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Research paper

Design and Simulation of Automated Swaging Machine

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Abstract

One of the major time consuming factor on calculating the machine time for the job is loading and unloading. By decreasing the time taken during the loading and unloading of the job, play a significant role in increasing the production of the company. In the proposed study, the swaging machine is automated by means of simple but effective mechanism. The mechanism involves from lifting of the job from its initial position to the top of the slope with the help of slider operated by the pneumatic piston .Then, it is carried to the designated position in the work holding device with the help of controlled gravitational force by belt operated profile. The feeder attached to the swaging machine feed the job and bring back the job, back to the work holding device form there, it is carried to the unloading area by hooks attached belt conveyor. Position sensor is used to sense the position of the job and feed it as an input to operate the other Mechanisms. This work is a cyclic process which converts the swaging machine automated and work continuously. By this proposed work, the production increase, dependency on the reduction of man power, working hours of the swaging machine is increased.

Keywords: *Hydraulic lifter, Timer sensor, Motor, Belt conveyor.*

1. Introduction

One of the biggest factors consider, when calculating the machine time for a specified machine is time taken during the loading and unloading of a job. It affects the production in the company. By reducing the loading and unloading time, the production increases. Automating the machine is the one of ways to reduce the machine time. It also decreases the dependency on the worker for loading and unloading of the job in the machine. It is the biggest challenge faced by many major manufacturing industries. The proposed project helps to automate the rotary swaging machine and to achieve the best possible outcome with considering the economic factors and other safety factors.

1.1. Rotary Swaging Machine

Swaging is a forging process in which the dimensions of an item are altered using dies into which the item is forced. As a general manufacturing process swaging may be broken into two categories. The first category of swaging involves extrusion of the work piece, forcing it through a confining die to reduce its diameter.
The second category involves two or more dies used to hammer a round work piece into a smaller diameter. This process is usually called "ROTARY SWAGING".

It's an effective process comparing other process in terms of cost and job chemical property.
The fast development of manufacturing industry, rotary swaging technology is applied more and more widely in automobile, aviation and aerospace industries, due to its advantages such as saving materials, reducing lead time and improving product quality. Rotary swaging technology is mainly used to fabricate tubes, rods or act as pre-processing of other process.
For instance, it can conduct necking of the tube ends before tube hydro forming process and internal gear machining process.
According to the swaging method and presence of mandrel, rotary swaging process of tubes includes four categories, and metal flow and stress state of those four kinds of method are investigated.

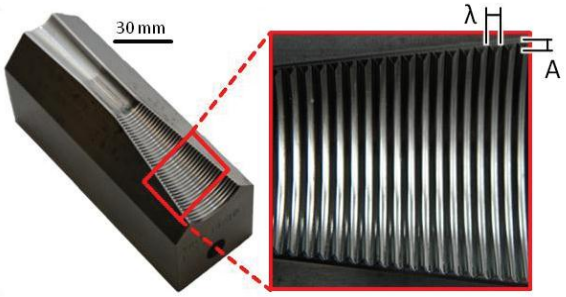


Fig.1: Die segment

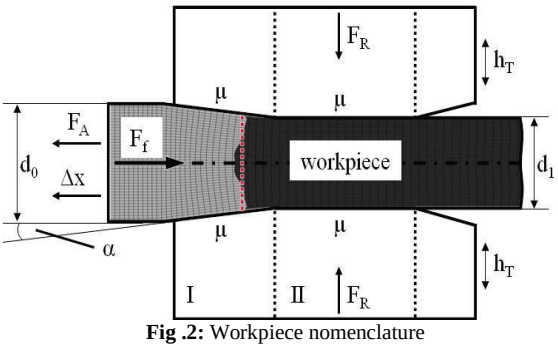


Fig .2: Workpiece nomenclature

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α	°	tool angle
μ	-	coefficient of friction
d_0	mm	initial diameter
d_1	mm	final diameter
F_A	N	axial reaction force
F_f	N	feed force
F_R	N	radial force
h_T	mm	tool stroke
Δx	mm	tracking error
I	-	reduction zone
II	-	calibration zone

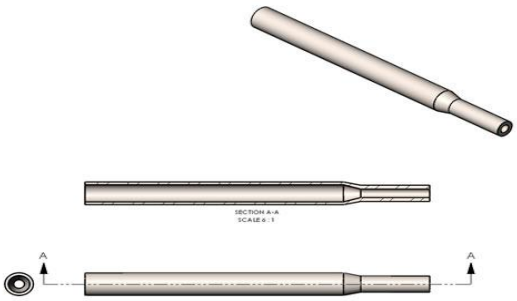


Fig.3: Work piece

2. Existing Methods:

2.1 Robotic Arm:

A robotic arm is the is a type of mechanical arm, usually programmable, with similar Functions to a human Arm, The arm may be the sum total of the Mechanical or May be part of a more complex Robot.

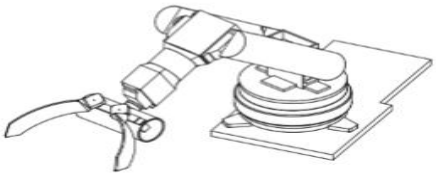


Fig .4: Robotic arm

2.1.2 Five Degrees of Freedom:

Serial and parallel manipulator systems are generally designed to position an end effector with five degrees of freedom, consisting of three in translation and tow in orientation. This provides a direct relationship between actuator positions and the configuration of the manipulator.

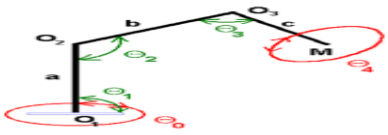


Fig .5: Degrees of freedom

2.2 Manual Loading and Unloading:

It is the process of loading and unloading the job in the machine by the use of man power. A manual machining process is one of the First methods to do machining .While Doing Manual machining The Labour Work is high and also labour cost is high.
Dis advantages:

- Mass production is less
- Labour cost is high
- Production time is high

3. Proposed Method:

The proposed project helps to automate the rotary swaging machine from the existing method of loading and unloading the job by manual method. This helps in the increase the production, reduce the dependency on the worker and many other improvements in the machine. Some of the major consideration in this project is manufacturing cost of the project, complexity of parts, flexibility of assembling the parts.

3.1 Parts Used to Automate the Rotary Swaging Machine:

List of parts used to automate the rotary swaging machine are mentioned below

- Storage box
- Loading Section
  - Slider
  - Supporting beams
  - Pneumatic actuator
- Position sensor
- Slope
  - Spur Gear
  - Profile
  - DC stepper motor
  - Belt
- Work holding Device
- Unloading Section

3.1.1 Storage Box:

It consists of both loading & unloading storage box. The tubes are placed in this area before & after the forming process. The tubes from the storage box slides to the slider at the end of the box by gravitational force.

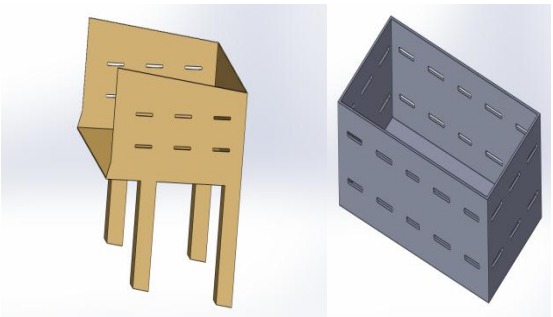


Fig.6: Loading & Unloading storage box

3.1.2 Loading Section:

Loading section comprises of Slider, Supporting beam, Pneumatic actuator.

3.1.2 A Slider:

It is used for carrying the tubes to the top of the supporting beam and to the beginning of the slope it is lifted by the pneumatic actuator. It has slopes in it to carry more than one tube in a row manner for performing cyclic process.

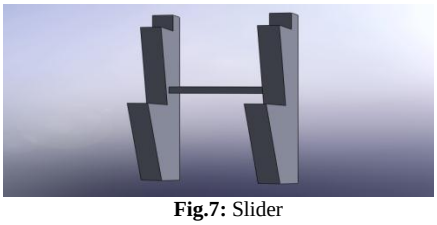


Fig.7: Slider

3.1.2b Supporting Beam:

It is used to support the slider and slope in the loading section. It is also used to reduce the vibration coming from the rotary swaging machine.

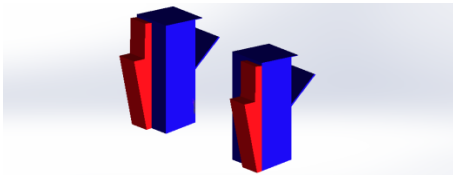


Fig.8: Supporting Beam

3.1.2c Pneumatic Actuator:

It is used to lift the slider to carry the tube. It has both push & Pull movements. The max pressure applied over pneumatic actuator is 2 bar considering the safety factors.

3.1.3 Position Sensor:

It is used to sense the displacement position of the tube and sent the feedback to other parts and this feedback is taken as a input to the other part to act synchronously with each other.

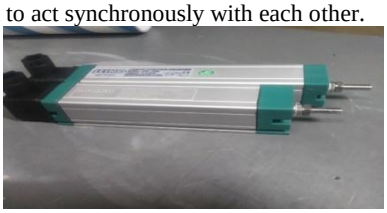


Fig.9: Position sensor

3.1.4 Slope:

The slope is used to move the tubes from the top of the supporting beam to the work holing device. It is placed over the supporting beam with some inclination. In the slope the tube slides by the gravitational force produced by the design of the slope and the movement is controlled by the belt operated profile. It has a guide way attached to it to maintain the tube in the desirer path. It is designed in the certain manner that minimum four numbers are constantly stayed over the slope to carry over the cyclic process without any intrusion.

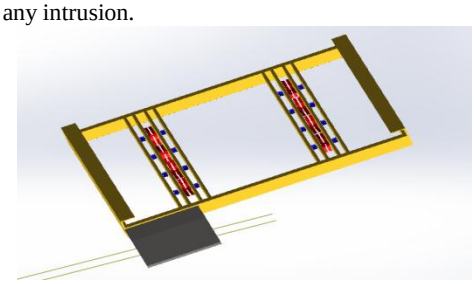


Fig.10: Slope

3.1.4 A Spur Gear

The spur gear is used to convert the power from shaft into a rotary motion and to drive the attached profile in shaft. Spur gear is preferred over the other because it has limited slip angle.

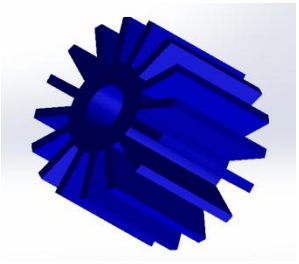


Fig.11: Spur gear

3.1.4 B Profile:

It is a type of specially designed plate attached to the shaft of the spur gear. It is designed in a manner that it is used to control the movement of the tube by arresting and withholding it over the slope. It also moves the tube in the slope after getting the feedback from the sensor.



Fig.12: Profile

3.1.4 C DC Stepper Motor:

The Dc stepper motor is used is drive the shaft attached with the gear and profile. It provides the necessary rotary motion to control the motion of the tubes over the slope. The Dc stepper motor is been used has it has its own advantage comparing the other type of motor.

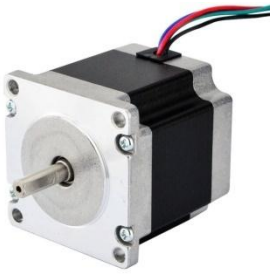


Fig.13: DC stepper motor

3.1.4 D Belt:

The belt is used to transmit the rotary motion from one gear to the other and helps to maintain rotation of all the profile in synchronous manner.



Fig.14: Belt

3.1.5 Workholding Device:

The main role of it to hold the tube from the slope and to position the tube in the desired position according to the feeder in the rota-

ry swaging machine. After the completion of the forming process the feeder places the tube again in the work holding device. It is operated by the means of pneumatic actuators. Senor feedback is sent as an input to operate the actuators.

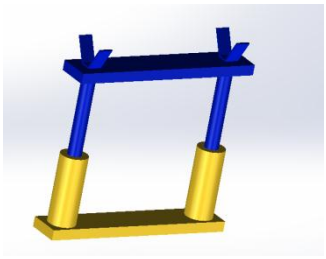


Fig.15: Workholding device

3.1.6 Unloading Section:

Unloading section comprises of Hooks attached with belt conveyor. The conveyor is to handle the job after forming process from the work holding device to the storage box. The hooks attached with belt conveyor are used to lift and arrest the free motion of the tube from work holding device and over the conveyor. It is operated by the means of DC motor feedback from the sensor is used to operate the DC motor.

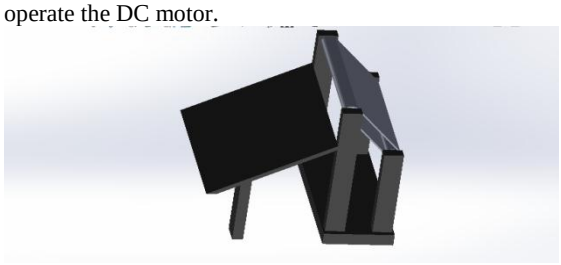


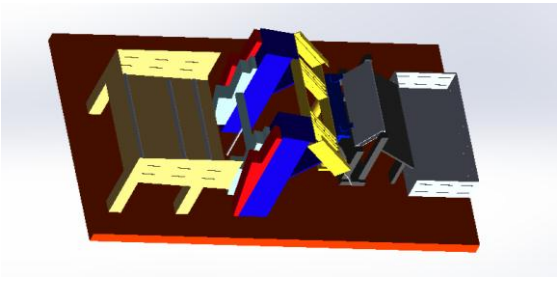
Fig.16: Unloading section

4. Working Principle:

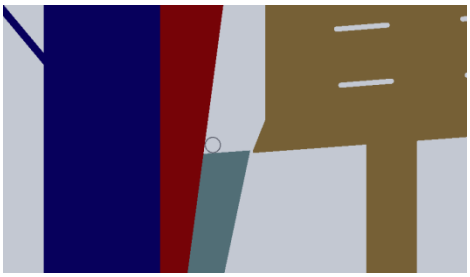
Stage -1
The tubes is been loaded in the loading storage box.
Stage -2
From the loading storage box a single tube is been carried over to slider initial position with help of gravitational force produced by the slope arrangement within the storage box.
Stage-3
The position sensor senses the position of the tube and sent the feedback to the pneumatic actuators to operate and constantly senses the displacement of the tube.
Stage - 4
The pneumatic actuators push the slider moves the tube from the initial stage to the second stage in the slider position. In this stage the tube is been rolled over to the side supporting beam.
Stage -5
At this stage the slider moves down and goes back to the initial position and stage-1 to stage-4 is performed. At the same time the tube in the side supporting beam is carried by the top of the slider to the staring position of the slope.
Stage -6
Tubes are now placed at the starting position of the slope. From there it slides over the slope by the means of gravitational force.
Stage –7
The motion of the tube is been controlled over the slope by the profile. The sensor sense the displacement of the tube in the slope and it give the feedback, according to the position the DC stepper motor rotates and shaft attached with the gear and profile will also rotate. Profile surface control the movement of the tubes over the slope.
Stage -8
The rotation of spur gear at the top of the slope is carried to other gear with the help of the belt attached to it.
Stage – 9
The job is finally pushed over to the end of the slope by the profile. From there the tube slides over the small sliding member.
Stage – 10
At this stage the pneumatic actuators in the work holding device is activated and the work holding device is lifted upwards.
Stage – 11
In this stage the job is rolled over to the work holding device. After that the pneumatic in the device get activated and it pulls down the work holding device. At this stage the tube is place in-between the jaws of the feeder.
Stage – 12
In this stage the feeder closes the jaws along with the tube in it. It moves in forward direction inside the rotary swaging machine to perform the swaging operation. Inside the machine the tube is plastically deformed by the continuous hammering on the tube.
Stage – 13
After the forming process the feeder moves in the reverse direction to its initial position along with the tube. And the jaw of the feeder is opened. The stage 10 and stage 11 is performed. Now the job is in the work holding device.
Stage – 14
The sensor senses the displacement position of the tube. The feedback is sent to all the actuator and motors. At this stage the Dc motor attached with the belt conveyor is operated and the hook in the conveyor is positioned in manner the tube is hook.
Stage – 15
The hook then moves with the conveyor carry over the finished job to the unloading storage box.
Stage – 16
In this stage the stage-5 to 15 is been performed. And after completion of one successful forming process of the tube staring from the loading storage box to a finished product at the unloading storage box, the next tube is carried by the other parts as a cyclic manner and continuously to automate the rotary swaging process.

5. Simulation:

Simulation of tube displacement from the initial stage to the processed final stage is shown below:



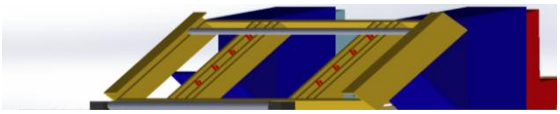
In this stage the tubes are been loaded in the loading storage box



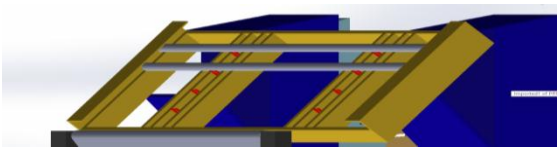
In this stage the position sensor sense the position of the tube and operate the pneumatic cylinder. It lift the slider which in turn lift the tube along with it.



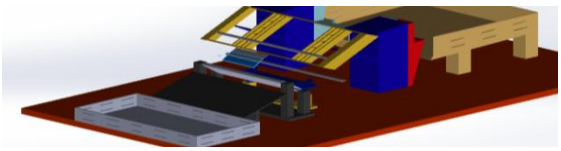
Pneumatic cylinders are activated at this stage and the tube at the top of the slider is pushed to the top of slope.



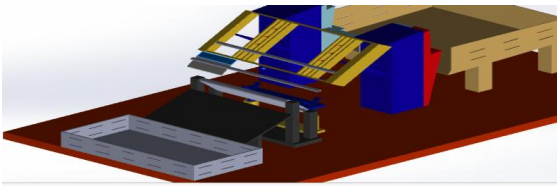
The tube slides over the slope by the gravitation force. The sliding of tube over the slope is controlled by the profile operated by the stepper motor.



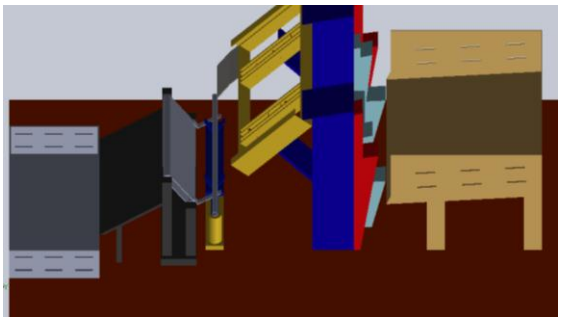
The position sensor sense the displacement and it give gives power to the stepper motor which rotates the profile to move the tube over the slope .



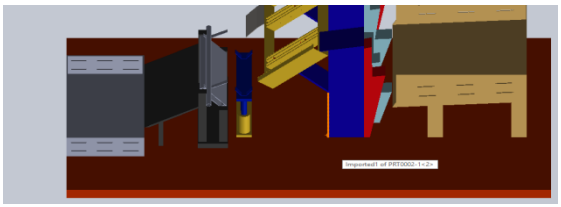
The feeder moves the work piece along its direction into the rotary swaging machine to perform the swaging operation.



After the completion of the forming process in the tube the feed pulls back the tube to its initial position and the work holding device moves upward to hold the tube and the it move down ward after receiving the tube.



After this the position the tube is been carried over to the unloading storage box by the mean s of belt attached conveyor operated by the dc motor.



The hook lifts the tube to the unloading area and drops the tube in the storage box.

6. Calculations

1. Pneumatic calculation:
Diameter of piston = 100mmForce = 500N
Safety Factor = Force / Pressure
= 500 / 29.0075 = 4
2. Workpiece:
Before Swaging:
Job Diameter = 32 mm
Job length = 950mm
After swaging:
Job diameter= 25.97 mm
Job length = 950 mm

7. Conclusion:

From the proposed project, the rotary swaging is automated by the concept of simple mechanism. With the help of this project the automated machine can reduce the time needed for loading and unloading of job in the machine. This increase the production time of the machine and also it help the machine to operate continuously. There are many other major advantage in automating the machine including reducing the dependency on the worker for loading and unloading of the job in the machine. Thus , it is considered some major plots while designing the machine including the vibration from the machine, cost to fabricate and automate the machine, aesthetics of the machine, reliable, maintenance free or easy to maintain and environment of the working area. Based on the key consideration design and material selection of the parts are been decided. Future aspects are also considered and the machine is designed as flexible as possible of that each component can be dismantle and assemble with the upgraded rotary swaging machine and with a slight adjustment, it can be used to automate another machine. With the help of this work, the production of component by the rotary swaging machine will increase so as the benefit for the company increases.

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