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# Performance Analysis of Twin Head Special Purpose Machine (SPM)

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Abstract: **Welding is a joining process in which localized permanent joint can be produced with or without application of heat, pressure and filler material. Automation can be defined as use or application of combined mechanical, electronic and computer based system in the operation and control of production system. This paper deals with the analysis of twin head special purpose machine (SPM) we has to check the results of clamping pressure on the elements of bellow assembly. Bellow assembly contains three different parts such as bend pipe, bellow and straight pipe. The material used for the assembly is steel that is often used in fabrication. The deformation and stress are on bellow assembly because clamping pressure loaded on elements are found using structural analysis by using ANSYS 19.5 software. The deformation and stress results are presented during there paper.**

***Keywords —*** ***special purpose machine, ANSYS 19.5, deformation, clamping, stress.***

## I. INTRODUCTION

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is typically done by melting the work-pieces and adding a filler material to create a pool of liquid material (the weld pool) that cools to become a robust joint, with pressure typically utilized in conjunction with heat, or by itself, to produce the weld. This is in distinction with attachment and brazing, which involve melting a lower-melting-point material between the work-pieces to form a bond between them, without melting the work pieces. There are many alternative ways to weld, such as: Oxy-fuel welding, Shielded metal arc welding (SMAW), Gas tungsten arc welding (GTAW), Gas metal arc welding (GMAW), Flux-cored arc welding (FCAW), Submerged arc welding (SAW), Electro slag welding (ESW), Electric resistance welding (ERW).[1]

Many different energy sources can be used for welding, including a gas flame (chemical), an electric arc (electrical), a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding may be performed in many different environments, including in open air, under water, and in outer space. Welding is a hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation.[2]

Automated welding can give substantial gains in efficiency and productivity - in the correct applications. Welding is ostensibly the most unpredictable assembling process and is much of the time the slightest comprehended. An amazing number of organizations burn through a huge number of dollars to robotize gathering while at the same time overlooking the welding procedure. Manual welding is as yet the best procedure for some gatherings. Be thatas it may, numerous constructing agents are actualizing computerized welding frameworks to expand quality, efficiency, and productivity.[3]

Welding computerization can be separated into two fundamental classifications: self-loader and completely programmed. In self-loader welding, an administrator physically stacks the parts into the welding installation. A weld controller at that point keeps the welding procedure, the movement of the light, and stillness of the parts to preset parameters. After the weld is finished, the administrator expels the finished get together and the procedure starts once more.[4]

Despite all the benefits, welding system automation is accompanied by some drawbacks. Although the drawbacks can be controlled, they should be recognized from the onset of an automated welding project.[5]

Automated welding systems require a higher initial investment than manual systems.Flexibility is also an issue. The flexibility of a machine has an inverse relationship with the degree of automation. While a manual welder can easily move from one part to the next, specialized welding equipment and systems can only satisfy a dedicated niche in the manufacturing process. Flexibility of performance is exchanged for accurate, repeatable andprecise welds.[6]

## II. LITERATURE REVIEW

Prof. Shendage and Yogesh. R, in 2018 works on Special Purpose Machine for Linear Welding which give detail understanding on designing of mechanism, which can weld

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the circular as well as line component with accuracy, a linear motion with an improved degree of fineness and are relatively less cumbersome than traditional welding process. [1]. Tanveer Majeed and Mohd Atif Wahid in 2018 works on Applications of Robotics in Welding, an Industrial robot is reprogrammable, automatically controlled, multifunctional manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications. Technical innovations in robotic welding has facilitated manual welding processes in sever working conditions with enormous heat and fumes to be replaced with robotic welding.[3] Shriya Khedekar, Sampada Lokhande, Akash Pasari in 2018 works on Survey on Automatic Welding System. Automation plays powerful role in many fields. Automation in welding has grabbed significant role in industries since last few years. This research introduces various methods used to automate the welding process used in industries.[4] Swapnil k. Gundewar and Prof. M. R. Nagare in 2015 reseaech in Advances in technologies are necessary for every industry to survive in competition. The main factors by improving which the industry can survive in the market are productivity, quality & customer delivery date. In this paper I am going to present the scope of improvement in the manual Gas Tungsten Arc Welding (TIG) by replacing it with automated Gas Tungsten Arc Welding.[5] Sateesha Patil, Prashant Vavhal, Abhinav Whatte in 2016 research in mass production of manufacturing the welding may be of Electric arc welding, CO2 Welding, or TIG welding. The processes of Electric arc welding or CO2 welding are normally done manually. With the help of idler weld machine we can a make a machine for welding the housing of the idler to the pipe. The successful machining of any mass production depends upon the inter-changeability to facilitate easy to assembling and reduction of unit cost so there is necessary of special purpose tools which are used to facilitated production.[6] Arghya Ganguly, Naveenkumar Kumbhare, in 2014 research on to describe a PLC based Control System for Hardening and Tempering Furnace in Heat Treatment Plant as implemented at the Siddheshwar unit for Mahindra Automobiles Limited, which is one of India's largest vehicle manufacturing corporation. The proposed system deals with designing of a PLC based control system for Hardening and Tempering Furnace. The automated process efficiently reduces the man power required for the process and also increases the efficiency of hardening and tempering process of raw steel bits. This paper provides the description of the components implemented for the control system along with the flow of working of various required components. The system is controlled with the help of Messung PLC.[7]Dhage Kalyani, Chavan Harshal in 2016 together works on design and manufacturing of automated circular CO2 welding machine. This research gives detail understanding on circular CO2 welding. Circular Co2 welding process is a very critical welding which is done on cam shaft with different profile cams, to achieve the dimensional accuracy for different cam shaft welding on same platform special purpose machine is required. Using PLC and SCADA systems we can synchronize the outcome.[8]Deokar Sushant Sanjay, Kumbhar Vaibhav Rajendra, Kokare Kishor in 2017 Works On Design of Circular Welding Positioner, which gives knowledge on working and construction of the all the components of circular welding positioner Which is very important for mass production related to the circular welding.

## III. PROBLEM STATEMENT

Now a days in most of the industries circular welding for flexible bellow in exhaust system is done by manually. This project is done in Yogeshwar industries situated in MIDC, Nashik. We have to weld two circular points in an exhaust system. It has two points on two faces of the bellow in exhaust system. These two points are located at two different planes. Onto these two points it has the input and output pipes. To weld two pipes onto their respective locations, we have to made a SPM which must carry an automated drive for uniform and precise welding.

## IV. OBJECTIVE

- Reduced errors.
- Cost savings.
- Increased productivity.
- Uniform and Precise welding.
- Reduced labor requirement.
- Greater productivity.
- Simple and smooth process.
- Reduction in inventory.
- Increased machine utilization.

## V. DESIGN OF MODEL

The various parts required for project is designed and assembly of the same is created in Nx12 & AutoCAD software. For knowing the working principle we have designed separate components in Nx12 and then assembled in it.

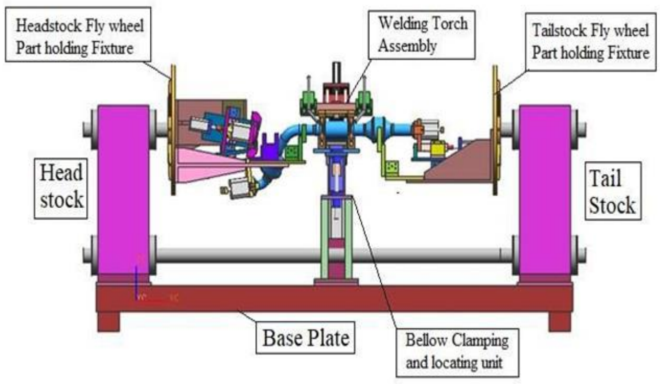


Fig.1. Assembly of Twin head welding SPM

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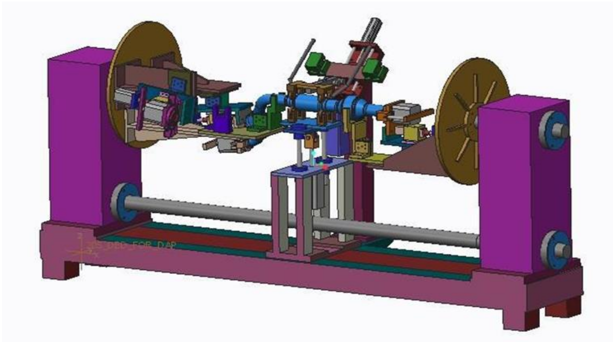

Fig.2. Isometric view of Twin Head welding SPM

## VI. MATERIAL SELECTION

Table 1. Material Specification

| Sr. No. | Part Name | Material | Quantity |
|---|---|---|---|
| 1 | Base Plate (Whole Structure) | M.S. | 1 |
| 2 | Center Plate for Bellow | M.S. | 1 |
| 3 | Flange for Shaft | M.S. | 2 |
| 4 | Geared Motor | C50 | 1 |
| 5 | Flywheel | M.S. | 2 |
| 6 | Lock Nut | M.S. | 4 |
| 7 | Taper roller bearing | STD | 6 |
| 8 | Bearing Housing | M.S. | 4 |
| 9 | Bearing Flange | M.S. | 1 |
| 10 | Slip Rings | - | 1 |
| 11 | Ball Bearing | STD | 2 |
| 12 | Boss for fly wheel | M.S. | 2 |
| 13 | Bellow resting plate | M.S. | 1 |
| 14 | Bearing Cover | M.S. | 4 |
| 15 | Star washer | STD | 4 |
| 16 | Roller clamping assembly | M.S. | 1 |
| 17 | Supporting structure | M.S. | 4 |
| 18 | Bush | M.S. | 4 |
| 19 | Supporting rod | M.S. | 2 |
| 20 | Plate for bellow clamping | M.S. | 1 |
| 21 | Part holding cradle | M.S. | 3 |
| 22 | Locating fixture | M.S. | 1 |
| 23 | Clamping jaw | M.S. | 2 |
| 24 | Torch assembly column | M.S. | 1 |
| 25 | Base plate for torch assembly | M.S. | 1 |

M.S. = Mild Steel

STD = Standard Part

## VII. INTRODUCTION TO FLEXIBLE BELLOW AND PIPE USED IN EXHAUST SYSTEM

The Twin head welding SPM for the circular welding process utilizing MIG welding for flexible bellow in the exhaust pipe framework. It comprises of three sections as, flexible bellow, bend pipe and straight pipe. There is two circular welding positions.

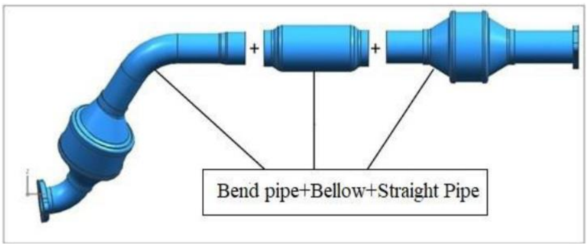


Fig.3. Exhaust assembly and its parts

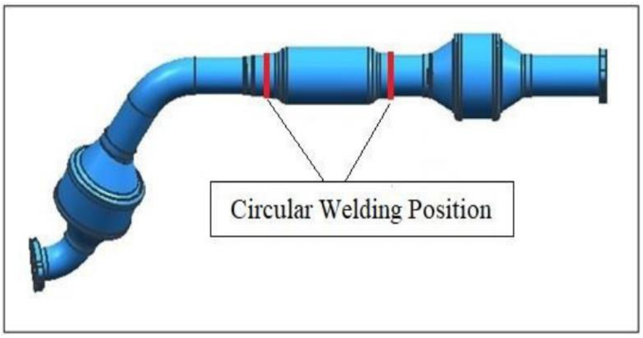


Fig.4. Circular welding positions

## VIII. ANALYSIS

Analysis has been carried out by using finite analysis method with help of ANSYS 19.2 software. The analysis of bend pipe, bellow and straight pipe has been carried out.

Thus the analysis of clamping pressure is applied and needed clamping pressure was selected. As per planning, clamping pressure is applied on faces for appropriate clamping. The solid model of element and geometric conditions are selected, the direction of the pressure is chosen and the clamping pressure is given as per the conditions and results are evaluated.

### 8.1. Analysis of Bend pipe

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 i.e. 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.

Pressure Exerted by pneumatic cylinder is up to 5 bar. So applying Pressure of 5 bar (5.e5 Pa) on work piece we calculated total deformation, equivalent stress (Von-Mises stress) maximum principal Stress, Minimum Principal Stress, maximum shear stress.

Table 2. material Properties for bend pipe.

| Material | Density | Tensile ultimate strength (Pa) | Yield strength (Pa) | Poisson's ratio |
|---|---|---|---|---|
| Structural Steel | 7.85e-006 kg mm^-3 | 4600e5 | 2500e5 | 0.3 |

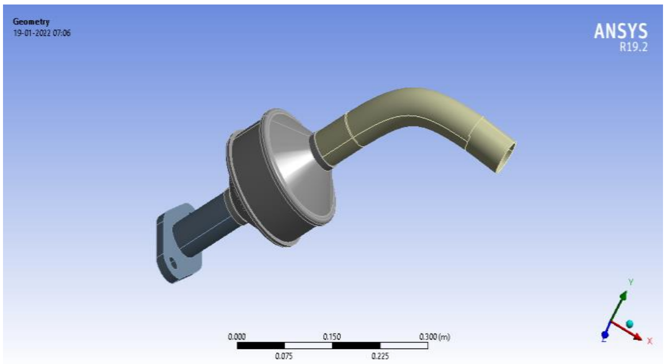


Fig.5. Geometry of bend pipe


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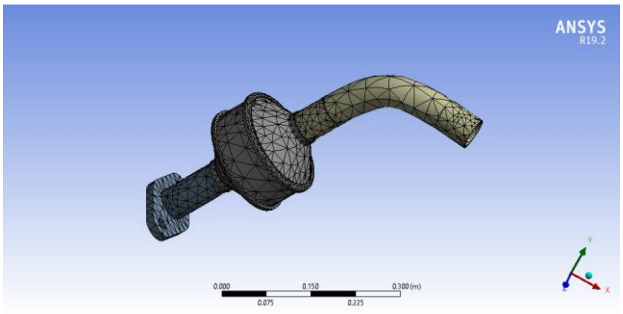

Fig.6. Meshing of bend pipe

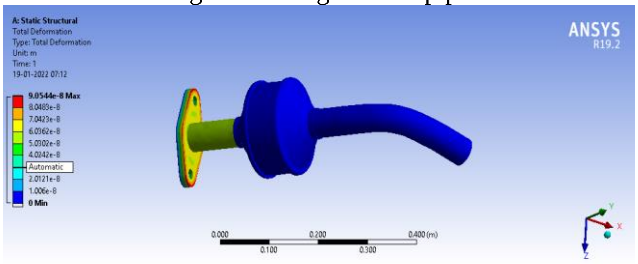

Fig.7. Total deformation of bend pipe

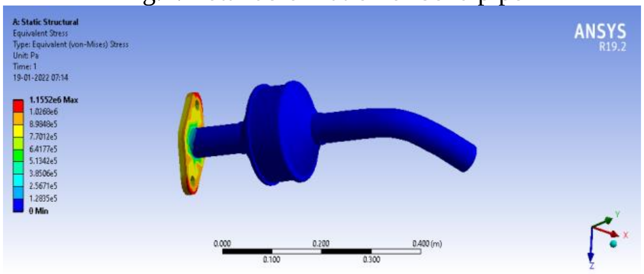

Fig.8. Equivalent stress (Von-mises stress) of bend pipe

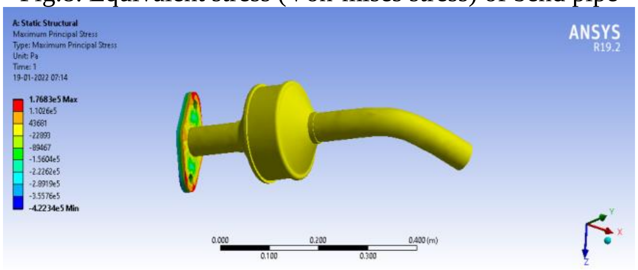

Fig.9. Max. principle stress of bend pipe

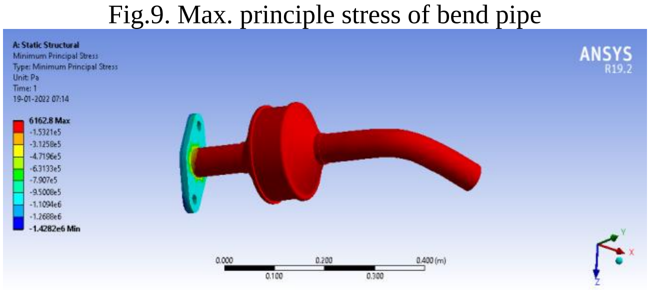

Fig.10. Min. principle stress of bend pipe

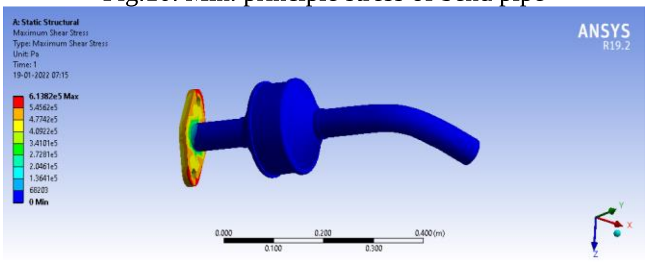

Fig.11. Max. shear stress of bend pipe

**8.2. analysis of Bellow**

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. Because of these, 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 Pressure exerted by the pneumatic cylinder on work piece i.e. Bellow.

Pressure Exerted by pneumatic cylinder is up to 3 bar. So applying Pressure of 3 bar (3.e5 Pa) on work piece we calculated total deformation, equivalent stress (Von-Mises stress) maximum principal Stress, Minimum Principal Stress, maximum shear stress.

Table 3. material properties for bellow

| Material | Density | Tensile ultimate strength (Pa) | Yield strength (Pa) | Poisson's ratio |
|---|---|---|---|---|
| Structural Steel | 7.85e-006 kg mm^-3 | 4600e5 | 2500e5 | 0.3 |

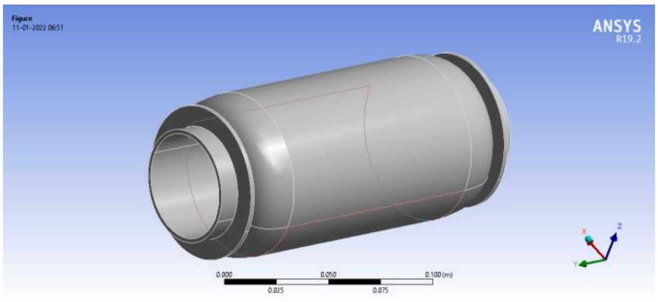

Fig.12. Geometry of Bellow

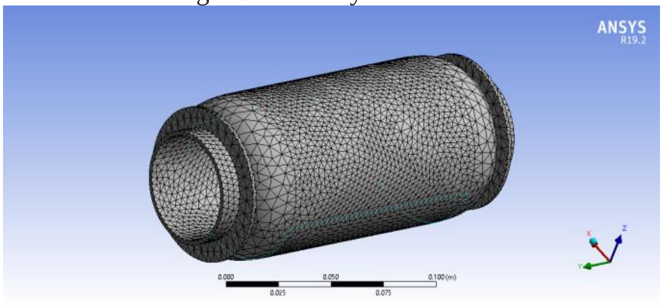

Fig.13. Meshing of Bellow

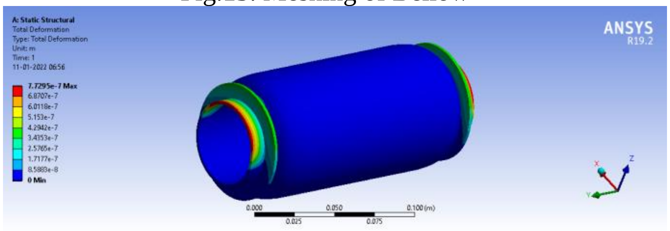

Fig.14. Total deformation of Bellow

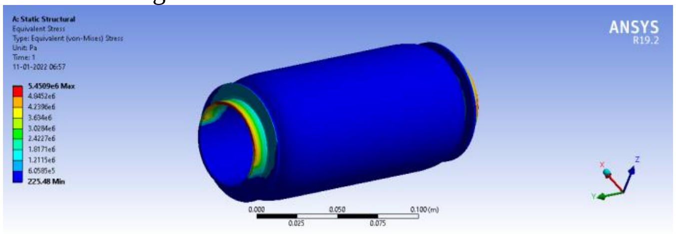

Fig.15. Equivalent stress (Von-mises stress) of bellow

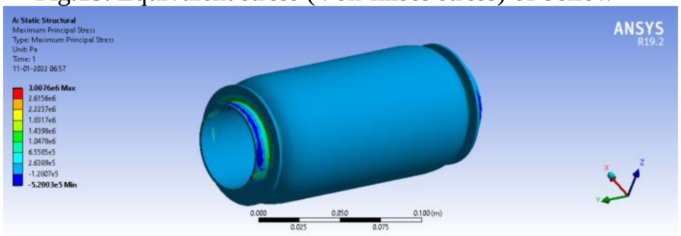


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Fig.16. max. principle stress of bellow

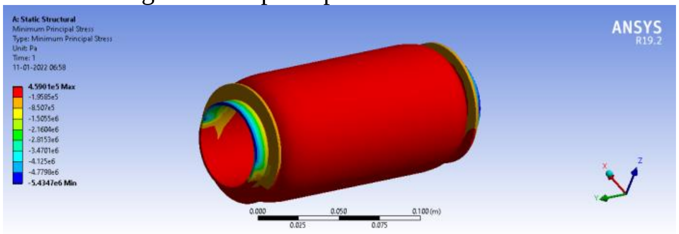

Fig.17. Min. principle stress of bellow

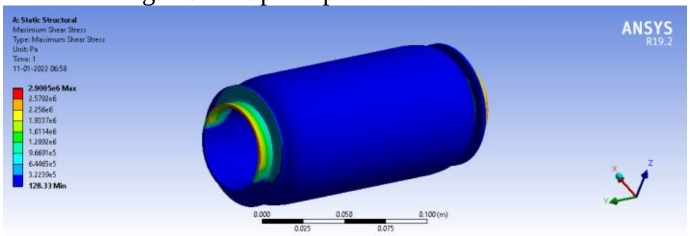

Fig.18. Max. shear stress of bellow

### 8.3. Analysis of Straight Pipe

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 i.e. 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.

Pressure Exerted by pneumatic cylinder is up to 5 bar. So applying Pressure of 5 bar (5.e5 Pa) on work piece we calculated total deformation, equivalent stress (Von-Mises stress) maximum principal Stress, Minimum Principal Stress, maximum shear stress.

Table 4. Material properties for straight pipe

| Material | Density | Tensile ultimate strength (Pa) | Yield strength (Pa) | Poisson's ratio |
|---|---|---|---|---|
| Structural Steel | 7.85e-006 kg mm^-3 | 4600e5 | 2500e5 | 0.3 |

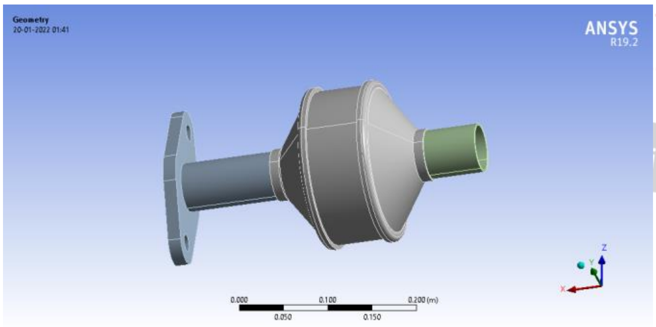

Fig.19. Geometry of Straight pipe

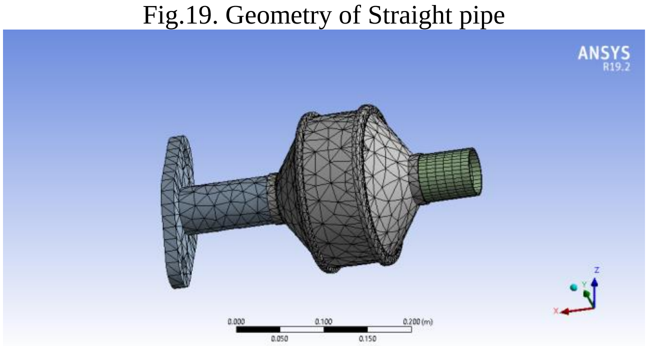

Fig.20. Meshing of Straight Pipe

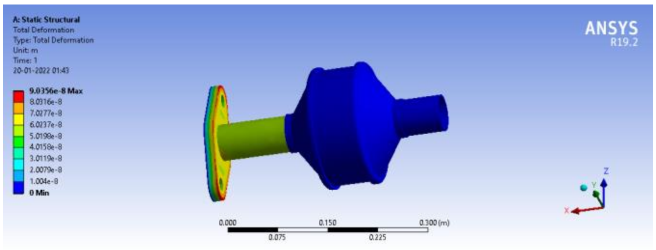

Fig.21. Total deformation of straight pipe

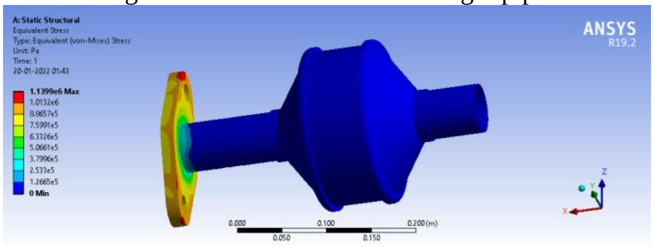

Fig.22. Equivalent stress (Von-mises stress) of straight pipe

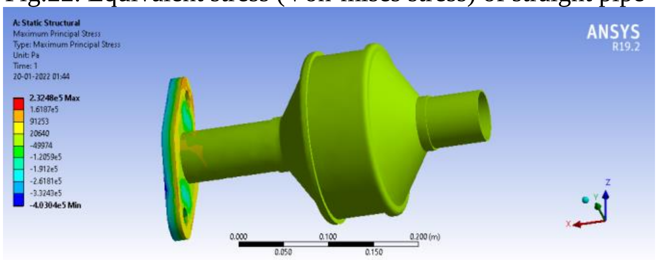

Fig.23. Max. Principle stress of straight pipe

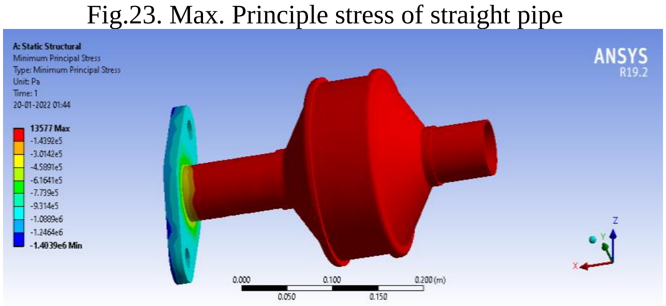

Fig.24. Min. principle stress of straight pipe

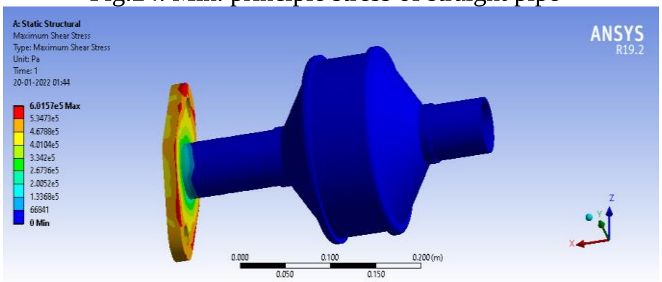

Fig.25. max. Shear stress of straight pipe

## IX. RESULTS

Table 5. Analysis results for bend pipe

| Analysis type | Unit | Minimum | Maximum |
|---|---|---|---|
| Total Deformation | M | 0 | $9.0544*10^{-8}$ |
| Equivalent (Von-misus) stress | Pa | 0 | $1.1552*10^{6}$ |
| Max. Principle stress | Pa | $-4.2234*10^{5}$ | $1.7683*10^{5}$ |
| Min. Principle stress | Pa | $-1.4282*10^{6}$ | 6162.8 |
| Max. Shear stress | Pa | 0 | $6.1382*10^{5}$ |

Table 6. Analysis results for bellow

| Analysis type | Unit | Minimum | Maximum |
|---|---|---|---|

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| | | | |
|---|---|---|---|
| Total Deformation | M | 0 | $7.7295*10^{-7}$ |
| Equivalent (Von-misus) stress | Pa | 225.48 | $5.4509*10^{6}$ |
| Max. Principle stress | Pa | $-5.2003*10^{5}$ | $3.0076*10^{6}$ |
| Min. Principle stress | Pa | $-5.4347*10^{6}$ | $4.5901*10^{5}$ |
| Max. Shear stress | Pa | 128.33 | $2.9005*10^{6}$ |

Table 7. Analysis results for straight pipe

| Analysis type | Unit | Minimum | Maximum |
|---|---|---|---|
| Total Deformation | M | 0 | $9.0356*10^{-8}$ |
| Equivalent (Von-misus) stress | Pa | 0 | $1.1399*10^{6}$ |
| Max. Principle stress | Pa | $-4.0304*10^{5}$ | $2.3248*10^{5}$ |
| Min. Principle stress | Pa | $-1.4039*10^{6}$ | 1.3577 |
| Max. Shear stress | Pa | 0 | $6.0157*10^{5}$ |

## X. FUTURE SCOPE

- This is automated machine so labour required is less. This will solve the problem of lack of manpower.
- This is time saving machine hence it will increase the productivity.
- Due to uniform circular speed of welding torch, welding is uniform with no micro cracks so quality is improved.
- In manual welding, the efficiency of the operator decreases due to fatigue. This may result in a lower welding strength at the end of the shift, specifically for the elderly operators, causing lesser future orders.
- As there is no scope for non-uniformity due to automation, the weld thickness is never increases hence saves energy which frequently takes place in manual welding due to human errors.

## XI. CONCLUSION

Due to limitations of circular welding our project will leads to automation of circular welding, which can successfully achieved in the form of Twin Head Welding SPM with all desirable features. Also quality improvement and decrease in time consumption of welding process. Company will enjoy benefits of improved lead time, quality, customer satisfaction and increase in the number of orders.

As well as in this paper, the analysis of Twin head Special Purpose machine (SPM) performed successfully and in this process of designing. The analysis is done by ANSYS 19.5 WORKBENCH. 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 $9.0544*10^{-5}$m, $7.7295*10^{-7}$m and $9.0356*10^{-8}$m respectively which is nearly negligible, that's shows there no any impact of clamping Pressure on the work piece use in Twin head Welding SPM. Which gives safe design of machine and appropriate use of pneumatic cylinder with perfect clamping force generated by cylinders.

Further this SPM allots the benefits to the industry like economical benefits and status improvement among the competitors. We gained unique experience of integrating and evaluating theory and practical aspects of design. This helps us to extract valuable knowledge and data. We are sure that this valuable experience will be helpful in our future in all aspects.

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