

A New Model in Design, Manufacturing and Assembly of Mobile Hydraulic Pipe Bending Machine in Industry

P.Pravinkumar¹, C.Ravindiran²

Assistant Professor, Dept. of Mechanical Engineering, Sasurie College of Engineering, Tirupur, Tamilnadu, India^{1,2}

ABSTRACT: In recent years pipe bending machine is used in both industry and domestic purpose for bending the pipe under the required angles and dimensions. Sometimes Heat treatment is used for pipe bending but the heat treatment technique is not safe and have problems are produced in the pipes, such as wrinkling, curve forming, reduced thickness, whole forming, reduced strength, easy breakable. In the hydraulic pipe bending machine having an good advantage compared to heat treatment methods, the advantages are accurate degree and radius, no crack formed in the pipe, easy handling, does not change in thickness and also a time consuming is very less. The required dimensions for the profile cutting, bending angle are choosing choosing for the bending requirements and creating a design using CATIA and AUTOCAD software for the profile modules. After that, the hydraulic pipe bending machine will be prime for the required pipe bending purpose under various required dimensions and angles.

KEYWORDS: wrinkling, forming, profile modules, dimensions, CATIA.

1. INTRODUCTION

1.1 Fluid power

Fluid power is energy transmitted and controlled

by means of a pressurized fluid, either liquid or gas. The term fluid power applies to both hydraulics and pneumatics. Hydraulics uses pressurized liquid, for example, oil or water; pneumatics uses compressed air or other neutral gases. Fluid power can be effectively combined with other technologies through the use of sensors, transducers and microprocessors.

1.2 Hydraulics

Hydraulics is the transmission and control of forces and motions through the medium of fluids. Short and simple. Hydraulic systems and equipment have wide-spread application throughout industry. For example: machine tool manufacturing, press manufacturing, plant construction, vehicle manufacturing, aircraft manufacturing, shipbuilding, injection molding machines [8].

1.3 Conversion of Energy in Hydraulics



“Figure 1. Energy Conversions”

International Journal of Innovative Research in Science, Engineering and Technology

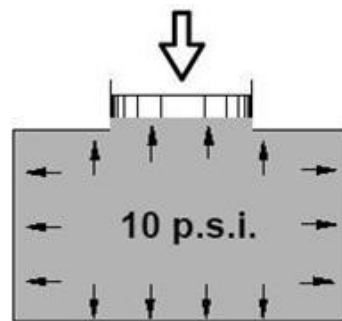
(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

Various forms of energy are converted to accomplish mechanical movement in the injection molding machine. Electrical energy is converted to mechanical energy, which in turn is converted to hydraulic energy to operate and control the moving components of the machine. The hydraulic energy is converted to mechanical energy to achieve the final desired result, which may be “mold clamping pressure” or “material injection”. The terms of Pump, motor, Fluid reservoir, Pressure relief valve, Filter, Piping are the aggregate; Valves, determining the path, pressure, flow rate of the working fluid are the control elements and Linear, Rotational, Swinging are the actuators. The “Figure 1” above summarizes the energy conversions for an injection molding machine.

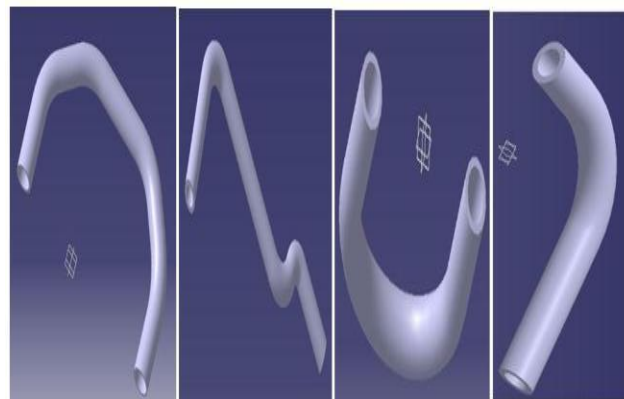
1.4 Pascal's Law

Pascal's Law states that pressure acting on a confined fluid is transmitted equally and undiminished in all directions. In the figure below, a 10 pound force acting on a 1 square inch area generates a pressure of 10 pounds per square inch (psi) throughout the container acting equally on all surfaces [9].



“Figure 2. Working of Pascal’s Law”

The principle is that the pressure in any portion of a hydraulic system is equal throughout that system. This statement is valid with the omission of the force of gravity, which would have to be added, according to the fluid level. “Figure 2” shows the application of Pascal’s Law. The bending contour is not dependent on the tool geometry. “Figure 3” shows the application of Pipe or Pipe Bending.



“Figure 3. Applications of Pipe Bending Machine”

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

1.5 Mobile

Mobile: Fluid power is used to transport, excavate and lift materials as well as control or power mobile equipment. End use industries include construction, agriculture, marine and the military. Applications include backhoes, graders, tractors, truck brakes and suspensions, spreaders and highway maintenance vehicles.

1.6 Pipe Bending Machine

Bending is a manufacturing process that produces a V-shape, U-shape, or channel shape along a straight axis in ductile materials, most commonly sheet metal [10]. Commonly used equipment includes box and pan brakes, brake presses, and other specialized machine presses. Typical products that are made like this are boxes such as electrical enclosures and rectangular ductwork.

Pipe bending is the umbrella term for metalforming processes used to permanently form pipes or tubing. One has to differentiate between form-bound and freeform-bending procedures, as well as between heat supported and cold forming procedures. Form bound bending procedures like “press bending” or “rotary draw bending” is used to form the work piece into the shape of a die. Straight pipe stock can be formed using a bending machine to create a variety of single or multiple bends and to shape the piece into the desired form. These processes can be used to form complex shapes out of different types of ductile metal tubing [7]. Freeform-bending processes, like three-roll-push bending, shape the work piece kinematically, thus

II. PROBLEM IDENTIFICATION

2.1 Due to the Heating Technique

Heating is used for pipe bending but the heat treatment technique is not safe and have problems are produced in the pipes, such as wrinkling, curve forming, reduced thickness, whole forming, reduced strength, easy breakable. In the heat treatment having various stages of heat treatment

Heating the pipe for bending is accomplished in three major stages:

Stage 1 -Heating the metal slowly to ensure a uniform temperature

Stage 2 -Soaking (holding) the metal at a given temperature for a given time and cooling the metal to room temperature

Stage 3 -Cooling the metal to room temperature

2.2 Problem Description

2.2.1 Wrinkling

In the Figure 4 denotes the wrinkling on the heat treatment technique.



Figure 4 Wrinkling”

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

2.2.2 Hole Forming

In the Figure 5 denotes the hole forming on the heat treatment technique.



“Figure 5 Hole Forming”

In the Figure 4 and 5 shows the problems in heating the pipe at various conditions (both room and heating temperature), the time consuming for this process in very high about 2 to 3 hours. The problems are rectified by the using of hydraulic pipe bending machine wit more advantages of accurate thickness and less time consumption.

3.1.3 Hydraulic Pump

Hydraulic pumps are used in hydraulic drive system and can be hydrostatic or hydrodynamic. **Gear pumps** (fixed displacement) having swept volume for hydraulics will be between about 1 cm^3 (0.001 litre) and 200 cm^3 (0.2 litre). “Figure 7” shows the Gear type Hydraulic Pump.

III. METHODOLOGY

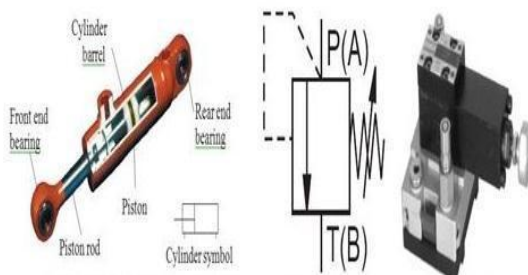
3.1 Components used for Pipe Bending Machine 3.1.1 Double Acting Cylinder

A double-acting cylinder is a cylinder in which the working fluid acts alternately on both sides of the piston. It has a port at each end, supplied with hydraulic fluid for both the retraction and extension of the piston.

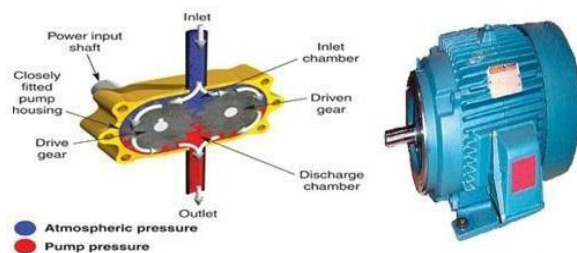
“Figure 5” shows the Double Acting Cylinder.

3.1.2 Pressure Relief Valve

The relief valve (RV) is a type of valve used to control or limit the pressure in a system or vessel which can build up by a process upset, instrument or equipment failure, or fire. The pressure is relieved by allowing the pressurized fluid to flow from an auxiliary passage out of the system. “Figure 6” shows the Pressure Relief Valve.



“Figure 6. Hydraulic Cylinder and Pressure Relief Valve”



“Figure 7. Hydraulic Pump and Motor”

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

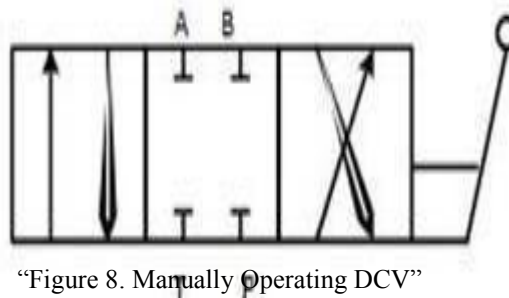
3.1.4 Hydraulic Motor

A hydraulic motor is a mechanical actuator that converts hydraulic pressure and flow into torque and angular displacement (rotation). The hydraulic motor is the rotary counterpart of the cylinder. A gear motor (external gear) consists of two gears, the driven gear (attached to the output shaft by way of a key, etc.) and the idler gear. "Figure 7" shows the Hydraulic motor.

3.1.5 Manually Operating 4/3 Directional Control

Valve (DCV)

Directional control valves they allow fluid flow into different paths from one or more sources. **Manually operated valves** work with simple levers or paddles where the operator applies force to operate the valve. A **hydraulically operated 4/3 DCV** works at much higher pressure. "Figure 8" shows the Manually operated 4/3 Directional control valves.



"Figure 8. Manually Operating DCV"

IV. WORKING, ASSEMBLY AND DESIGN

4.1 Working

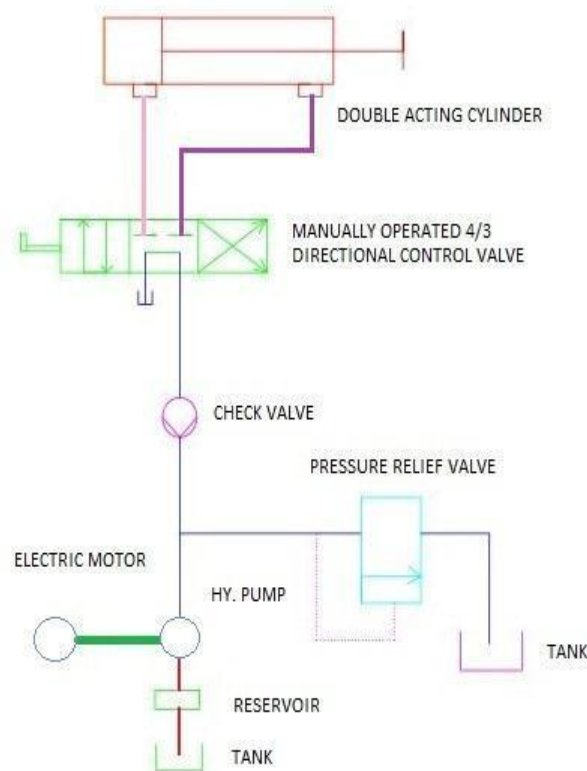
4.1.1 Hydraulic Power Pack

Hydraulic Power Units are the main driving components of hydraulic systems. Consistently mainly of a motor, a reservoir and a hydraulic pump, these units can generate a tremendous amount of power to drive most any kind of hydraulic ram. Hydraulic Power Units are based on Pascal's law of physics, drawing their power from ratios of area and pressure. "Figure 9" shows the Mobile Hydraulic Pipe Bending Machine-Power Pack Circuit.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015



“Figure 9 Hydraulic Power Pack Circuit”

4.2 Assembly

Assembly of Profiles with Cylinder,

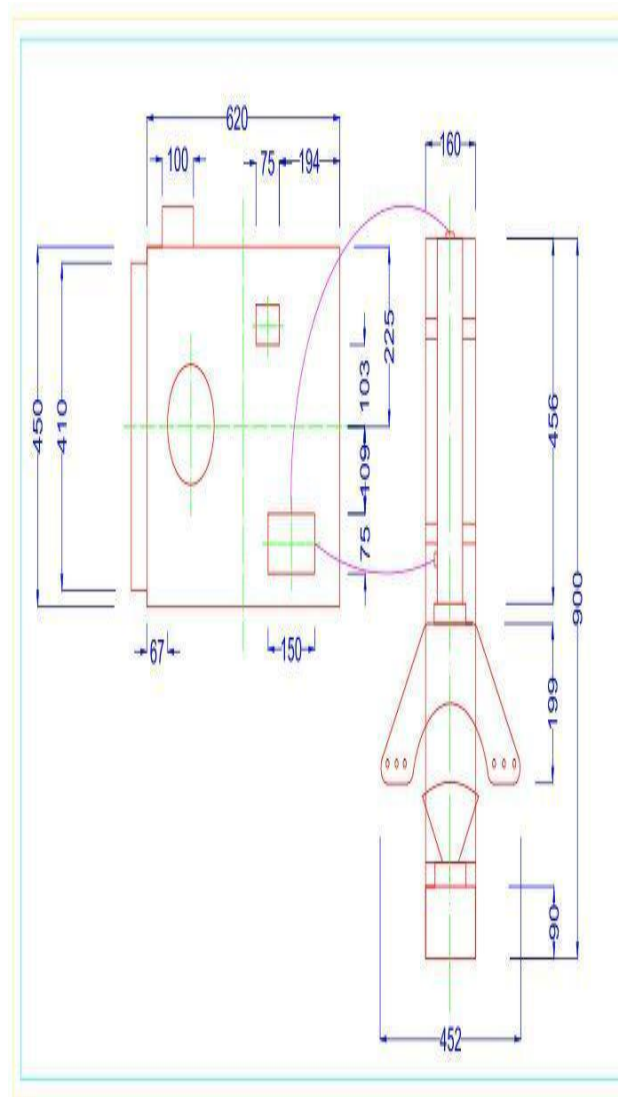
Assembly of the lower plate: First turn over the cylinder and remove the hex bolts on the base of the cylinder. Align the holes of the lower plate with the holes of the cylinder base, and affix with the hex bolts taken from the cylinder base.

Assembly of the upper plate: When the lower plate is assembled, turn the cylinder over and insert swaging blocks in the hole of the lower plate. Place the upper plate over the swaging blocks and use the die cover shaft to secure the swaging block and the back oil cylinder seat. “Figure 10” shows the Assembly and the Figure 11 and 12 shows profile cuttings by using CATIA and AUTOCAD softwares.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015



“Figure 10 Assembly.”

International Journal of Innovative Research in Science, Engineering and Technology

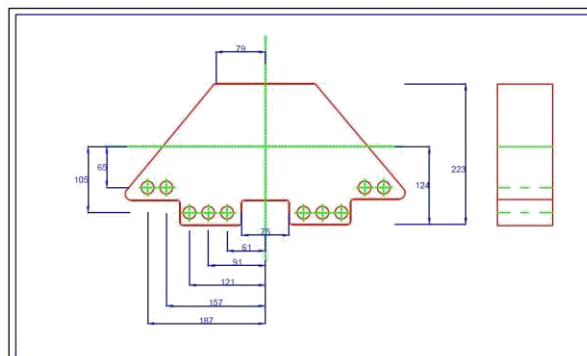
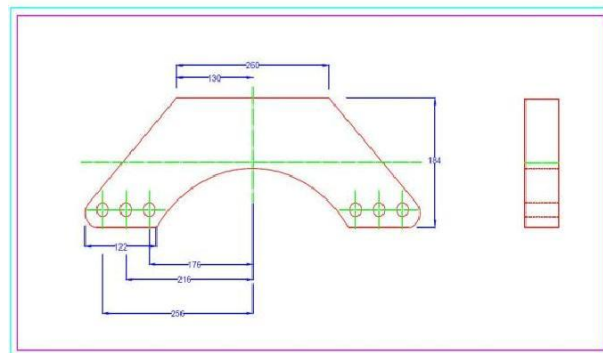
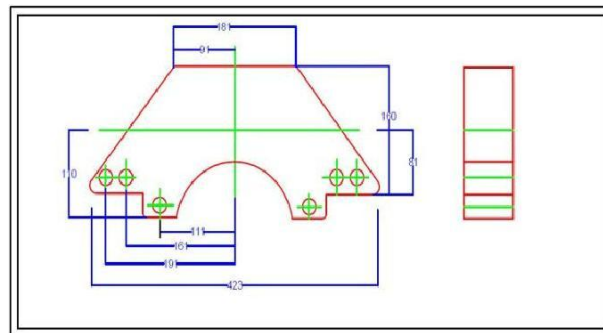
(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

4.3 Design

4.3.1 Software : AUTOCAD

Profile Cutting



“Figure 11 Profile cuttings”

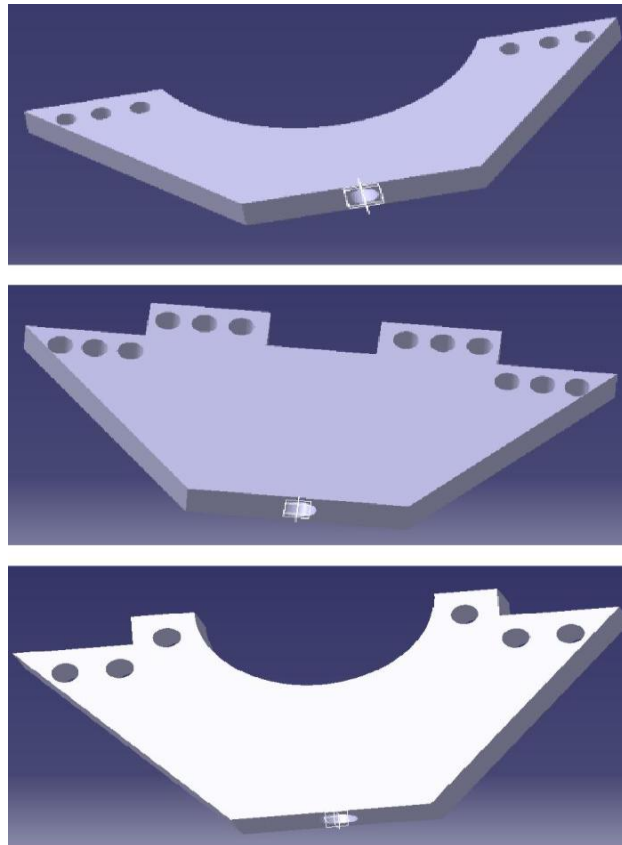
International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

4.3.1 Software : CATIA

Profile Cuttings



“Figure 12 Profile cuttings”

V. CALCULATION

5.1 Bend Allowance

The bend allowance (BA) is the length of the arc of the neutral line between the tangent points of a bend in any material. Adding the length of each flange taken between the center of the radius to the BA gives the Flat Pattern length. This bend allowance formula is used to determine the flat pattern length when a bend is dimensioned from 1) the center of the radius, 2) a tangent point of the radius or 3) the outside tangent point of the radius on an acute angle bend [4]. “Figure 13” shows the Bending Allowance diagram.

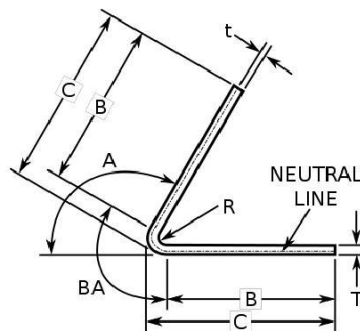
The BA can be calculated using the following formula:

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

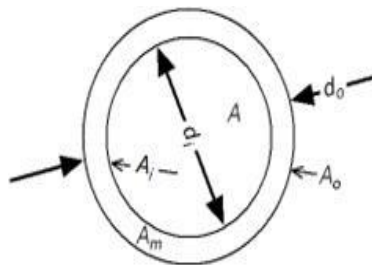
$$BA = A \left(\frac{\pi}{180} \right) (R + K \times T)$$



“Figure 13 Bending Allowance”

Where, t = distance from inside face to the neutral line [3], A = bend angle in degrees (the angle through which the material is bent), T = material thickness, R = inside bend radius, BA = bend allowance, K = K-Factor, which is t / T .

5.2 Cross Sectional Area



“Figure 14 Cross Sectional Area of a Pipe”

5“Figure 14” shows the Cross Sectional Area and other Calculations diagram.

1. Cross-sectional Area of a Steel Pipe can be calculated as $A = 0.785 d_i^2$
2. Moment of inertia can be expressed as $I = 0.0491 (d_o^4 - d_i^4)$
3. Outside surface area of steel pipes can be calculated as $A_o = 0.2618 d_o$
4. Area of the metal can be calculated as $A_m = 0.785 (d_o^2 - d_i^2)$
5. Section modulus can be expressed as $Z = 0.0982 (d_o^4 - d_i^4) / d_o$

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

Where, A_m = area of the metal (Square inches), A = cross-sectional area of pipe (Square Inches), A_o = outside area of pipe - per foot (Square Feet), I = moment of inertia (inches), d_o = outside diameter (inches), d_i = inside diameter (inches), Z = section modulus (inches).

VI. RESULTS

Assembly Drawings



International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015

VII. CONCLUSION

The current urgent demands for high efficiency and precision production are vitally related to the accurate prediction and effective controlling of the various failures or instabilities in pipe bending. Thus, advances on the studies of these common topics in pipe bending are summarized including wrinkling instability, wall thinning (cracking), spring back phenomenon, cross-section deformation and process/tooling design/optimization.

S.NO	PROPERTY	HEATING	HYDRAULIC
1	Pipe Thickness	Reduced	Accurate
2	Wrinkling	Formed	Reduced
3	Hole	Formed	Reduced
4	Time consuming	High	Low

ACKNOWLEDGEMENT

This work was financially supported by BHIPL Coimbatore. The authors acknowledge to the Shri. T.K.Karupanasamy, Managing Director for the facilities and support provided by them for doing the successful one and sincere thanks to Mr. MohanaPranesh, Mr. Naveen Babu, Mr. KeerthiRajan and other concerned officials at BHIPL Coimbatore for the supply of components and necessary technical help.

REFERENCES

1. M.S.J. Hashmi, "Aspects of tube and pipe manufacturing processes: Meter to nanometer diameter" *Journal of Materials Processing Technology*; Vol. 179, No. 1-3, pp. 5-10, 2006.
2. How to Calculate Bend Allowance for Your Press Brake, archived from the original on 2010-02-24, retrieved 2010-02-24.
3. <http://www.ciri.org.nz/bendworks/bending.pdf>
4. Li Heng, and Yang He, "A Study on Multi-defect Constrained Bendability of Thin-walled Tube NC Bending Under Different Clearance", *Chinese Journal of Aeronautics*, Vol. 24, pp. 102-112, 2011.
5. Peter Nachtwey, "Fluid Power Basics", Delta Computer Systems, Inc., 2009.
6. Todd, H. Robert, Allen, K. Dell, Alting, Leo,
7. *Manufacturing Processes Reference Guide (1st ed.)*, Industrial Press Inc., ISBN 0-8311-3049-0, 1994.
8. H. Yang, Z. C. Sun, Y. Lin, "Advanced plastic processing technology and research progress on tube forming", *Journal of Plasticity Engineering*; Vol. 8, No. 2, pp. 83-85, 2001.