DESIGN AND ANALYSIS OF PIPE BENDING MACHINE

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***Abstract* :-** This paperis aimed at manufacturing and analysis of pipe bending machine. It also describes the construction of the machine and mechanism involved. It covers various drawbacks of manually operated pipe bending machine. As bent pipes have various applications in industry it is important that the pipes should be bend at accurate angle with minimum errors. This design of machine ensures minimum errors also less time consumptions. The large advantage of machine is that it can be operated by low skilled workers.

Index Terms- *arc of pipe bend, bending, Design Fixture, Pressure, Torque.*

I. INTRODUCTION

As we know bent pipes have numerous applications in industry. They are mainly used for transportation of fluids. In some cases it is also used for supporting purpose (frame). Previously bending operation was done manually which requires lots of human efforts and accuracy was very low. The other drawbacks of manual bending machine include injuries to workers, low productivity, more time consumption etc.

The main purpose of this invention is to cover the drawbacks of manual bending machine. In some applications very high accuracy in bending angle is needed. This is not possible with the help of manual machine.

The machine works with the help of stepper motor. The main components of machine are stepper motor, reduction gearbox, PLC (programmable logic controller) and fixture. Stepper 3 PH induction motor provides input energy for operation. Reduction gearbox is usefull for the reduction of motor speed upto required speed. PLC ensures the cycle time of operation and also governs human machine interaction. Fixture plays important role in bending operation. It provides path for bending pipe and also acts as a support structure for pipe.

II. Literature Review

Aniruddha Kulkarni Et.al [1]

This paper involves information about development of power operated sheet metal bending machine. It shows the drawbacks of manual bending machines and how they are clarified in this machine. It states that the manual operation is replaced by automatic operating equipment. It

Also involves the analysis of bending machine by considering various aspects. It gives brief information about how tis machine is capable of fulfilling today's industry needs.

A. D.Zope [2]

The main objective of this paper is to design, development and analysis of metal bending machine. The machine is able to bend the sheets into curve shape. It states that the size of machine is so convenient that it can be easily transported from one place to another. The material used for production of machine is MS. Hence it is easy to carry from one place to other. It reduces human efforts and also increases accuracy. The main advantage of this machine is that it requires less skilled operators. It uses shaft, hydraulic jack, bearing and frame. It uses simple mechanism instead of complicated one. It is light weight in nature and easy to transport. It can bend up to 8 mm thickness sheet.

Akbar H Khan [3]

The main purpose of paper is development of manual operated pipe bending machine. This machine is useful to bend pipe of various thickness in workshops also use in industry. Paper provides brief information about design and construction of pipe bending machine. It ensures safety of workers. It is made of steel. It can bend pipe of different thickness into different angles. It can also bend pipe into curvature shape. It is basically manually operated bending machine. Machine requires less skilled operator. The machine uses dies, gears and frame for its operation. Pipe with 0-10 mm thickness can be bend with this machine. It reduces cost of machine as well as increases its efficiency.

III. Working

Pipe bending is a complex process. This process starts with loading of pipe into a bending machine. Then the pipe is clamped between two dies, one of the die exerts pressure and force and other die is the fix die.

When pipe is fed into the machine one die supports it and with help of mechanical force and pressure the pipe gets its shape through fixture. Buckling is one of the most dangerous problem during operation. Folding can may occur due to excess pressure. Before this invention pipe is bent with forcing it into pre-determined shape.

IV. Component of machine

1. fixture

Bending is a commonly forging operation. Simplicity process is the bending a piece of metal, is to support it on the punch and to support its free end with automatically. If bending sample is thins out then the

Fixture is commonly used for work holding purpose. It holds, supports and locates the job or work piece. It also provides a reference surface for particular operation.

In case of our pipe bending machine it supports the pipe while operation and also provides path for bending work. Bending is forging operation. Hence it is necessary to use correct fixture for the process. In this case the fixture is securely attached to base plate.

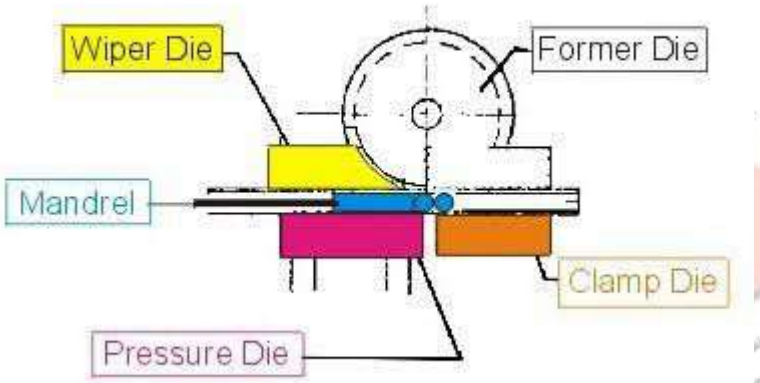

fig 1:- fixture

2. 3 PH Induction motor

The main components of induction motor are stator and rotor. A stator is provided with AC supply. After supplying AC supply to stator it creates magnetic field around it. Hence it starts rotating. Due to induction effect the rotor also starts rotating. This is how induction motor works. In this machine motor act as actuator i.e. provides required rotation for the operation.

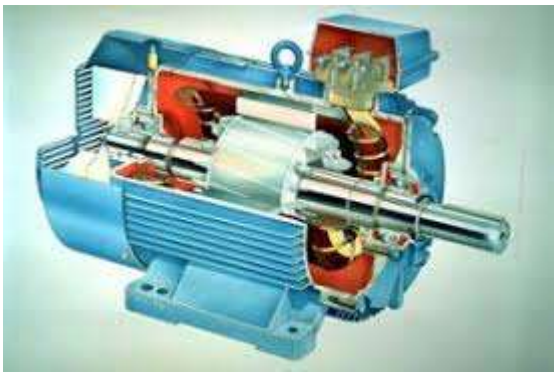

fig 2:- 3 ph induction motor

3. Reduction gearbox

A reduction gearbox is a mechanical device which is used to shift or reduce speed. Reduction drives are used in engines to increase the amount of torque per revolution of a shaft. The no of revolutions of induction motor are not suitable for operation as they are very high in numbers. This will lead to cause damage to pipes. Hence reduction gearbox is necessary to reduce rotational speed of motor.

fig 3:- reduction gearbox

4. Pulley

Pulley is mostly useful for this machine. Mainly use for the pressure and force on the tube or pipe and the die also. Pulley sizes will be changes as per requirement of drawing. One pulley is fixed for using die and other is moving use to punch as.

fig 3:- pulley

5. Assembly of Machine

This build machine more equipment are used. the forming rolling punch of tube or pipe bending is suggested for all types of bend.where the centerline radius is at the 2 to 3 times outside diameter of the tube or pipe. I had design these machine with the more quality and low cost

fig 4:- pipe bending machine

IV. Material list

Material used for pipe bending machine is listed below in the table. The material list is finalised by using research paper referred and by discussion with organisation.

Table 1:- Material list

Name of part	Material	No	Hardness	Tempering temp	Density
Base plate	Mild Steel	01	-	-	-
Die	OHNS	01	48/50 Hrc	760°c - 870° c	8670 kg/m^3
Punch	OHNS	01	48/50 Hrc	760°c - 870° c	8670 kg/m^3

V.Design calculations;-

[1] Force

Material – Mild Steel

Allowable bending stress (σ_b) =300 N/mm^2

Flexural formula

$$\frac{M}{I} = \frac{\sigma}{Y}$$

Bending moment is given by,

M=F×L

$$F = \frac{(\sigma \times \mathrm{I})}{L \times Y}$$

Where, I= Moment of inertia

Y= Distance between C.G. and base line

L= Length of pipe

$$I = \frac{\pi}{64}(D^4 - d^4)$$

D= Outer diameter =25.4 mm, t=thickness=1.4mm

d= inner diameter= 25.4-2.8= 22.6 mm

$I = \frac{\pi}{64}(D^4 - d^4)$ = 7626 mm^4

Y = $\frac{D}{2}$ = 12.7 mm

Assume length of pipe 500mm

Therefore force will be,

F= $\frac{300 \times 7626}{12.7 \times 500}$ = 360.28 N

[2] Torque:-

Power = 1.5 kw = 1500 w, N= 1440 rpm

T= $\frac{P \times 60}{2\,\pi\,N}$ = $\frac{1500 \times 60}{2\,\pi \times 1440}$ = 9.95 N m

T = $\frac{\pi}{16}$ (D3- d^3) τ

rTherefore τ = 10.46 N/mm^2

[3] Pressure:-

P= $\frac{F}{A}$ = $\frac{360.28}{\frac{\pi}{4}(D^2 - d^2)}$ = 3.41 N/mm

[4] Arc of the bending

R= 3.5d or 0.4d (where- d- is outer Dia. Of pipe)

=88.9 mm or 101.6mm

VI. Result and analysis

1] The designed machine is tested and analyzed using Ansys software. The results after analysis are given below:-

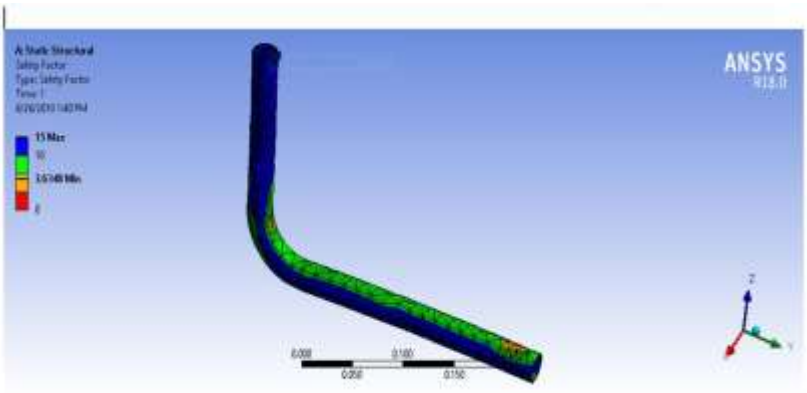

fig 1:- safety factor

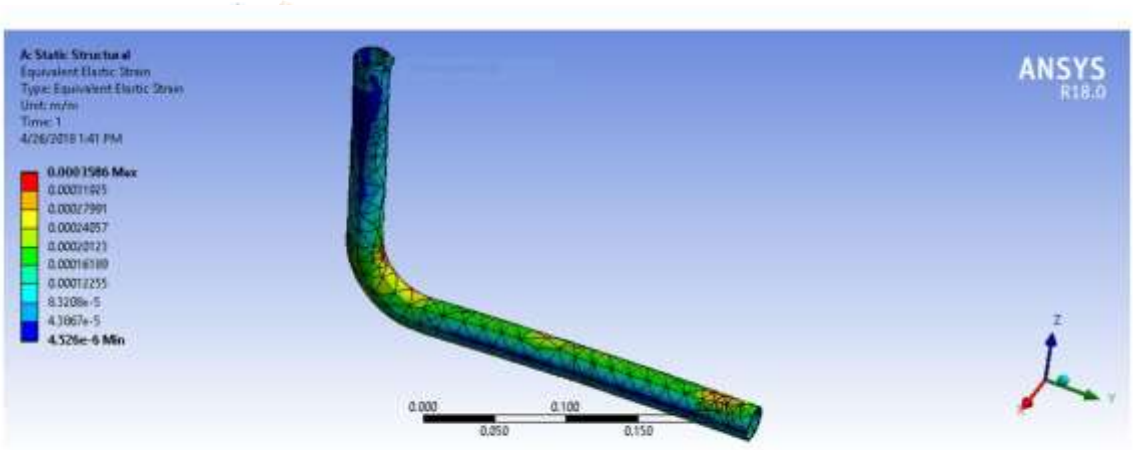

fig 02:- equivalent elastic strain

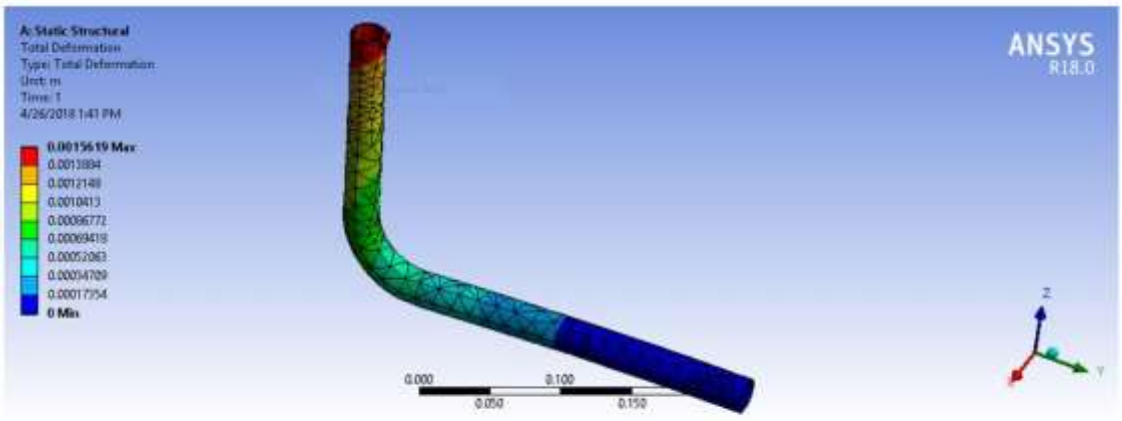

fig 03:- total deformation

2] Analysis report

Sr. No.	Name	Value	Unit
1	Compressive ultimate strength	0	Pa
2	Compressive yield strength	2.5e+008	Pa
3	Tensile yield strength	2.5e+008	Pa
4	Tensile ultimate strength	4.6e+008	Pa
4	Possion's ratio	0.3	-
5	Bulk modulus	1.6667e+011	Pa
6	Young's modulus	2.e+011	Pa
7	Shear modulus	7.6923e+010	Pa
8	Ductile coeffiecient	0.213	
9	Strength coeffiecient	9.2e+008	Pa

VII. Conclusion

Tube or pipe bending process are used in automobile, power plant and industries etc. Our bending machine is automatic an based on PLC. It can preferable for small workshop, industry holder because of the light weight and less expensive.

VIII. Acknowledgement

I would like to express my special thanks appreciation to my teacher Assi. Prof. Joshi A.V. as well as our principle Dr. Ghule C.V. who gave me the golden opportunity to do this wonderfull project on this topic Pipe Bending Machine.

IX. Reference

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