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Fabrication of wire drawing machine

Nihal Kumar Dasoju *, Sai Sampath Chary Rameshwaram, Prashanth Gante, Ranadeer Nallapu, Sandeep Nelakurthi, Mahesh Kodisela and Gowlikar Vamshi Raj

Department of Mechanical Engineering, Vignan Institute of Technology and Science, Hyderabad, India.

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Abstract

Wire drawing is a metal working process used to reduce the cross-section of a wire by pulling the wire through a single, or series of, drawing dies. There are many applications for wire drawing, including electrical wiring, cables, tension loaded structural components, springs, paper clips, spokes for wheels, and stringed musical instruments. Although similar in process, drawing is different from extrusion, because in drawing the wire is pulled, rather than pushed, through the die. Drawing is usually performed at room temperature, thus classified as a cold working process, but it may be performed at elevated temperatures for large wires to reduce forces. The main objective of this project is to Fabrication of Wire Drawing Machine for reducing the silver and gold wire diameter.

Keywords: Draw dies; Gears; Pulleys; Motors

1. Introduction

In drawing, the cross section of a long rod or wire is reduced or changed by pulling (hence the term drawing) it through a die called a draw die. Thus, the difference between drawing and extrusion is that in extrusion the material is pushed through a die, whereas in drawing it is pulled through it. Although the presence of tensile stresses is obvious in drawing, compression also plays a significant role because the metal is squeezed down as it passes through the die opening. For this reason, the deformation that occurs in drawing is sometimes referred to as indirect compression. Drawing is a term also used in sheet metalworking. The term wire and bar drawing are used to distinguish the drawing process discussed here from the sheet metal process of the same name. Rod and wire products cover a very wide range of applications, including shafts for power transmission, machine and structural components, blanks for bolts and rivets, electrical wiring, cables Etc. Process variables in wire drawing. The die angle, the reduction in cross sectional area per pass, the speed of drawing, the temperature and the lubrication all affect the drawing force, F.

The major processing variables in drawing are similar to those in extrusion that is, reduction in cross-sectional area, die angle, friction along the die-workpiece interface, and drawing speed. The die angle influences the drawing force and the quality of the drawn product. The basic difference between bar drawing and wire drawing is the stock size that is processed. Bar drawing is the term used for large diameter bar and rod stock, while wire drawing applies to small diameter stock. Wire sizes down to 0.03 mm (0.001 in) are possible in wire drawing. Bar drawing is generally accomplished as a single draft operation—the stock is pulled through one die opening.

Because the beginning stock has a large diameter, it is in the form of a straight cylindrical piece rather than coiled. This limits the length of the work that can be drawn. By contrast, wire is drawn from coils consisting of several hundred (or even several thousand) feet of wire and is passed through a series of draw dies. The number of dies varies typically between 4 and 12.

* Corresponding author: D. Nihal Kumar

Figure 1 Fabrication of Wire Drawing Machine.

2. Literature review

T.-S. Cao et al, (2015) published "Comparison of reduction ability between multistage cold drawing and rolling of stainless-steel wire –Experimental and numerical investigations of damage".

Analyzed comparison of reduction ability between multistage cold drawing and rolling of the stainless-steel wire. Test is carried out and higher reduction can be obtained with drawing process and ductile damage can be investigated by numerical simulations. In this study, two phenomenological damage models were calibrated and small die angle was used to reduce the risk of central burst. The shear effect and friction on the wire surface must be controlled due to the high contact length.

Lee et al, (2010) published "Process design of multistage wet wire drawing for improving the drawing speed for 72 wt. %C steel wire"

Analyzed design of multistage wet wire drawing process for improving drawing speed for high carbon (0.72 % C) steel wire. In this study wire temperature variations observed. After that no of passes executed for preventing the rise in wire temperature. A new machine designed to implement the new pass schedule at high speed for improvement of productivity. The no of passes can be increased from 24 to 29 in order to increase the final drawing speed from 1100 m/ min -2000 m/min. Wire temperature calculation model for wet wire drawing process was used and appropriate pass schedule was also considered. Finally, the final drawing speed was doubled with respect to current drawing process.

Prakash Gawali et al, (2012) "Effect of high-speed drawing on properties of high carbon steel wires"

Investigated the effect of high-speed drawing (25m/sec) on mechanical and technological properties of high carbon steel wire. Wire rod 5.50mm from steel grade 0.46% carbon and 0.71% carbon were drawn to 1.35mm in 13 draws and two speeds 8m/sec and 25m/sec. After each draw the following properties were determined; tensile strength (Ts), temperature (T), number of twists (Nt), number of bends (Nb). A large drop in the number of has been observed for final wires because of increased draw speed. However, there is also an advantage as the wire surface is much smoother after drawing at high speed than at low speed. The results were practically and statistically estimated.

Wiewiorowska et al, (2015) published "The Experimental and Numerical Analysis of Trip Steel Wire Drawing Processes Drawn with Different Partial Reductions"

Evaluated the experimental and numerical analysis of the trip steel wire drawing process drawn with different partial reduction. In this study numerical analysis of drawing process with use of 2D programme, for steel wire made from trip steel with 0.29% had been shown in work. The change in strain value of redundant strain determined for particular draws in dependence of used single partial reduction. The change in strain intensity and redundant strain value of partial reduction determined from the theoretical analysis of multistage drawing process.

B.Y. Lee et al, (2000) published "Cutting-parameter selection for maximizing production rate or minimizing production cost in multistage turning operations"

Evaluated drawing parameters selection for maximizing production rate or minimizing production cost in multistage drawing process. This paper investigated about drawing parameter for maximum production rate or minimum production cost in multistage wire drawing process. A polynomial network constructed to develop relationship between parameter such as speed and wire drawing performance such as applied force, die angle etc.

M.Suliga, (2015) published "Analysis of high-speed wire drawing process of high carbon steel wire under hydro dynamically lubrication conditions"

Analyzed the high-speed wire drawing process of high carbon steel wire under hydrodynamics lubrication conditions. In this paper, analysis of wire drawing process was done in hydrodynamic dies. The drawing process of wire diameter of 5.5mm wire rod to final wire of diameter 1.5mm conducted in 12 passes. Drawing speed was 5-25m/s. The topography of wire surface investigated amount of lubrication on the wire and pressure of lubricant in hydrodynamic dies. The industrial trial of high-speed drawing process of high carbon steel showed that multi sodium lubricant improved the lubricating conditions significantly

3. Methodology

3.1. Materials required

Table 1 Materials Required

Sr. No	Materials
1	Dies
2	Gears
3	Bearing
4	V-Belt pulley
5	V-Belt
6	Electric motor
7	Pump

3.1.1. Dies

Four regions of the die can be distinguished:(1) entry, (2) approach angle, (3) bearing surface, and (4) back relief. The entry region is usually a bell-shaped mouth that does not contact the work. Its purpose is to funnel the lubricant into the die and prevent scoring of work and die surfaces.

The approach is where the drawing process occurs. It is cone-shaped with an angle normally ranging from about 6 to 20degrees.

3.1.2. Gears

Gears are used to transfer motion and torque between machine components in mechanical devices. Depending on the design and construction of the gear pair employed, gears can change the direction of movement and/or increase the output speed or torque.

3.1.3. Bearing

A bearing is machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

3.1.4. V-Belt pulley

V-belt pulleys (also called vee belt sheaves) are devices which transmit power between axles by the use of a v-belt, a mechanical linkage with a trapezoidal cross-section. Together these devices offer a high-speed power transmission solution that is resistant to slipping and misalignment.

3.1.5. V-Belt

V-belts are belts with a trapezoidal cross-section. Like other types of belts, they are used to transmit power or torque from the driving component to the driven component.

3.1.6. Electric Motor

An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft. An electric generator is mechanically identical to an electric motor, but operates with a reversed flow of power, converting mechanical energy into electrical energy.

3.1.7. Pump

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into hydraulic energy. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.

3.2. Methods

3.2.1. Hydrostatic wire drawing

It is now well established and is practically suitable for brittle materials and composites. In hydrostatic Extrusion, it is not necessary that the billet be straight or cylindrical and it need not have a constant cross-sectional area along its entire length.

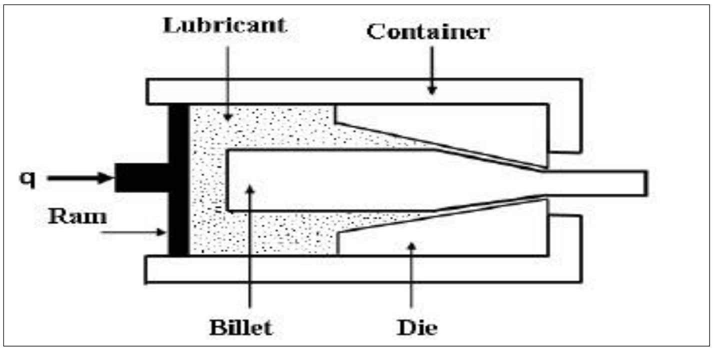

Figure 2 Hydrostatic Wire Drawing

3.2.2. Bundle wire drawing

Although very fine wire can be produced by drawing, the cost be high. One method employed to increase productivity is to draw many wires simultaneously as a bundle. Bundle drawing produces wires that are somewhat polygonal, rather than round, in cross-section. In addition to producing continuous length, technique have been developed to produce fine wire that is chopped into various sizes and shapes.

Figure 3 Bundle Wire Drawing

3.2.3. Tandem wire drawing

It is clear that for fine wear, (10mm dia), the drawing involves passage through several dies in series, especially for copper wire, which is very ductile. This is called multistage or tandem or continuous wire drawing. The wire is passage through several dies.

Figure 4 Tandem Wire Drawing

3.2.4. Working of wire drawing machine

The wire drawing process is quite simple in concept. The wire is prepared by shrinking the beginning of it, by hammering, filing, rolling or swaging, so that it will fit through the die; the wire is then pulled through the die. As the wire is pulled through the die, its volume remains the same, so as the diameter decreases, the length increases. Usually, the wire will require more than one draw, through successively smaller dies, to reach the desired size. The American wire gauge scale is based on this. This can be done on a small scale with a draw plate, or on a large commercial scale using automated machinery. The process of wire drawing changes material properties due to cold working.

The area reduction in small wires is generally 15–25% and in larger wires is 20–45%. The exact die sequence for a particular job is a function of area reduction, input wire size and output wire size. As the area reduction changes, so does the die sequence.

Very fine wires are usually drawn in bundles. In a bundle, the wires are separated by a metal with similar properties, but with lower chemical resistance so that it can be removed after drawing. If the reduction in area is greater than 50%, the process may require an intermediate step of annealing before it can be redrawn.

Commercial wire drawing usually starts with a coil of hot rolled 9 mm (0.35 in) diameter wire. The surface is first treated to remove scales. It is then fed into a wire drawing machine which may have one or more blocks in series.

Single block wire drawing machines include means for holding the dies accurately in position and for drawing the wire steadily through the holes. The usual design consists of a cast-iron bench or table having a bracket standing up to hold the die, and a vertical drum which rotates and by coiling the wire around its surface pulls it through the die, the coil of wire being stored upon another drum or "swift" which lies behind the die and reels off the wire as fast as required. The wire drum or "block" is provided with means for rapidly coupling or uncoupling it to its vertical shaft, so that the motion of the wire may be stopped or started instantly. The block is also tapered, so that the coil of wire may be easily slipped off upwards when finished. Before the wire can be attached to the block, a sufficient length of it must be pulled through the die; this is affected by a pair of gripping pincers on the end of a chain which is wound around a revolving drum, so drawing the wire until enough can be coiled two or three times on the block, where the end is secured by a small screw clamp or vice. When the wire is on the block, it is set in motion and the wire is drawn steadily through the die; it is very important that the block rotates evenly and that it runs true and pulls the wire at a constant velocity, otherwise "snatching" occurs which will weaken or even break the wire. The speeds at which wire is drawn vary greatly, according to the material and the amount of reduction.

Machines with continuous blocks differ from single block machines by having a series of dies through which the wire is drawn in a continuous fashion. Due to the elongation and slips, the speed of the wire changes after each successive redraw. This increased speed is accommodated by having a different rotation speed for each block. One of these machines may contain 3 to 12 dies the operation of threading the wire through all the dies and around the blocks is termed "stringing-up". The arrangements for lubrication include a pump which floods the dies, and in many cases also the bottom portions of the blocks run in lubricant.

Often intermediate anneals are required to counter the effects of cold working, and to allow further drawing. A final anneal may also be used on the finished product to maximize ductility and electrical conductivity.

While round cross-sections dominate most drawing processes, non-circular cross-sections are drawn. They are usually drawn when the cross-section is small and quantities are too low to justify rolling. In these processes, a block or Turk's-head machine are used.

4. Results and discussion

According to the standard, die numbers of wire drawing machine. We drawn the silver wire of three samples from the dies. The values of length and diameter of the silver wire are listed below.

4.1. Observation table

Initially, we had taken silver wire of length 31inches and the diameter of the wire was 1mm. The silver wire test of three samples was carried out by a wire drawing machine and the results are included in the following table.

Table 2 Variation of Diameter and Length of Silver wire in Different Dies

S.NO	Standard Die Number	Diameter of Wire (mm)			Length of Wire [inch]		
		Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
1	21	0.92	0.92	0.91	36	36	37
2	22	0.88	0.87	0.86	47	48	48
3	23	0.81	0.82	0.80	58	57	58
4	24	0.77	0.76	0.75	69	70	70
5	25	0.72	0.70	0.70	73	82	83

4.2. Graph

4.2.1. Die Numbers vs Length

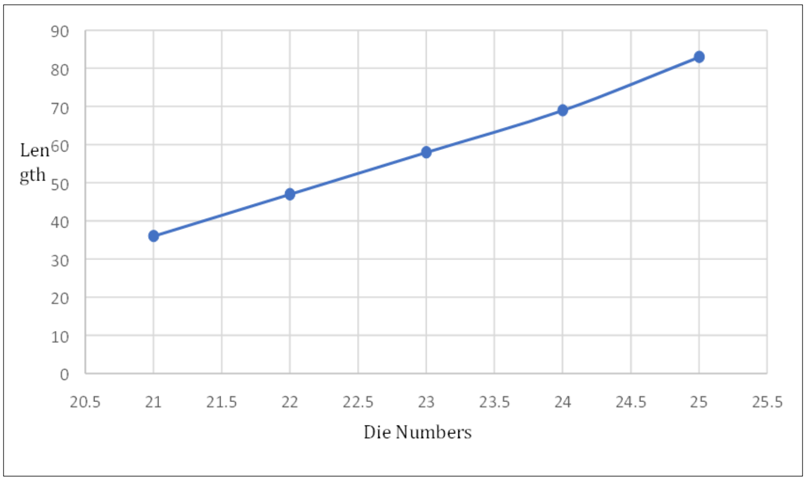

Figure 5 Graph, Die Numbers vs Length for sample 1

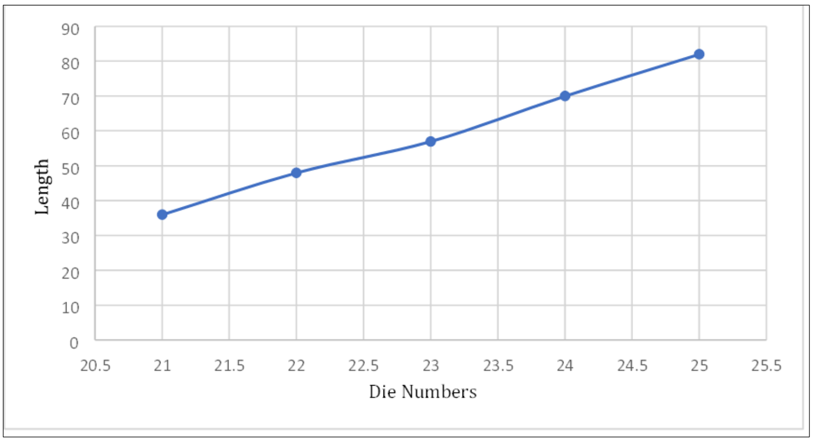

Figure 6 Graph, Die Numbers vs Length for sample 2

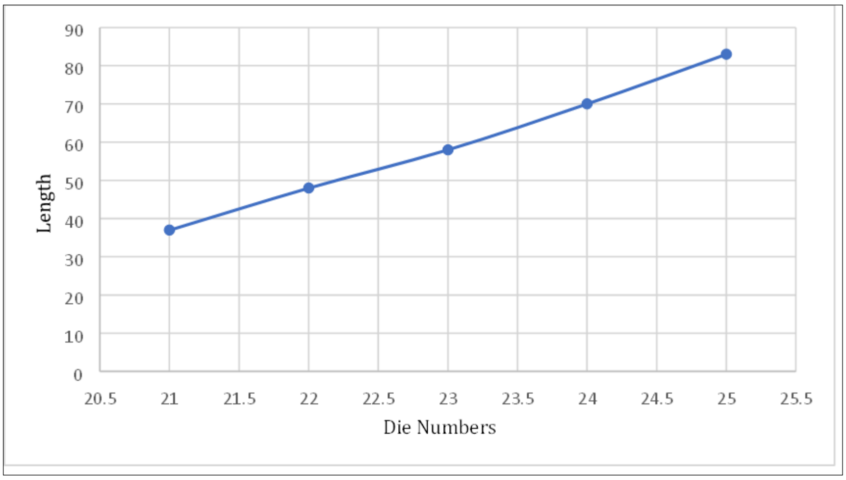

Figure 7 Graph, Die Numbers vs Length for sample **3**

The figures 5, 6 and 7 shows the graphs of silver wire tested samples showing the variation of length with die numbers is increasing in order.

4.2.2. Die Numbers vs Diameter

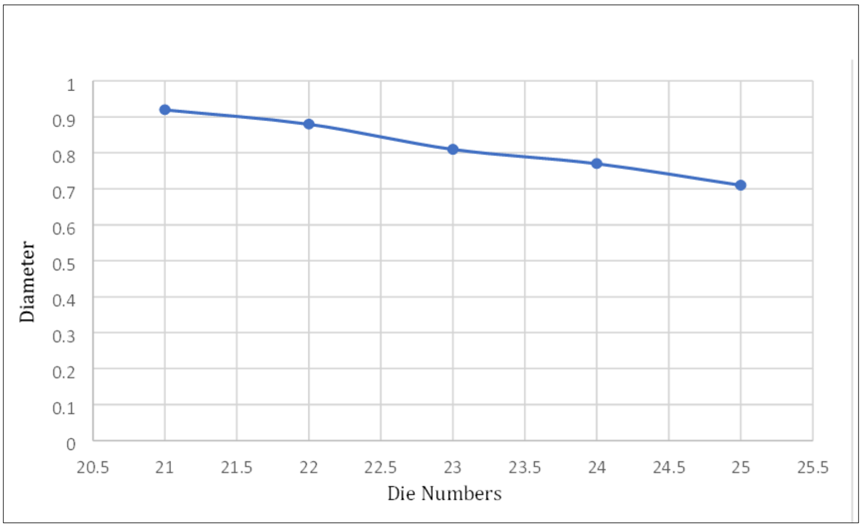

Figure 8 Graph, Die Numbers vs Diameter for Sample 1

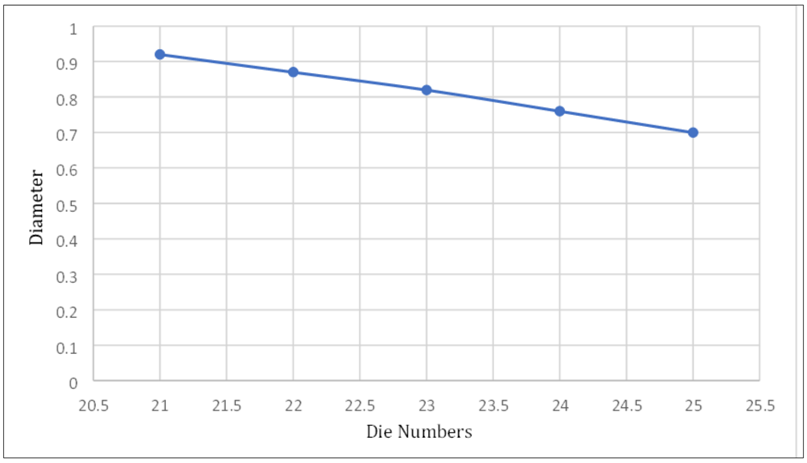

Figure 9 Graph, Die Numbers vs Diameter for Sample 2

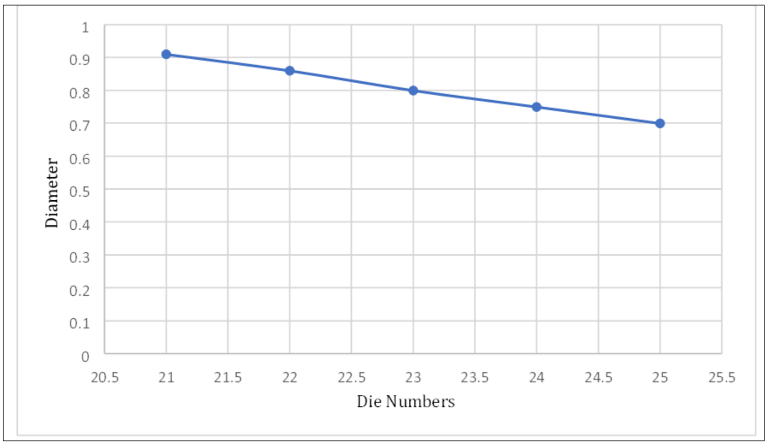

Figure 10 Graph, Die Numbers vs Diameter for Sample 3

The figures 8, 9 and 10 shows the graphs of silver wire tested samples showing the variation of diameter with die numbers is decreasing in order. The average value of diameter is 0.812mm.

4.2.3. Length vs Diameter

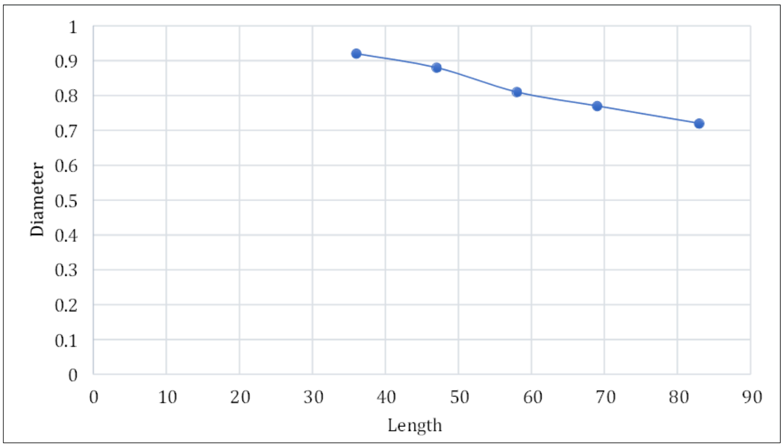

Figure 11 Graph, Length vs Diameter for sample 1

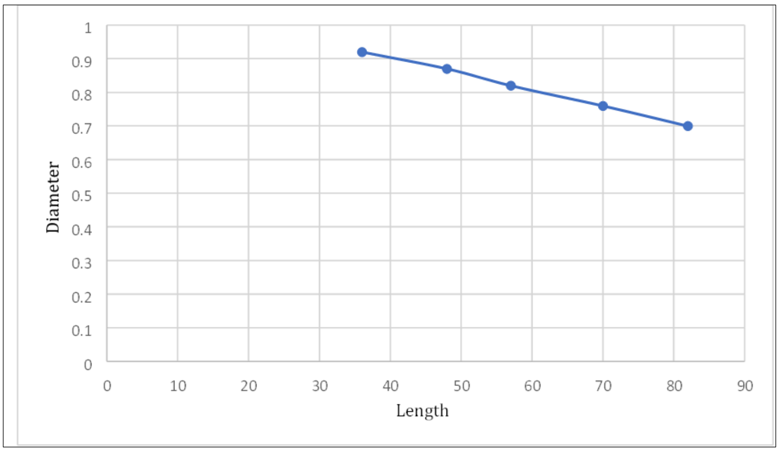

Figure 12 Graph, Length vs Diameter for sample 2

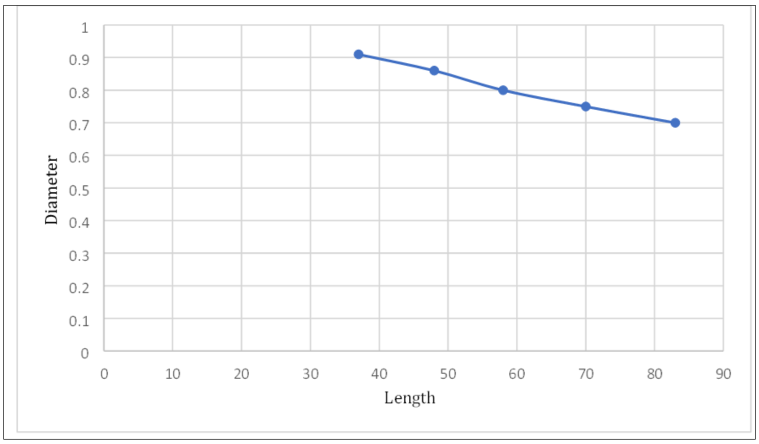

Figure 13 Graph, Length vs Diameter for sample 3

The figures 11, 12 and 13 shows the graphs of silver wire tested samples showing the diameter with length. While length increasing and diameter decreasing of the silver wire.

5. Conclusion

The experimental studies and the detailed discussion of the results obtained on the fabrication of a wire drawing machine have been presented in the earlier chapters. From the results reported in those chapters and the discussions made have yielded the following conclusions:

The wire drawing machine was successfully fabricated and the working of wire drawing machines the same as the earlier wire drawing machine but the machine's construction was different. Here we replaced the components for reducing the weight and cost of the machines.

Silver wire sample is tested by using this wire drawing machine and it shows the better results and now we are using this machine for drawing the wires for making the silver jewelry ornaments.

Compliance with ethical standards

Acknowledgments

This is an acknowledge of the intensive drive and technical competence of many individuals who have contributed to the success of our project.

We would like to express our sincere thanks to our CEO, Mr. Shravan Boyapati and the principal, Dr.G. Durga Sukumar and management for giving us an opportunity to carry out the project in college workshop.

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We, immensely thankful to our Guide Ms P. Madhavi, Assistant Professor, Department of Mechanical Engineering, for her valuable guidance and suggestions in each and every stage of this work, which helped us in completing this project work successfully.

We are thankful to one and all, who co-operated with us to complete our project successfully.

Disclosure of conflict of interest

- I am Nihal kumar Dasoju, When I was helping my father in a nihal jewellery shop on corona pandemic and I seen my father of he is working very hard with hands to reduces the diameter of silver wire. Then I decided, why don't I reduce his efforts? And I have started research on wire diameter reducing process mechanisms. After some days, I saw some wire drawing machines in a market. But, the cost of wire drawing machines on the market is more than 2 lakhs. And I see those machines and though that simplifying the mechanism and reducing the cost. Then I discussed with my project team mates. I requested them to do this project and they also accepted. In this project we used wooden rollers instead of steel rollers? For reducing the cost.
- I am Prashanth Gante. I suggest a gear mechanism for reducing the speed of rollers without a gear box mechanism. We were designed with 3 simple gears we designed and we used 20,25 and 30-number teethes gear. So that the 1440rpm speed motor will reduce the 200rpm final speed.
- I am Mahesh Kodisela, I assemble pulleys of 12 inches and 2 inches. After college we will work late nights to complete a machine. We re-designed the body for a better mechanism. Me and Sandeep went to Raniganj to bring gear, motors and body materials.
- I am Sandeep Nelakurthi, Sai Sampath Chary Rameshwaram, Ranadeer Nallapu and Gowlikar Vamshi Raj . We did documentation and ppt for the final report and my project guide Ms P. Madhavi Assistant Professor helps us to complete documentation of my project.

References

[1] T.-S. Cao, C Vachey, P. Montmitonnet, P.-O Bouchard, "Comparison of reduction ability between multistage cold drawing and rolling of stainless-steel wire –Experimental and numerical investigations of damage", Journal of material processing technology, Vol.217, 2015, pp.30-47.

[2] PrakashGawali, Amiteshpaul, G. R. Selokar, "Effect of high-speed drawing on properties of high carbon steel wires", International journal of Modern Engineering Research, Vol.2, Issue.2, pp.209-214, 2012.

[3] Wiewiorowska, Sylwia and Zbigniew Mikulski, "The Experimental and Numerical Analysis of Trip Steel Wire Drawing Processes Drawn with Different Partial Reductions", International Journal of chemical, molecular, nuclear, materials and metallurgical engineering, Vol. 9.12, 2015, pp.1349-1352.

[4] B.Y. Lee and Y. S. Tarng, "Cutting-parameter selection for maximizing production rate or minimizing production cost in multistage turning operations", Journal of materials processing technology, Vol. 105.1, 2000: pp.61-66.

[5] M.Suliga, "Analysis of high-speed wire drawing process of high carbon steel wire under hydro dynamically lubrication conditions", Archives of metallurgy and materials, Vol.60, 2015, pp.66-70.