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Sheet Metal Bending System by Pneumatic Pressure

Yogesh V. Chandratre[1], Shweta P. Lokhande[2], Pankaj P. Dadhich[3], Mukund Holkar[4]
Faculties, Department of Electronics & Telecommunication[1,2,3]
Faculty of Mechanical Department[4]
Guru Gobind Singh Polytechnic, Nashik, India

Abstract: *The bending machine is most important in sheet metal industry. This machine should be used for bending machine with wide application. But in some industry hand bender are used. For that machine to operate the human effort are required. The machine should be simple to operate and easy to maintain, hence we tried out to develop the Pneumatic Bending Machine. In bending operation the bend has been made with the help of punch which exerts large force on the work clamped on the die. The bending machine is designed in such a way that, it works automatically. The machine is designed by observing the factors to improve the efficiency and to reduce the cycle time by producing quality output. Automation of machine is achieved with the help of pneumatic system controlled with Arduino. We created the design of an efficient system, which reduces the human effort, and help to increase production output. It also includes pneumatic system, pneumatic component and bending die.*

Keywords: Bending, Pneumatic Cylinder, Directional Control Valve, Solenoid Valve

I. INTRODUCTION

In industries the automatic sheet bending are widely used. Earlier the process was carried out manually. The manual process was time consuming as well as the output of machine was very less. The main aim of the project is to improve the efficiency of the required output and to increase the production with quality output. In this project we used pneumatic system, „Pneumatics", from the Greek (pneumatikos, coming from the wind) is the use of pressurized gases to do work in science and technology. Pneumatics was first documented by Hero of Alexandria in 60 A.D., but the concept had existed before then. Pneumatic devices are used in many industrial applications. Generally appropriate for applications involving less force than hydraulic applications, and typically less expensive than electric applications, most pneumatic devices are designed to use clean dry air as an energy source. The actuator then converts that compressed air into mechanical motion. Pneumatic cylinders are generally less expensive than hydraulic or electric cylinders of similar size and capacity. We have developed the system in which bending operation are carried out in one machine by changing the machine die according to the given application. In this operation the pneumatic system is installed on the frame body with required attachment. And pneumatic cylinder is placed on frame body vertically with front foot mounting. The model which have prepared to working in 85 to 100 psi (6 to 7 Bar) air pressure. And for bending we used various types of angles which can be replaced according to the output we require.

II. LITERATURE REVIEW

Sheet metal bending is one of the most widely applied sheet metal forming operations. The understanding of the bending mechanics is aimed at obtaining two kinds of information important for industrial applications. The first one is the springback prediction for die design and shape control. The second is an estimation of the bend force for selection of press capacity, strength analysis and design of dies. Here an attempt is made to review the status of literature in pneumatic based on various criteria. The work done by various authors are explained below. Vallance and Matlock (1992) studied the friction behavior of zinc-based coated sheet steels and laboratory scale friction analysis techniques that involve sheet sliding over cylindrical dies. Mai Huang and Gardeen (1994) presented a literature review of the springback of doubly curved developable sheet metal surfaces and provided a bibliography on the springback in sheet metal forming. Reviewing the literature,it is found that researchers have been studying the phenomenon of spring back for nearly six decades. There have been diverse efforts to evaluate and/or decrease spring back in the sheet metal forming industry for a long time. Pertain and Hoogenboom (1995) derived a simple explicit bending couple curvature

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relation for small and larger curvatures and they verified the model with experimental results. Sanchez (1999) focused on a systematic analysis of testing equipment as a measurement system of the friction phenomena on sheet metal under plane strain. It provides experimental references in order to optimize the usage of lubricants and sheet metal. Samuel (2000) analysed the spring back in axisymmetric Unbending processes with a finite element program and discussed the effect of tool geometry and blank holder force on the final shape after spring back. Aleksey et al (2001) conducted experiments on spring back for dual phase steel and conventional high strength steel for a hat channel section with varying cross sections. They described the methodology of experiments and discussed spring back related results. Carlos Gomes et al (2005) investigated the variation of spring back in high strength steels based on experimental and numerical analysis. Dongye Fei and Peter Hodgson (2006) investigated the spring back behavior of cold rolled transformation induced plasticity (TRIP) steels in air vending process. Se Young Kim et al (2007) examined the effect of tool design and process parameters on the spring back of GLARE and the parameters studied include punch radius, punch speed, forming load and forming temperature. In shearing or cutting operation as or blade descends upon the metal, the pressure exerted by the blade first cause the plastic deformation of the metal. Since the clearance between the two blades is very small, the plastic deformation takes place in a localized area and the metal adjacent to the cutting edges of the blade edges becomes highly stressed, which causes the fracture to start on both sides of the sheet as the deformation progresses and the sheet is

III. COMPONENTS USED

Pneumatic Cylinder :

Pneumatic cylinders (sometimes known as air cylinders) are mechanical devices, which use the power of compressed gas to produce a force in a reciprocating linear motion. In pneumatic cylinder, a compressed air is used as working fluid and converts it into kinetic energy as the air expands in an attempt to reach atmospheric pressure. This air expansion forces a piston to move in the desired direction.

The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved.Engineers prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts or space for fluid storage. Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement

Figure 1. Pneumatic Cylinder

Direction Control Valve:

The directional valve is one of the important parts of a pneumatic system. Commonly known as DCV, this valve is used to control the direction of air flow in the pneumatic system. The directional valve does this by changing the position of its internal movable parts. This valve was selected for speedy operation and to reduce the manual effort and also for the modification of the machine into automatic machine by means of using a solenoid valve. A solenoid is an electrical device that converts electrical energy into straight line motion and force. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one in which

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the plunger is pulled when the solenoid is energized. The name of the parts of the solenoid should be learned so that they can be recognized when called upon to make repairs, to do service work or to install them.

Figure 2. Directional Control Valve

Polyurethane Tube:

A pipe is a tubular section or hollow cylinder, usually but not necessarily of circular cross-section, used mainly to convey substances, which can flow liquids and gases (fluids), slurries, powders, masses of small solids. It can also be used for structural applications; hollow pipe is far stiffer per unit weight than solid members are. In common usage the words pipe and tube are usually interchangeable, but in industry and engineering, the terms are uniquely defined. Depending on the applicable standard to which it is manufactured, pipe is generally specified by a nominal diameter with a constant outside diameter (OD) and a schedule that defines the thickness. Tube is most often specified by the OD and wall thickness, but may be specified by any two of OD, inside diameter (ID), and wall thickness.

Figure 3. Polyurethane Tube

Pneumatic Compressor:

An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank.

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Bending Punch and Die:

To perform bending operation, the bending punch and die has used to perform bending operation. Bending angle is 90 and also we are developing other angles also.

Solenoid Valve:

Solenoid valves are control units which, when electrically energized or de-energized, either shut off or allow fluid flow. The actuator takes the form of an electromagnet. When energized, a magnetic field builds up which pulls a plunger or pivoted armature against the action of a spring. When de-energized, the plunger or pivoted armature is returned to its original position by the spring action.

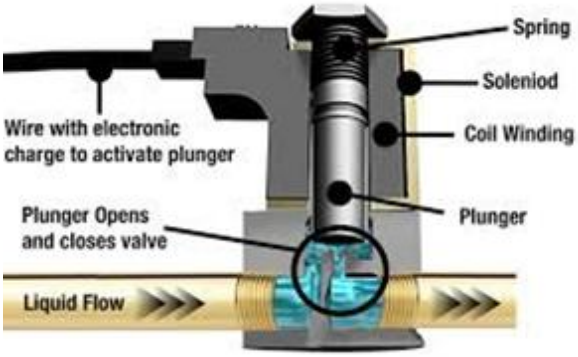

Figure 4: Solenoid Valve

IV. METHODOLOGY

Material Selection:

The frame is made up of mild steel material. Because, mild steel is readily available in market and is economical to use. It has good mechanical properties such as high ductility and high toughness. Mild steel has carbon content ranging from 0.15% to 0.25%. The ultimate strength and compressive of this steel increases with increase in the carbon content.

Sr.No.	Component Name	Material
1	Frame	Mild Steel
2	Cylinder	Alloy Steel
3	Piston Rod	Carbon Steel
4	Both Side Control Valve	Steel

Table 1: Component Material

Design:

Solid works software is used for designing and modelling.The frame design considerations are:

• Based on the length of the metal of bending used, the width of the frame is selected.

• The length of the frame is designed to make the machine compact and also to accommodate the length of the sheet metal to be bend.

Here below are two figures showing dimensions of model and isometric view of the model

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Figure 5: Actual Frame

Force Calculation:
The maximum pressure applied in the cylinder
(P) = 6 bar
Diameter of the cylinder bore (D) = 32 mm
Area of the cylinder (A) = ($\pi \times 4$) /D2
Area (A) = ($\pi \times 322$)/4 =804.2 mm^2
Therefore, Force acting on the sheet (F) = P×A
Force (F) = (6×105) (0.0008042) = 482.55 N

V. CONCLUSION

It is observed that the pneumatic bending is very cheap as compared to hydraulic bending machine. The range of the bending thickness can be increased by using high pressure compressor and more hardedned punch. This machine is advantageous to small sheet metal bending industries as they cannot afford the expensive hydraulic bending machine. Further with the employment of automation, it provides provision to enter the number of sheets to be bend and required mounting of the sheet. Hence human effort is reduced with increase in accuracy in operation.

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