International Journal of Advanced Mechanical Engineering.
ISSN 2250-3234 Volume 4, Number 4 (2014), pp. 447-452

http://www.ripublication.com/ijame.htm

Study of Automatic Pipe/ Rod Slitting Machine (Pneumatically Controlled) Sinhgad Institute of Technology and Science

Shinde Vaibhav Kailasingh, Ahiwale Anish Jahagirdar Kuldip and Sutar Onkar

Sinhagad Institute of Technology and Science, Narhe, Pune-41.

Abstract

To reduce human effort for repeatative work of cutter pieces of pipes as well as providing a convenient fixture to support and hold the pipes/rods during cutting. The subject is undertaken as a part of B.E mechanical project. It can be termed as smart machine.
To maintain a low cost automation, the pneumatic circuit is designed as compressed air supply is normally available at many workshops. The design of system is made versatile as this system can be easily adopted for various operations like drilling holes and for handling other small tools. The clamping arrangement can be varied according to need of operations suitable. Pipes are fed by rollers which are operated by air motors and direction control valves are used to control the vertical movements of rotary cutting operation. The innovative part used in this system is the use of current to pressure converter in a particular manner. The purpose of this converter is to vary the pressure in this system according to the variation of voltage given to the converter. The analog signals are converted to pressure signal. Its working is similar in terms like that of the potentiometer. The overall system is compact in size, light weight, modular and flexible to be used in small works jobs who need batch production. The setup overall configuration can be adopted by a semi skilled worker easily and can vary the operations by making certain small changes. The system even has the potential to add up a PLC system to control its overall working with ease and with less effort provided. This system has the potential to adopt higher level of automation if desired in future.

1. Introduction

The primary concern of this system is to carry out three operations Feeding, Clamping and cutting. Pneumatic system automation is future in automation system. Advantage of system is to slice the rod/pipe/cylinder with ease. The main concern is to control the pressure according to requirement. The sequenced operations of the system must be precisely timed. The major work of this system is to slice out large number of jobs in rod or pipe form according to the batch production. The arrangement of the pneumatic valves used in this system is according to the circuit designed. The selection of cutter is based on the stress calculated considering the pipe or rod material. The material preferred in this system is a PVC (polyvinyl chloride) pipe for demonstration. But mild steel rods and pipes also be worked out by using different cutters specifications.

The cutter to be used in the machine system has been considered by calculating the torque required for cutting PVC object by help of the design data available. With the help of this system the time required to slice the objects like the pipe or rod will be less .the accuracy of slicing or cutting of the material will also be improved. The system can be handled by semi skilled operators with ease. The layout of the machine is compact to be placed in a small workshops. The operator during the working of this system should only turn thee switch on/off with the pneumatic valve and collect the sliced pieces. The pressure of this system can be changed with the help of I/P(current to pressure convertor) which is an additional device used for operating the pressure difference supplied to the system. The I/p convertor can be adjusted similar to the potentiometer.

The cost of production for this machine is less than the electronic devices used for slicing the job. The whole operations carried out in this segment are controlled by air supplied by compressor.

2. Tool Geometry

2.1 Cutter Design

The cutter design is based on the calculations of the PVC pipe selected

We are considering outer diameter = 48.11mm

Shear stress =(Shear force/Shear Area)

So, Shear Force = $32.312*(\pi/4)(48.11^2-39.79^2) = 21824.89N = 21.824KN$

Which is minimum required cutting force

For our design we need that radius of cutter should be more then diameter of pipe hence we select

cutter of 5inch diameter i.e. 127mm

α=rake angle=10°

Clearance angle = 70°

Fc=22KN cutting force required

Ft, tangential force= Fc/2 = 11KN

Resultant Force, R = 24.59KN = 25KN

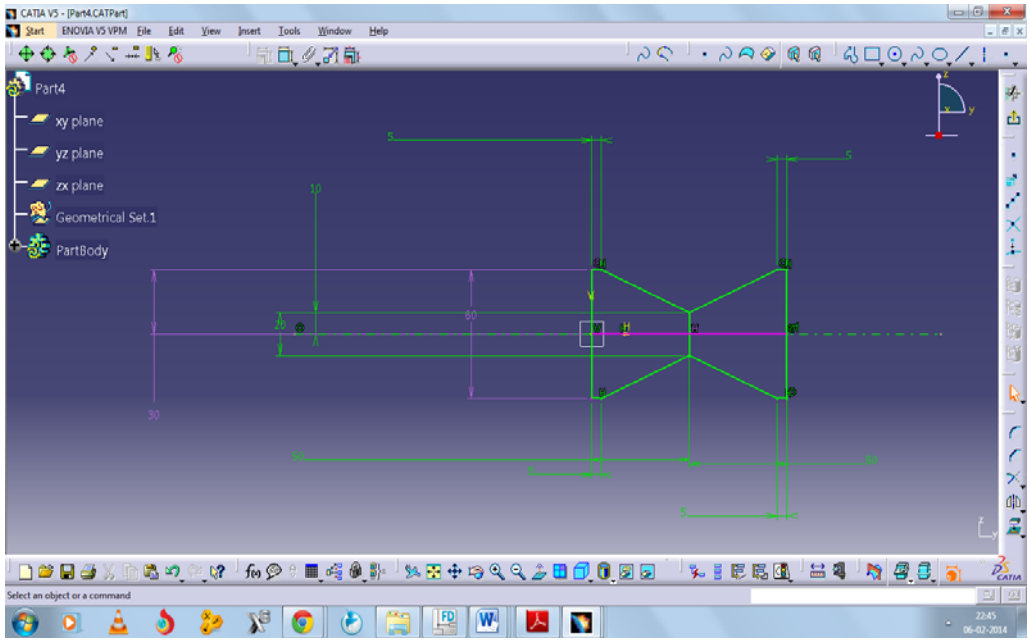
f, friction force = $Fc\sin\alpha+Ft\sin\alpha$

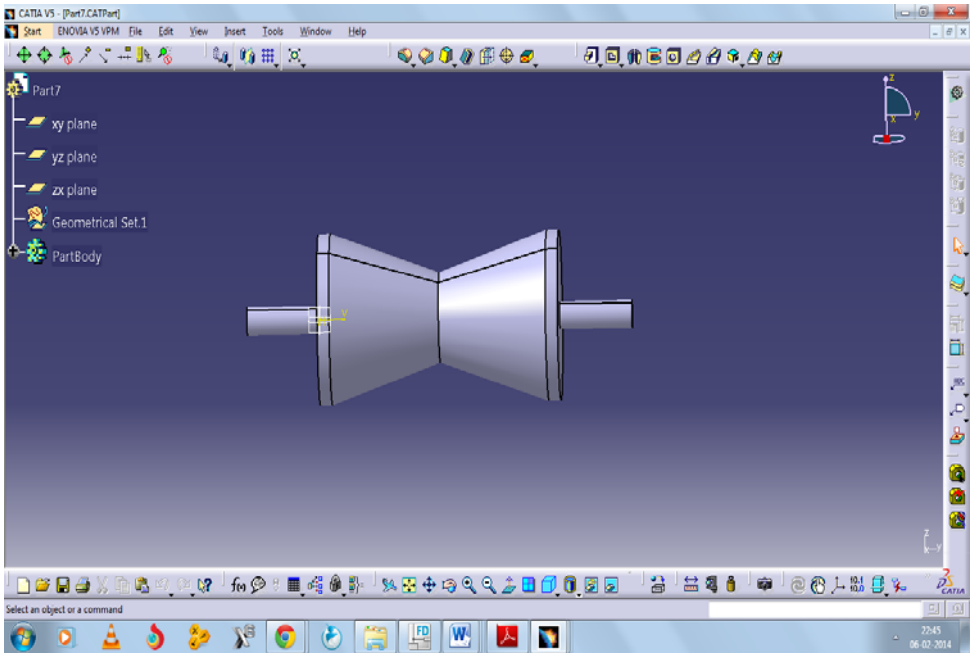
f=14.65KN

Normal force, N = Fccosα-Ftsinα
N=21.67KN;
ß= $\tan^{-1}$(14.65/19.75)=36.56°
Ø= 45-(1/2(ß-α)=13.28°
Shear force, Fs= FccosØ-FtsinØ
Fs= 18.88KN
Force perpendicular to shear plane Ns= FcsinØ-FtcosØ
Ns=5.64KN
Cutter Calculations
Power = Resultant force*Cutting speed=R*V
V=450 For plastic from data book
So P=1.8KN
P=(2πNT)/60
T=15.25Nm
We also know that V=(πDN)/1000
N= (450*1000)/(127*π)
N=1127.86rpm required for milling but for cutting operation rpm required is comparatively low

2.2 Feeding Rollers Design

The purpose of this roller is to provide a feeding mechanism to pipes with gripping of the pipe. The dimensions of the rollers are considered by selecting 1 inch diameter hollow pipe as the job to be worked. The rollers to used are designed by using the following software CATIA.





In this manner the feeder mechanism has been decided in innovation.

2.3 Bearings to Support the Rollers

The bearings which have been used to support the roller feeder are Deep grove ball type which are very easily available and are easy to assemble. Model 6502. The dimensions for the bearing are

Inner diameter: 10mm
Outer diameter: 27mm
Thickness ;8mm
The bearings here are considered according to the requirement given by the rollers.

2.4 Pneumatic Cylinder

The important part in this system is the pneumatic cylinder whose job is to displace the cutter vertically upward and downward according to the pressure provided. The selection of the cylinder based on the pressure range acquired from the forces removed for cutting the PVC material..the following are the specifications for the cylinder selected.

Bore diameter - 25mm
Stroke length - 150mm
Rod diameter - 10mm
Pressure - 5 bar

2.5 Pneumatic Motors for Feeding and Rotating Cutter

For feeding the motor used is a 250rpm which rotates the rollers clamped through bearings. The pressure required to rotate this motor is of range 3 to 5 bar can be adjusted according to production required in 1min or as per the production. The selection of motor can be varied as per individual requriements.

For cutting the motor is selected from the force and torque calculation carried out by considering the PVC material as mentioned above. The motor selected for rotating the slitter is of 450 to 600rpm. This motor selected is similar to the nut turner used for loosing or tightening of nuts and bolts . By providing the suitable clamping it can be connected to the piston rod of cylinder.

2.6 Current to Pressure Convertor

The current to pressure convertor is a device connected to the cylinder which converts current supplied in to pressure according to the adjustment provided in the voltage. Which might be low or high according to the requirement. The concept of such device used in such a system automation is new. The device to be selected is based upon the pressure provided to the system.

2.7 Direction Control Valves

The direction control valves used in this system are 5/2 lever operated lock valve and 4/2 push button spring return type of valve. This valves are selected based on the ease of operation.

2.8 Flow Control Valve

Flow control valves used in this system are variable type flow control valves. There are three number of flow control valves used.

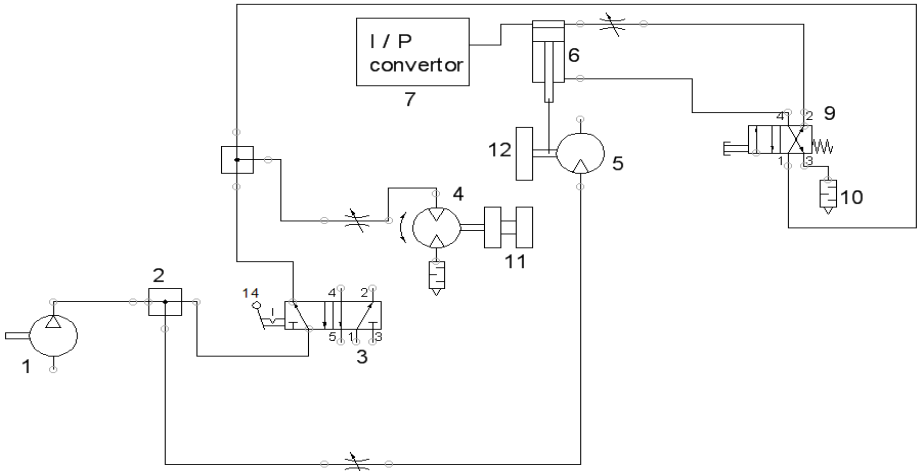
2.9 Pipes

Pipes used in this system are of varying diameters from 5mm to 10mm as per the change pressure in certain areas.

2.10 Tee Used

They are used in order to provide multiple connections.

3. Circuit Diagram for the System Operation



1)Compressor 2)Tee 3)5/2 DCV 4)Bidirectional pneumatic motor 5)Unidirectional motor 6)cylinder 7)I/P convertor 8) Flow control valve 9)4/2 DCV 10)Silencer 11)Feeder rollers 12)Cutter.

4. Acknowledgement

The research was supported by Prof.Kiran Jagtap, Prof. Nitin Gupte , Prof. Sachin Velapure from Sinhgad Institute of Technology and Science.

References

[1] Production Technology(Manufacturing process, technology and automation) by R . K. Jain, edition 17

[2] Material and Processes in manufacturing Eight Edition by E. P DeGarmo , J.T. Black and Ronald A Kohser .

[3] Pneumatic Systems principles and maintenance The McGraw-Hill By S. R. Majumdar Design Data Book of Engineers by M/s KalikakathirAchcagam 2010