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# Design and Analysis of Double End Drive Machine for Automation of Circular Welding Process

**Mr. Govind Chavan1, Mr. Dinesh Satpute2, Mr. Gokul Mahajan3, Mr. Mikhil Bhavsar4, Mr. Niteen Bhirud5, Mr. Brijeshwar Wagh6**
**Assistant professor1,2,3,4, Department of Mechanical Engineering, Sandip University, Nashik, India**
**Associate professor5, Department of Mechanical Engineering, Sandip University, Nashik, India**

**Abstract—** Welding is a joining process used to join materials, usually metals or thermoplastics, by causing coalescence. This is mostly done by melting the work-pieces and adding a filler material to form a pool of molten material that cools to become a strong joint, with pressure sometimes used in association with heat, or by itself, to produce the weld. The present work deals with a live task to design Double End Drive machine a SPM for manufacturing industry. The main aim is to design a machine to automate the circular welding process with the help of automatic drive. We have designed and analyzed various components of Double End drive machine and it is found that the newly designed machine is performing its intended function with expected effectiveness and efficiency. The newly designed machine automates the process of welding thereby reducing the work fatigue, Monotonous work and complexity of the process. The paper presents the details of design and analysis of components as well as pneumatic circuit to automate the welding process.

***Keywords*—** Automation, Circular welding, double end drive, Finite Element Analysis, pneumatic clamp, SPM Design.

## 1. Introduction

The proposed design of Double End Drive machine aims at giving the solution to automate the tedious and repetitive Circular welding process of the exhaust system. The bend pipe, bellow and straight pipe are the three parts of exhaust system as shown in the figure 1 below to join together with the help of MIG circular welding process.

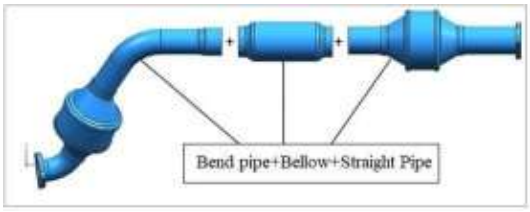


Fig. 1 Exhaust assembly

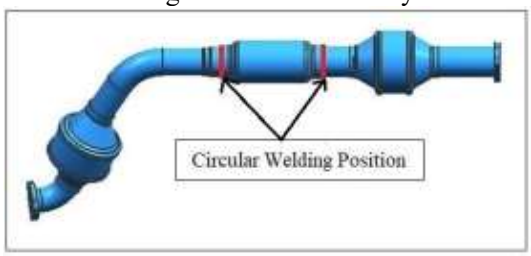


Fig. 2 Positions of circular welding

## 2. Proposed Assembly of DED machine

The proposed machine with various subassemblies is shown in figure 3.

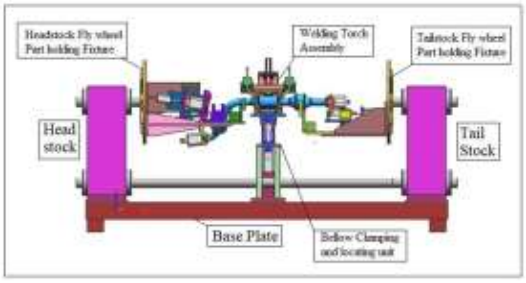


Fig. 3 Assembly of DED machine

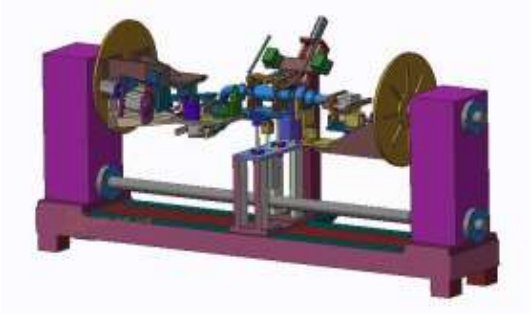

Fig. 4 DED Machine

Following are the major components of the assembly

1. Base Plate
2. Head Stock
3. Tail Stock
4. Headstock and flywheel part holding fixture
5. Tailstock and flywheel part holding fixture
6. Welding Torch assembly
7. Bellow clamping and locking unit

The more detailed insight into the design of different parts and pneumatic circuit is been made by BrijeshwarWagh et. al 1,2.

## 3. Analysis of exhaust assembly

### *3.1 Analysis of Bend Pipe Subjected to Clamping Force*

The bend pipe is hold on Head Stock Part holding cradle is the part which holds the bend pipe during the operation. It guides the work piece (Bend pipe) to the clamping jaw which is operated by the pneumatic cylinder.it is fixed on the part holding resting plate. It is designed and manufactured in such a way so that it can hold the work piece accurately during the operation.

Pneumatic cylinder is used for clamping the work piece during the machine operation. It is fixed in the between the fixture holding part and part holding cradle. The pneumatic cylinder actuates the clamping jaw which clamps the work piece in its place. As the flywheel rotates during the operation hence it is to be ensured that the work piece is properly clamped, for this the clamping jaw is provided which clamps the work piece tightly during the operation. Thus we need to analyzed the clamping force exerted by the pneumatic cylinder on work piece (Bend Pipe)

Force Exerted by pneumatic cylinder is up to 5 bar. So applying force of 5 bar (50KN) on work piece and determined total deformation, equivalent stress (Von-Mises stress).

TABLE I
PROPERTIES OF MATERIAL

| Material | Density | Tensile Ultimate Strength (MPa) | Yield Strength (MPa) | Poisson's Ratio |
|---|---|---|---|---|
| Structural steel | 7.85e-6 kg/mm$^3$ | 460 | 250 | 0.3 |

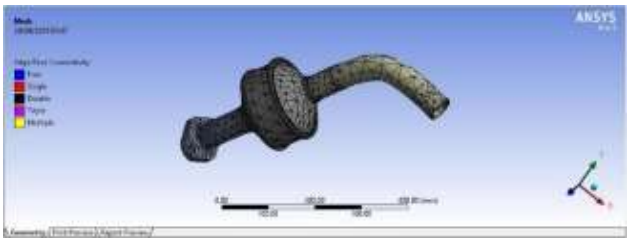

Fig. 5 Mesh Model of bend pipe

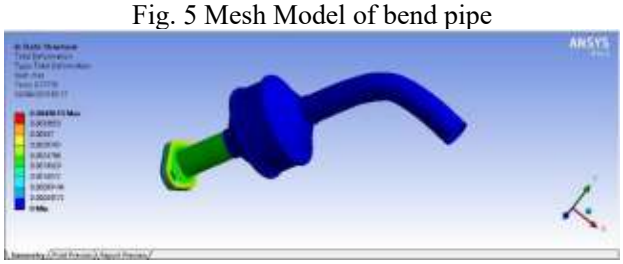

Fig. 6 Total deformation of bend pipe

Fig. 7 Stress in bend pipe

*3.2 Analysis of Bellow Subjected to Clamping Force*

Bellow is rested on bellow clamping and locating unit. Clamping and unclamping mechanism of roller is used for the proper clamping of the bellow for welding. So, for proper motion of the bellow without any errors, we required a roller which will allow rolling motion. For this purpose, rollers are used. This mechanism gives proper motion for clamping. Roller are attached to the bellow resting plate. The whole mechanism is powered by pneumatic cylinder. Thus, we need to analyzed the clamping force exerted by the pneumatic cylinder on work piece (Bellow)

Force Exerted by pneumatic cylinder is up to 3 bar. So applying force of 3 bar (30KN) on work piece the total deformation, equivalent stress (Von-Mises stress) is determined.

TABLE II
PROPERTIES OF MATERIAL

| Material | Density | Tensile Ultimate Strength (MPa) | Yield Strength (MPa) | Poisson's Ratio |
|---|---|---|---|---|
| Structural steel | 7.85e-6 kg/mm$^3$ | 460 | 250 | 0.3 |

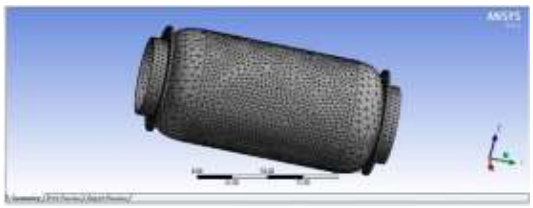

Fig. 8 Mesh Model of Bellow

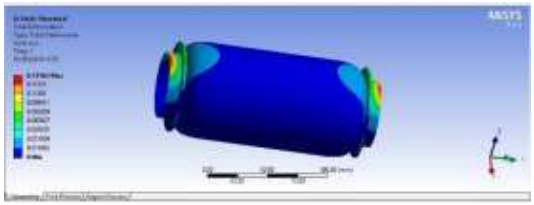

Fig. 9 Total deformation of bellow pipe

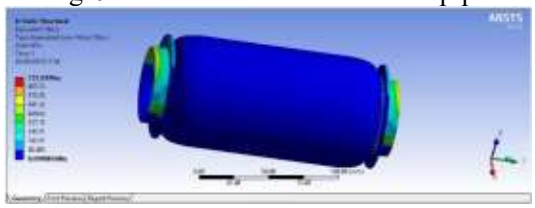

Fig. 10 Stress in bellow

*3.3 Analysis of Straight Pipe Subjected to Clamping Force*

The straight pipe is hold on tail stock Part holding cradle is the part which holds the bend pipe during the operation. It guides the work piece (Straight pipe) to the clamping jaw which is operated by the pneumatic cylinder.it is fixed on the part holding resting plate. It is designed and manufactured in such a way so that it can hold the work piece accurately during the operation.

Pneumatic cylinder is used for clamping the work piece during the machine operation. It is fixed in the between the fixture holding part and part holding cradle. Thus we need to analyzed the clamping force exerted by the pneumatic cylinder on work piece (Bend Pipe)

Force Exerted by pneumatic cylinder is up to 5 bar. So applying force of 5 bar (50KN) on work piece we calculated total deformation, equivalent stress (Von-Mises stress).

TABLE III
PROPERTIES OF MATERIAL

| Material | Density | Tensile Ultimate Strength (MPa) | Yield Strength (MPa) | Poisson's Ratio |
|---|---|---|---|---|
| Structural steel | 7.85e-6 kg/mm$^3$ | 460 | 250 | 0.3 |

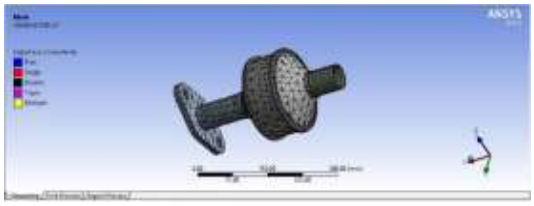

Fig. 11 Mesh model of straight pipe

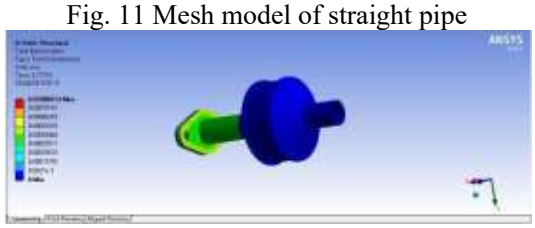

Fig. 12 Total deformation of straight pipe

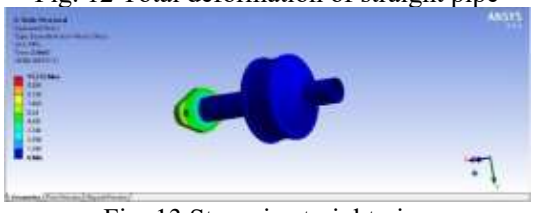

Fig. 13 Stress in straight pipe

## 4. Results

TABLE IV
ANALYSIS RESULTS FOR BEND PIPE

| Parameter | Total Deformation | Equivalent (von-Mises) Stress |
|---|---|---|
| Unit | mm | MPa |
| Minimum | 0 | 0 |
| Maximum | 0.0044615 | 56.921 |

TABLE V
ANALYSIS RESULTS FOR BELLOW

| Parameter | Total Deformation | Equivalent (von-Mises) Stress |
|---|---|---|
| Unit | mm | MPa |
| Minimum | 0 | 0.099084 |
| Maximum | 0.14762 | 737.24 |

TABLE VI
ANALYSIS RESULTS FOR BELLOW

| Parameter | Total Deformation | Equivalent (von-Mises) Stress |
|---|---|---|
| Unit | mm | MPa |
| Minimum | 0 | 0 |
| Maximum | 0.00089034 | 11.232 |

The work piece deformation and stresses in the component due to clamping load is taken into account. The total deformation takes place in bend pipe, bellow and straight pipe are 9.054×10-5mm, 7.72×10-4mm and 9.03×10-5mm respectively which is nearly negligible, that's shows there no any impact of clamping Pressure on the work piece use in Double End Drive (DED) machine. Which gives safe design of machine and appropriate use of pneumatic cylinder with perfect clamping pressure generated by cylinders.

Due to uniform circular speed of welding torch, welding will be uniform with no micro cracks so quality will be improved. As all processes of the welding are automated with proper drives, the worker is to just fix the work piece. Fixing and locating the work piece becomes so easy due to the presence of suitably designed fixtures. This kind of easy work profile enables to recruit less skilled manpower.

## 5. Conclusion

The newly proposed design of Double End Drive machine has automated the welding process which result in the increase in productivity, less fatigue to operator and also economical production. This machine is capable of producing 282 workpieces in a day with fifty percent cost saving. Automation allows to clamp and unclamp the work-piece in shorter time period which saves time. Quality improvement and a decrease in time consumption followed the objectives.

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