mmx 75mmx3mm
- Dimensions of magnets used: 30mmx30mmx6mm
- Dimension of hopper:

Inclination of wall: 10°

Inclination of base: 45°

Slot in wall facing the belt: 40mm

3. EXPERIMENTAL WORK

3.1 EXPERIMENTAL PROCEDURE

The present work is based on graphical analysis of the performance of a magnetic belt type feeder [1]. A systematic experimentation was carried out in which the part feed rate of the feeder was studied by varying the values of the operating parameters between two limits already found experimentally. The various operating parameters included:

rpm of motor; Part length; Part population; No. of magnets on belt Though the performance of feeder depends on many factors but it was found that the aforementioned factors only had the most significant effect on feeder performance. The specimen parts selected for the analysis were tubular components [2] having an outer diameter of 10mm

3.2 RANGE OF PARAMETERS

- Speed of rotation of motor: 12rpm – 18rpm
- Part length: 20mm – 50mm
- Part population: 75 – 300 parts
- No. of magnets on the belts: 3 – 12 magnets

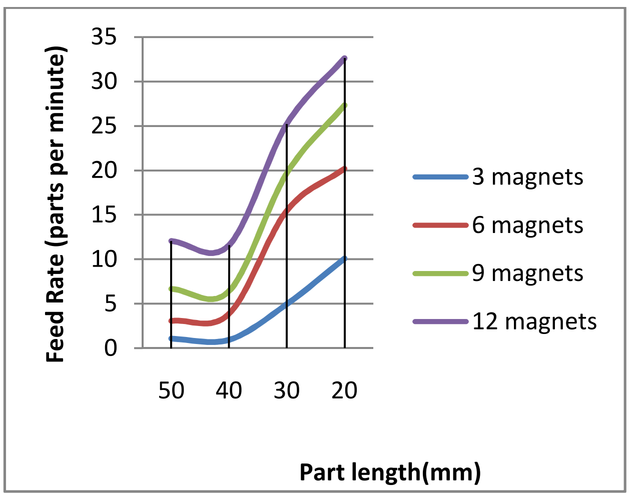
Each one of the parameter was varied in equal steps of four. The experimentation has been carried out by following the one factor at a time technique (OFAT) [6] in which one of the factor is varied during a set of reading by keeping the others constant [7]. Three readings corresponding to each combination was taken, each for five minutes to reduce the error and obtain a value as close to the feed behavior of the feeder as possible. Average of these readings was taken to calculate the feed rate in parts per minute.

4. GRAPHICAL ANALYSIS

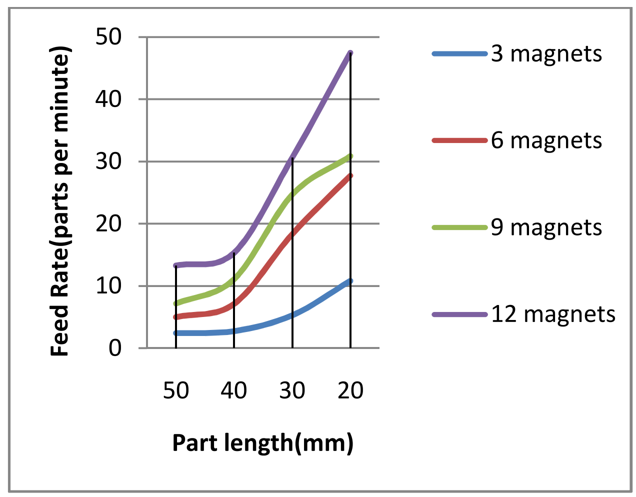
This section provides the graphical analysis which depicts the variation of feed rate corresponding to changes in various parameters.The graphs plotted show the variation of feed rate with change in two of the four parameters keeping the other two constant.

4.1. FEED RATE VARIATION WITH NUMBER OF MAGNETS AND PART LENGTH AT A CONSTANT SPEED AND PART POPULATION

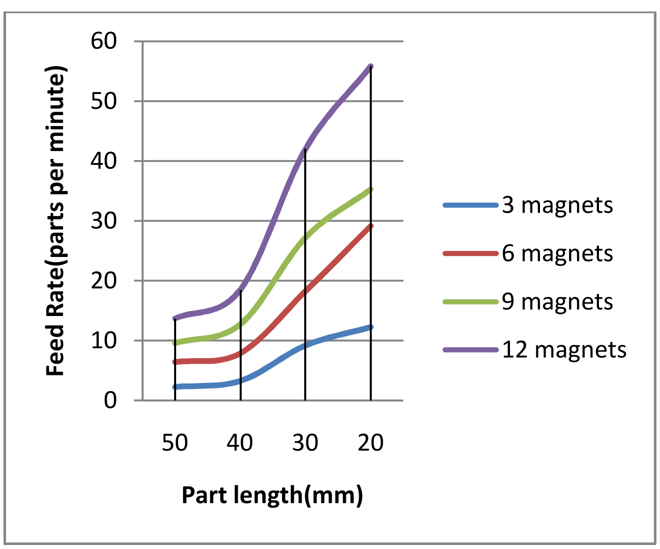
Speed: 12rpm



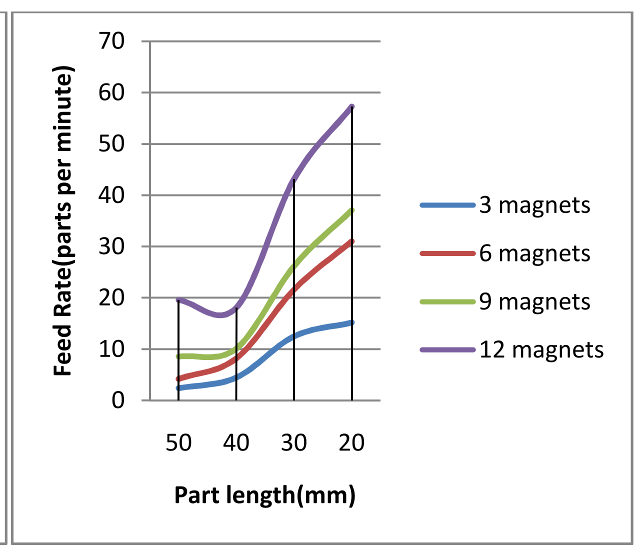
Part population: 75



Part population: 150

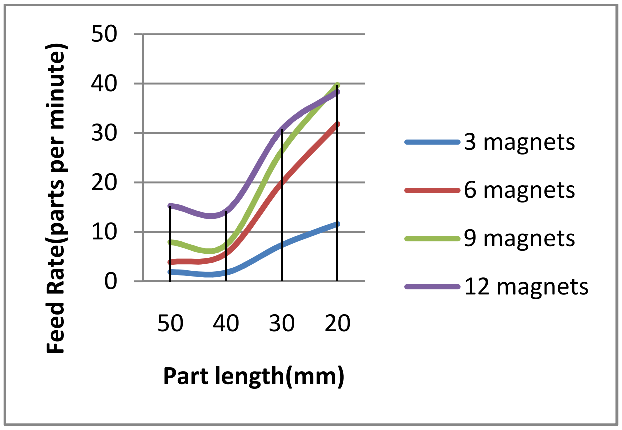


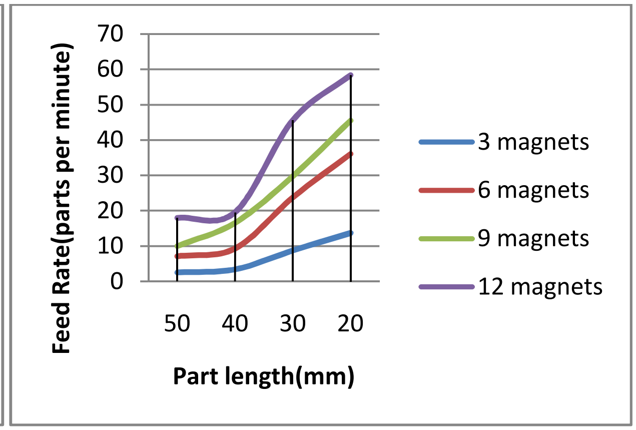
Part population: 225



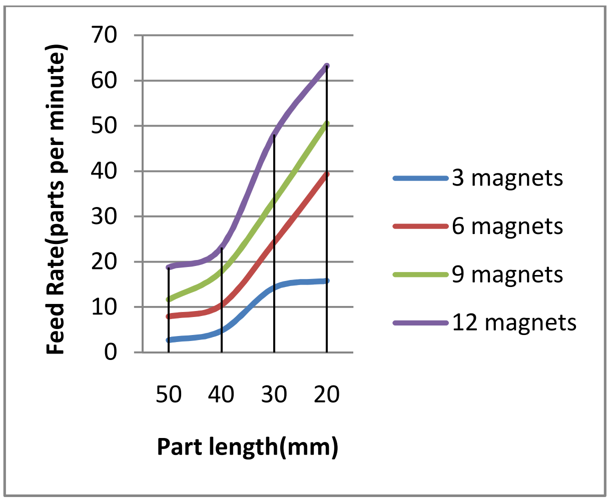
Part population: 300

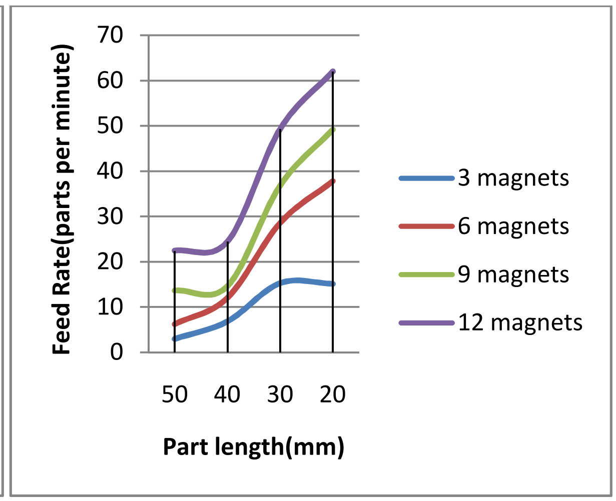
Speed: 18rpm





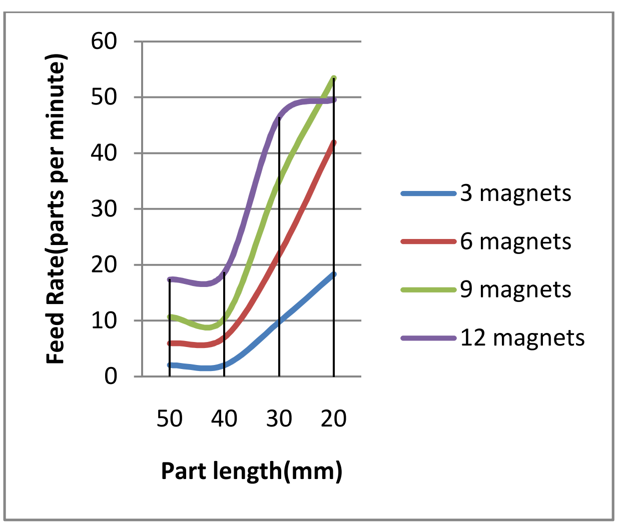
Part population: 75 **Part population: 150**

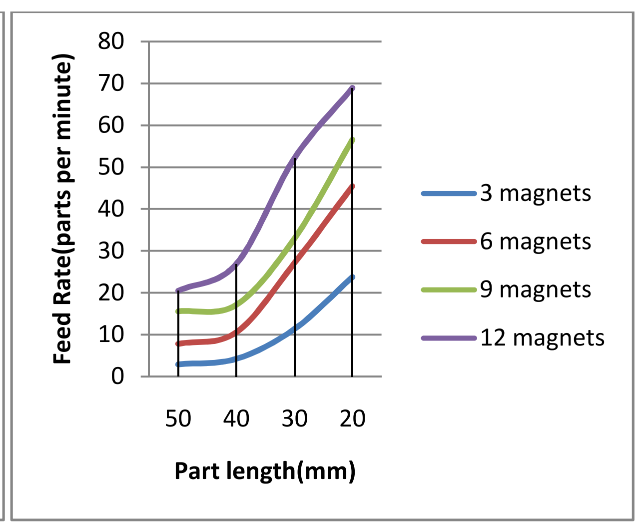




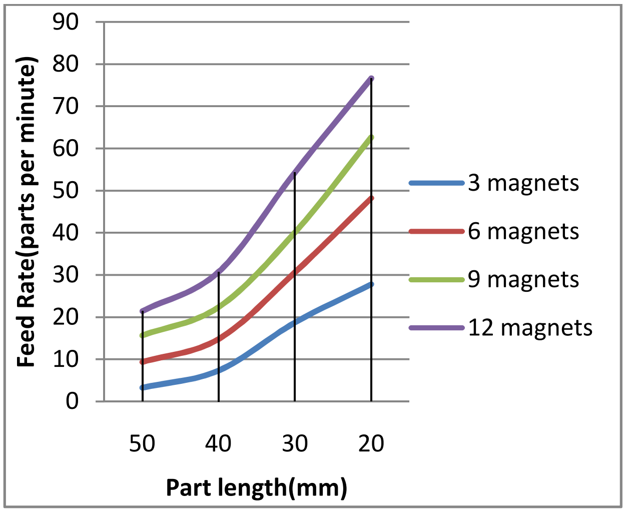
Part population: 225 **Part population: 300**

Speed: 24rpm

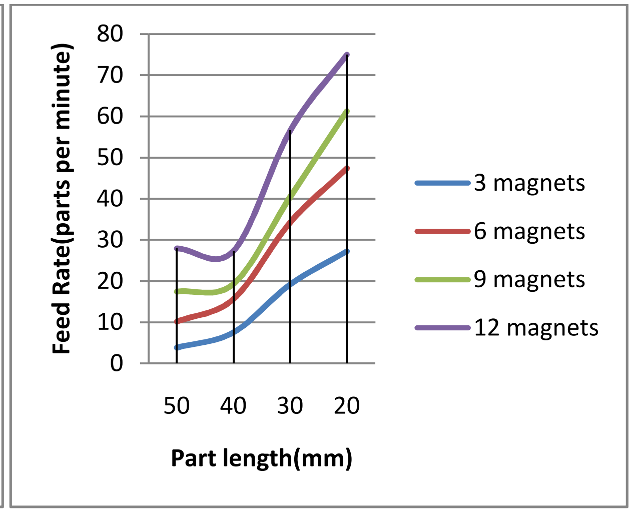




Part population: 75 **Part population: 150**

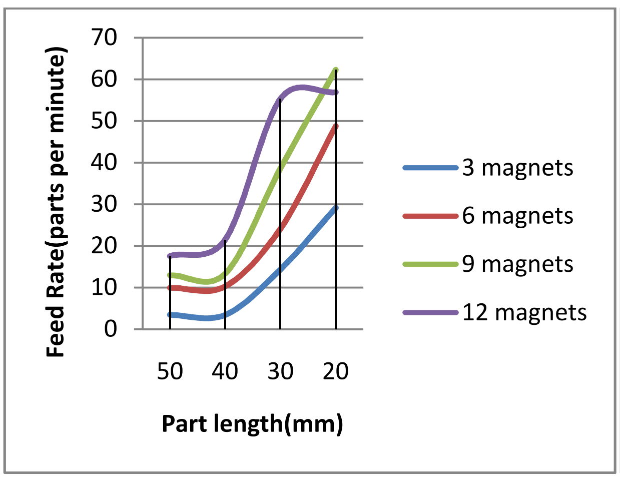


Part population: 225

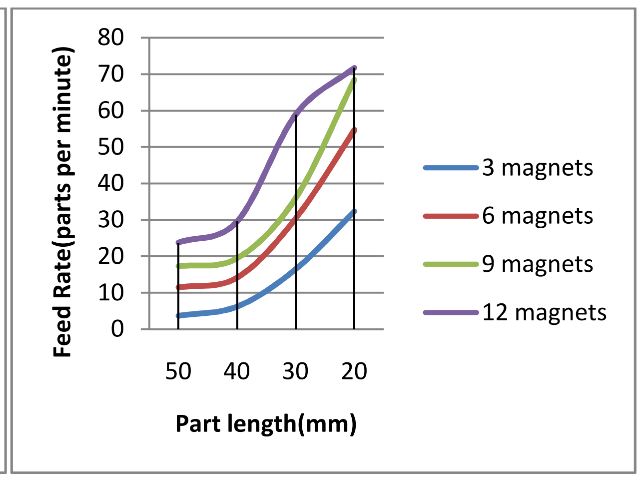


Part population: 300

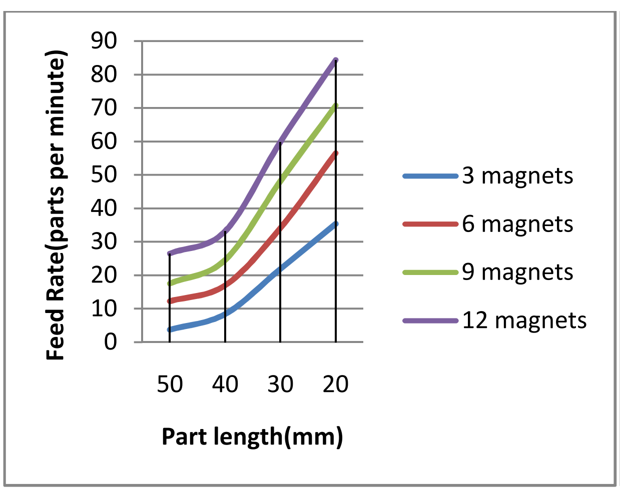
Speed: 30rpm



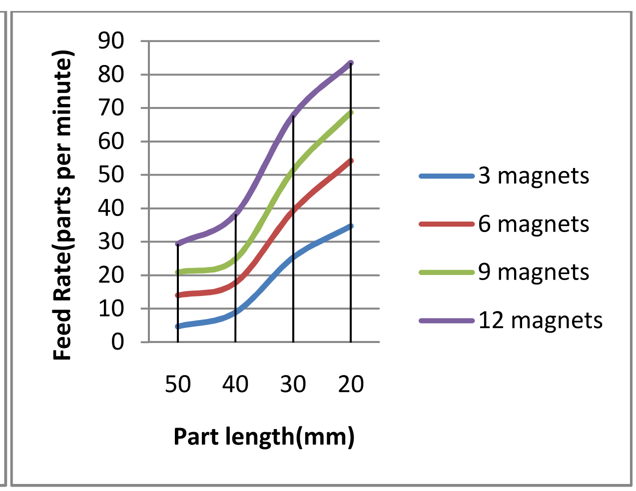
Part population: 75



Part population: 150



Part population: 225

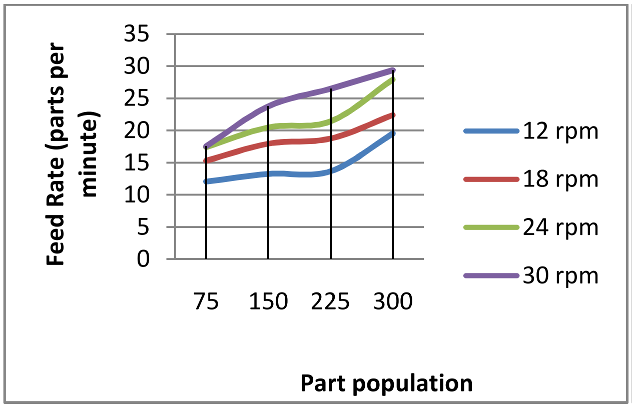


Part population: 300

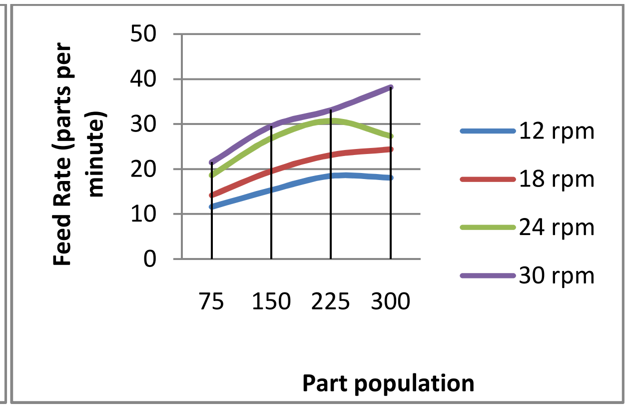
Fig. 1.

4.2 FEED RATE VARIATION WITH PART POPULATION AND SPEED AT CONSTANT NO. OF MAGNETS AND PART LENGTH

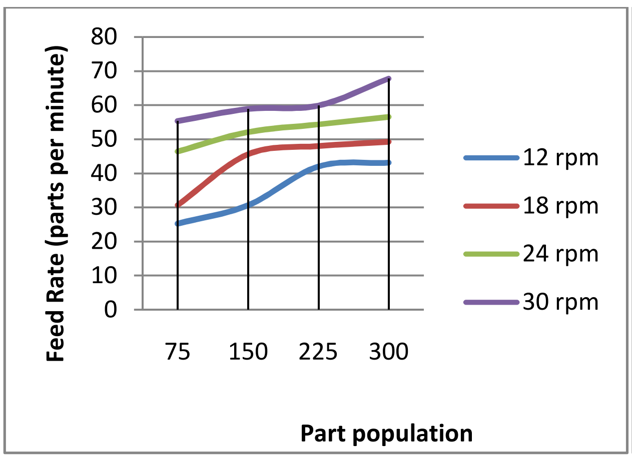
No. of magnets: 12



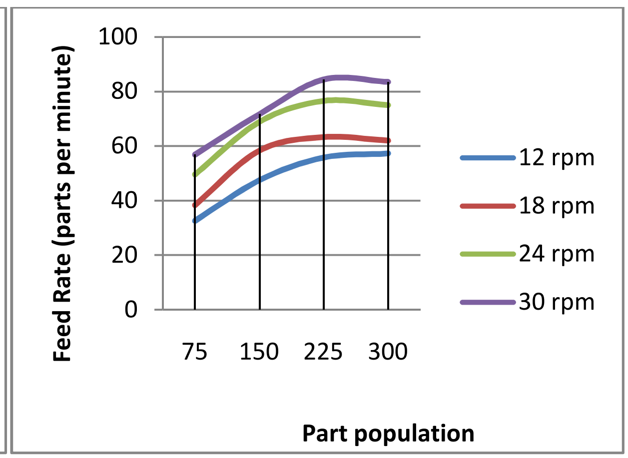
Part length: 50mm



Part length: 40mm

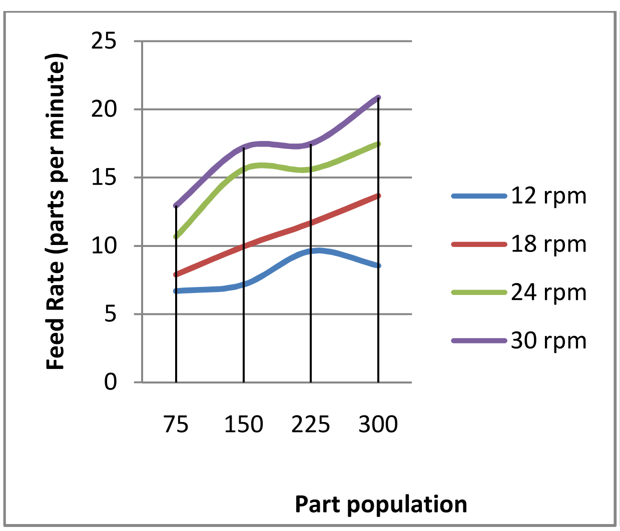


Part length:30mm

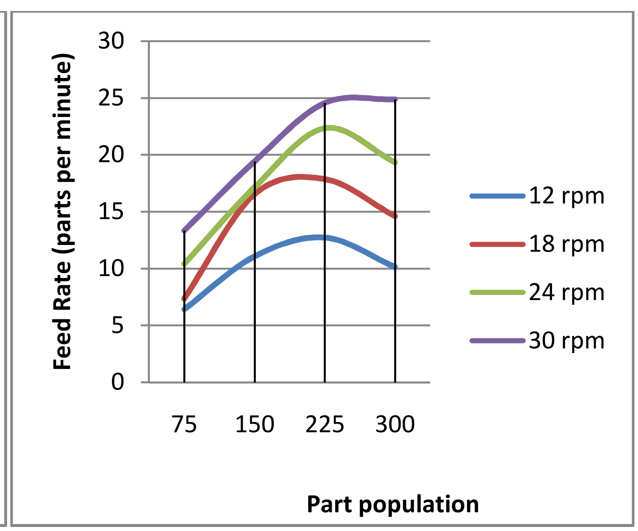


Part length: 20mm

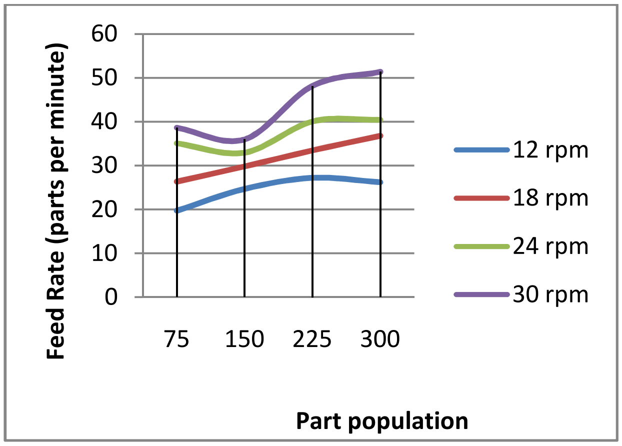
No. of magnets: 9



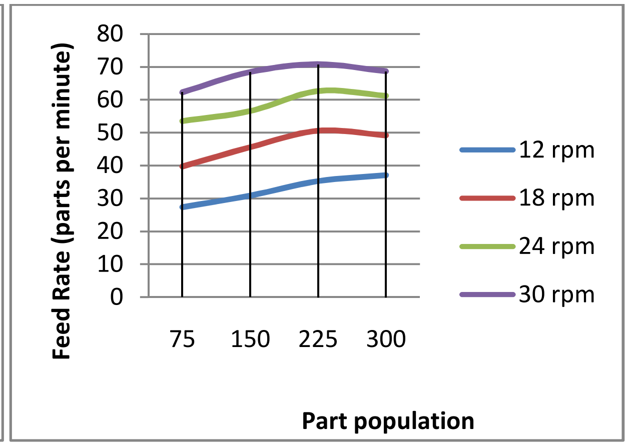
Part length: 50mm



Part length: 40mm

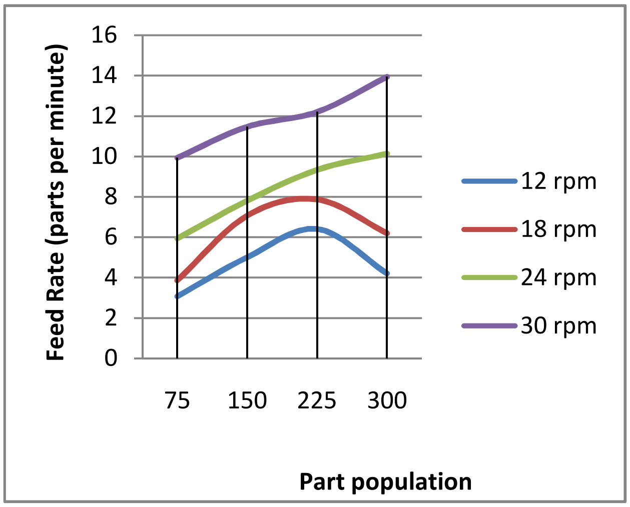


Part length: 30mm

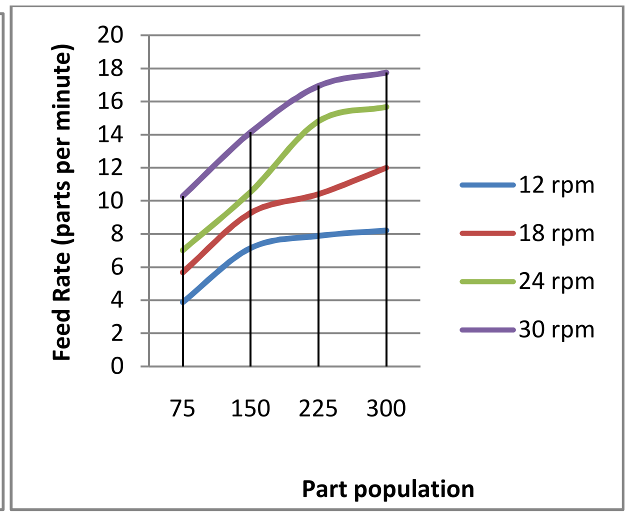


Part length: 20mm

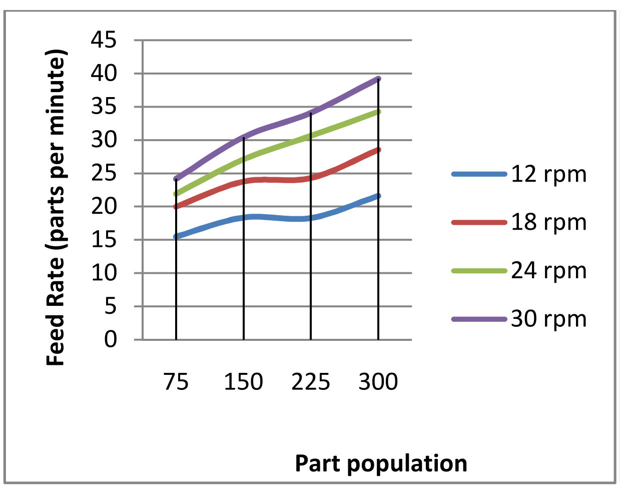
No. of magnets: 6



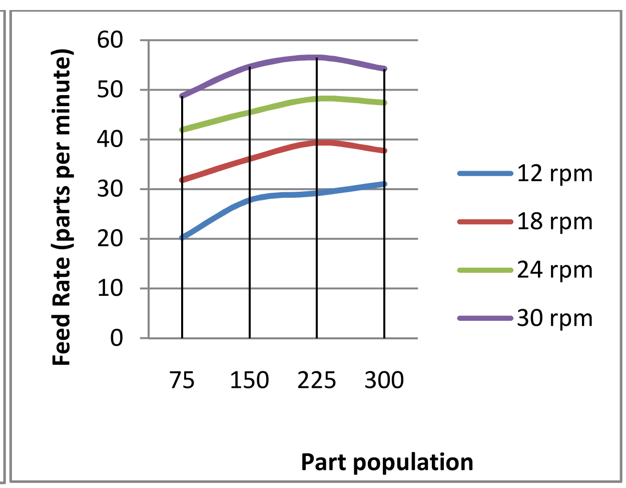
Part length:50mm



Part length: 40mm

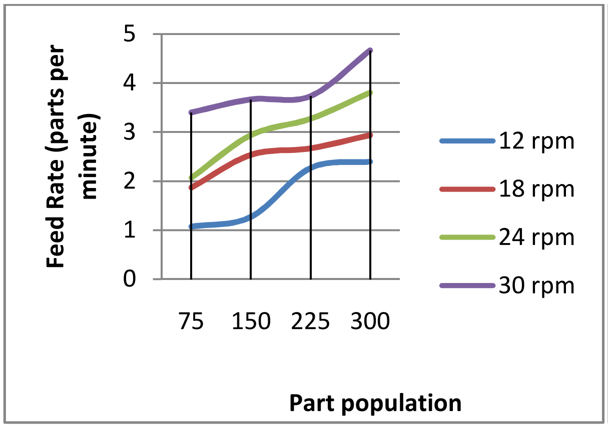


Part length: 30mm

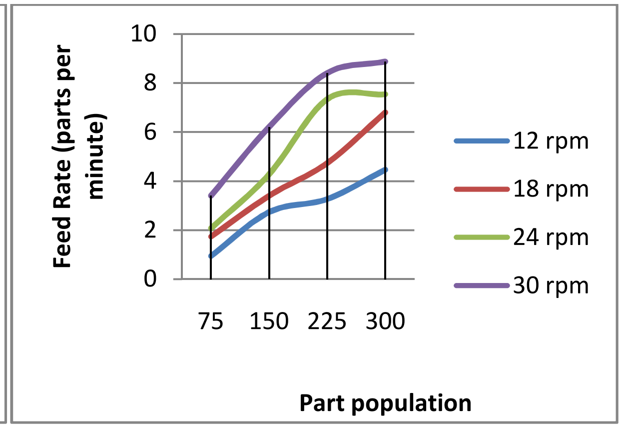


Part length: 20mm

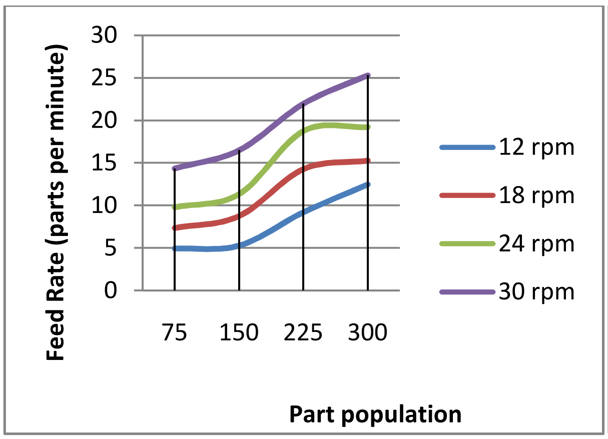
No. of magnets: 3



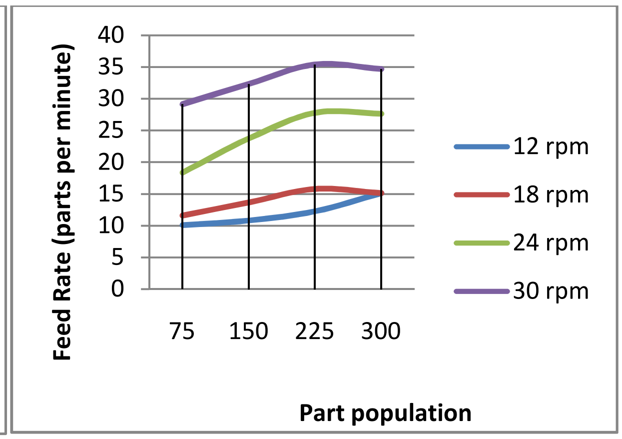
Part length: 50mm



Part length: 40mm



Part length:30mm



Part length: 20mm

Fig. 2.

5. RESULTS AND DISCUSSION

5.1 EFFECT OF MOTOR RPM ON THE FEED RATE

As can be observed in the graphs above (graph no. 17-32) when the speed of rotation of belt is increased, keeping the other three parameters constant, the feed rate increases. At low speed, in a given time interval less number of magnets pass through the hopper. As the speed is increased, the frequency of magnet passing across the parts kept in hopper increases, hence increasing the feed rate.

5.2 EFFECT OF PART POPULATION ON FEED RATE

With increase in part population, the feed rate increases for longer length of parts, as can be seen in graph no.17- 32. This is because at lower part population, less number of parts comes in contact with the belt. As the part population is increased, the number of parts coming in contact with the belt also increases, hence increasing the feed rate.

However, at smallest length of parts feed rate first increases then decreases with increase in part population. This is because although at higher population more parts come in contact with belt but the mutual interaction between them increases. Since smaller parts are lighter in weight, the magnitude of interaction between them is higher as compared to the heavier parts, hence decreasing their feed rate at higher part population

5.3 EFFECT OF PART LENGTH ON FEED RATE

As can be seen in graph no. 1- 16, feed rate is inversely related to the part length fed in the hopper. The weight of part decreases with decrease in the part length. As the weight decreases, less numbers of part roll down the magnet. Also it becomes easier for the magnet to pick up lighter parts. Due to this reason the feed rate increases with decrease in the part length.

5.4 EFFECT OF NUMBER OF MAGNETS ON BELT ON THE FEED RATE

As can be seen in graph no. 1- 16, feed rate varies proportionally to the number of magnets on the belt. As more magnets are available on the belt to pick up the parts, the feed rate also increases with increase in the number of magnets on the belt.

6. CONCLUSIONS

After carrying out the experiments and performing the graphical analysis of the data recorded, we may conclude that the feeder gives optimum output for the following parameters:

- Speed of motor: 30rpm
- Number of magnets on belt: 12
- Part length: 20mm
- Part population 225 parts

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