Improving the Joint Design in Silencer of Sprayer Machine using FEA

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Abstract—Brazing is used for joining parts of silencer used in sprayer machine which is manufactured by spark auto industry established in 1989. Silencer is a device used to reduce the noise produced by the engine. Cracks are generally form in the heat affected zone of the parent material. Residual stresses are an important consideration in the component integrity and life assessment of welded structure. Inspiring from the FEA, it has been carried out for estimating the stress generation in weld or brazed joint. Here value of residual stress for both, welding and brazing are carried out by thermal stress analysis and compared with each other. For the successful replacement of brazing by welding will only possible when the value of residual stress of welding must be lower than brazing.

Key words: Brazing, Welding, HAZ, Residual Stresses, FEA

I. INTRODUCTION

Spark auto industry establish in 1989, initially they were manufacturer of contact breaker point of automobile and then after they shifted for agriculture engine spare manufacturer. Their products are exhaust silencer, contact breaker point, LT coil, Ignition coil. Starting pulley, throttle lever, control cables etc.

Silencer is a device used to reduce the noise produced by the engine. Silencer is used to reduce the noise produced by the exhaust gases of the engine. Silencer is also used in many other engines and generators. The size, shape and construction vary according to the type and size of the engine. The primary function of the silencer is to reduce engine noise emission.

Permanent joints are carried out by riveting, soldering, brazing, welding etc. In silencer, brazing is used for joining parts of the silencer. Brazing is a process of joining two pieces of metals in which a non ferrous filler metal or alloy is introduced between the pieces to be joined. The melting point of the filler metal is above 450^0 c, but lower than the melting temperature of metal.

While brazing heat affected zone is generated. Cracks are generally form heat affected zone. The following needs to be considered for generation of crack: hydrogen, a microstructure of relatively low ductility, high residual stress, temperature below 200^o C. Residual stresses are an important consideration in the component integrity and life assessment of welded structure. The welding process is very complex time dependent physical phenomenon with material nonlinearity. The welding is a thermal process with convection between fluid flow and welding body, between welding body and environment.

II. LITERATURE REVIEW

R. Raguram,"Problem Solving Methodology", in this paper, author carried study on failure of silencer. It is study of the analysis of failure of silencer and silencer mounting brackets. Analysis of data revealed the presence of vibration as the predominant cause of failure which was proved by ANSYS analysis. One solution is extra clamping for the exhaust system, thus reducing the chances for failure. Also the incorporation of bigger rubber bushes will minimize the chance of vibration being transferred from the chassis to the exhaust system. Another possible solution is Heat treating the O-Clamp may provide it the adequate strength to withstand the load [1].

A. Thirugnanam, Manish kumar and Lenin Rakesh,"Analysis of Stress in Welded Joint in Bending And in Torsion Using Ansys", In this project the analysis of stress in welded joint in bending and in torsion has been carried out by using ANSYS version 12.1 and then the value of stresses and deflection obtained are compared with the values obtained by analytical solution. And the observation carried out was Stress concentration areas, the maximum stress bearing area around weld region are easily determined. The differences between theoretical and analytical values have been compared and found approximately equal [2].

Vishnu V.S, Nadeera M, Joy Varghese V.M,"Numerical Analysis of Effect of Process Parameters on Residual Stress in a Double Side TIG Welded Low Carbon Steel Plate", carried out study To predict distribution of temperature and residual stresses during Tungsten Inert Gas (TIG) double-side arc welding (DSAW) process on a low carbon steel plate. A parametric study on process variables such as welding current and welding speed were performed and its effects on residual stress were measured using FEM. Observed conclusion is Currents variations affect the total heat input per unit volume and directly influence the temperature distributions and consequently the residual stress profiles in the weld plate. The speed variation of top and bottom torches causes preheating and post heating effects on the weld plate [3].

Dattatray- dilip giripunje, Prof. Dr. Vilas B. Shinde, Swapnil S. Kulkarni, Thermal analysis for motor-bike exhaust silencer for ensuring reduction in hot spots through design enhancement. The main objective of the work was to develop high Temperature heat resistant powder coating for Mufflers of automobile applications with enhanced Aqueous corrosion, high temperature corrosion. Comparison of the data determined by the computational approach/ methodology with the physical (laboratory) experimentation would be a good pointer to validate the design. The design would be said to be validated if the geometry of the silencer yields a result that displays a good

match within the analysis and the physical experimentation [4].

Rajlaxmi- n. Mhetre, S.G. Jadhav, "Finite element analysis of welded joints", aim of this study is To develop an efficient and reliable method for simulation of the welding process using the Finite Element Method and the validation of study is A numerical simulation of the welding induced temperature field and corresponding distortions helps to investigate the heat effects of welding and, in the long run, to optimize the quality of welded parts. The analysis results help us understand the phenomena governing the welding of a joint, offering insight on the mechanisms and mechanical aspect particular to the welding process [5].

K.Ashok Kumar, T.N.Charyulu, Dr.CH.Srinivasa Rao, P. Surendra Babu, "Free Expansion and Thermal Stress Analysis of a Corner Welded Joint by Finite Element Method" aim of the work is To simulation of arc welding process for the study of stresses due to free expansion and temperature rise. Out come of study is The stresses are more for fixed conditions due to fin effect and heat loss through the exposed surface due to convection [6].

Mr. Harshal K. Chavan, Mr. Gunwant D. Shelake, Dr. M. S. Kadam, "Finite element model to predict residual stresses in MIG welding", carried out work To study the effects of varying the welding process parameters on the thermo mechanical responses. Thermal analysis was completed using ansys. And observed conclusion are, As heat input changes strain changes respectively, Stress value decreases as heat input increases and As the speed of welding increases the stresses induced in the plate decreases[7].

Peter bernasovsky, "Failure analysis of welded components – importance for Technical practice", the aim is to study about failure of welded component due to generated different types of crack. To distinguish the crack types and to know their causes is very important for adoption of proper measures at their remedy [8].

Naeem Ullah Dar, Ejaz M. Qureshi, M.M.I Hammouda1, "Analysis of weld-induced residual stresses and distortions in thin-walled cylinders", study carried out To precisely capture the distortions and residual stresses, computational methodology based on three-dimensional finite element model for the simulation of gas tungsten arc welding in thin-walled cylinders is presented. Outcome of study are Along and near the weld line, a high tensile and compressive axial residual stresses occurs on the cylinder inner and outer surfaces, respectively, Residual stresses are sensitive to the angular location from the weld start position and Maximum axial and radial deflection is observed near the weld line [9].

R. Melicher, J. Mesko, P. Novak, M. Zmindak, "Residual stress simulation of circumferential welded joints", carried out study on Weld simulation and residual stress modelling using the finite element method (FEM) by commercial software ANSYS and conclusion is Welding velocity and cooling by agitated gas have significant influence on temperature field and on temperature t8/5 but radiation and surrounding air have only negligible influence [10].

III. Issues with Failure of Silencer

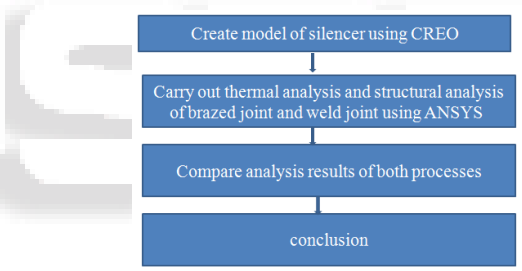
- Creak generated in HAZ
- Corrosion
- Leakage at joint
- Improper fastened assembly

IV. Problem Selection:

- Identified issues and its possible causes are described in ishikawa diagram, are issues within the organization.
- Among identified issues, crack is major issue for the failure.
- To overcome this defect, few possible remedies are mention below.
  1) Use impurities free, pure material.
  2) Increase the travel speed of torch.
  3) Adequate penetration of brass.
  4) Use base metal having high ductility.
  5) Operate torch movement accurately.
  6) Use Proper welding process.

Selection of remedies "Use proper welding process", because it's complete product development, it will provide me knowledge about real issues regarding industry and its remedies to avoid it. During this invention work my technical skill will improve.

V. Problem Solving Methodology



VI. Procedure for Finite Element Method

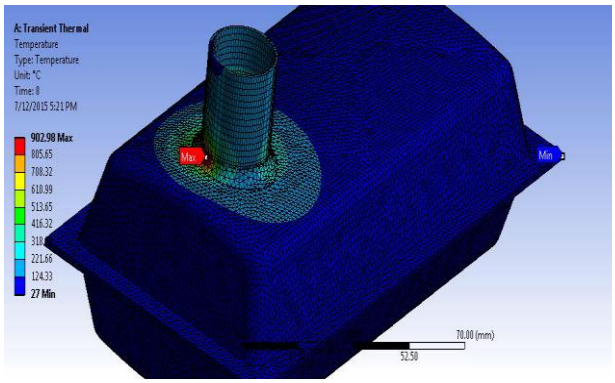
Present work requires that finite element model be created to study effect of process parameter on, deformation, residual stress and strain. One must set up transient thermal analysis to identify temperature distribution in weld and brazed joint and its surrounding components. Following these one should required to import the thermal loading to setup static structural analysis which result into deformation, residual stress. The weldment material properties employed in this study were MS crca sheet, which are considered as constant. The heat input from weld electrode is modeled by using heat flux as input from electrode to weld surface and is depends on the efficiency of arc and welder.

VII. Results

A. Analysis Result for Brazing

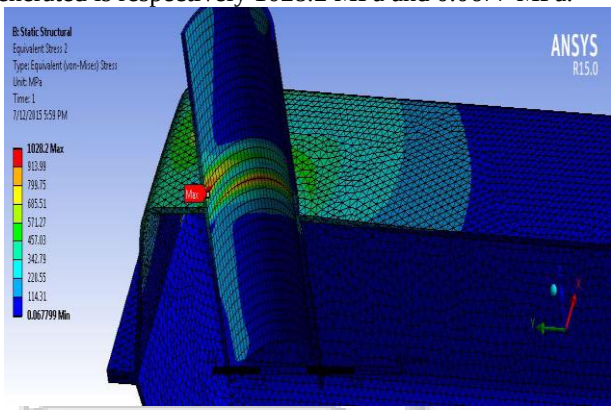
1) Transient Thermal Analysis

When heat flux applied to the parent metal, maximum temperature generated in brazing is 902.98^0 C and minimum is 27^0C.



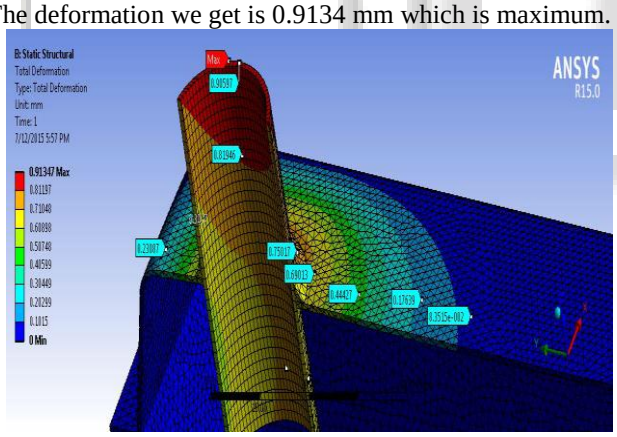
a) Equivalent Stresses

Due to thermal loading maximum and minimum stress generated is respectively 1028.2 MPa and 0.0677 MPa.



b) Total Deformation

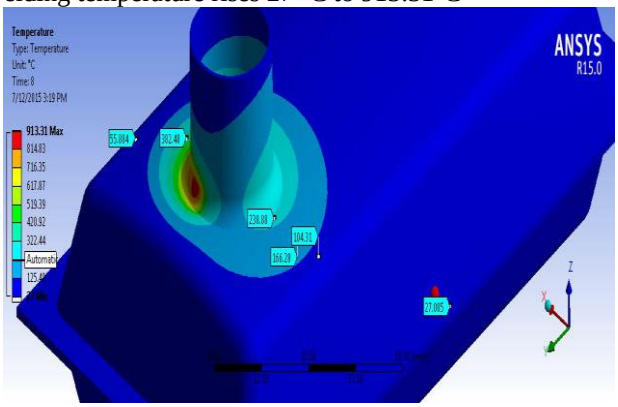
The deformation we get is 0.9134 mm which is maximum.



B. Analysis Result for Mig Welding

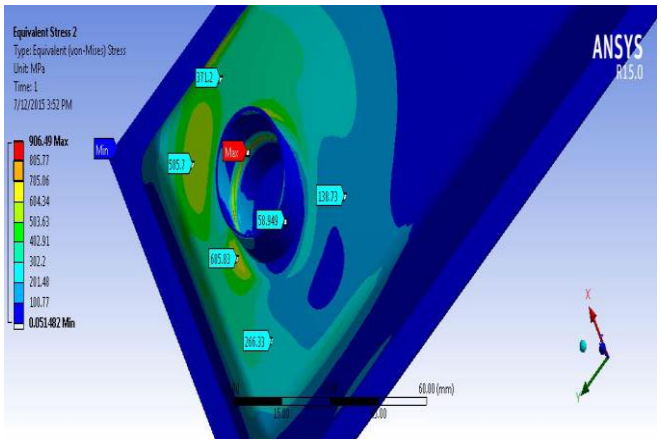
a) Transient Thermal Analysis

In this analysis heat flux is input and at the end of analysis we get temperature distribution. In simulation of MIG welding temperature rises 27^0 C to 913.31^0C



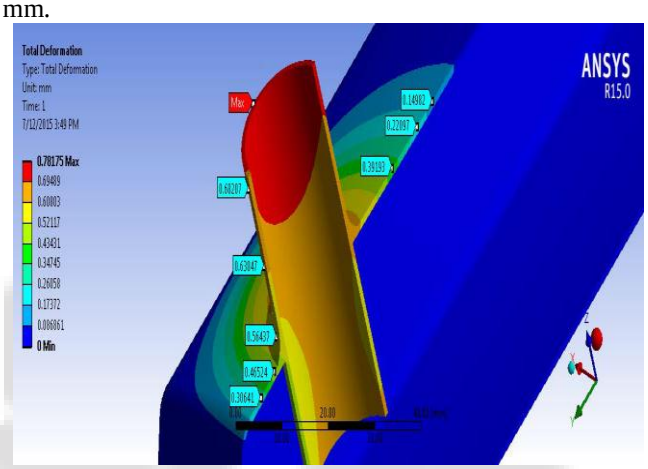
b) Equivalent Stresses

Stresses produced in weld joint is 906.49 MPa is maximum and 0.0514 MPa is min.



c) Total Deformation

Total deformation we get at the end of simulation is 0.7817 mm.



C. Comparison of Analysis Result:

Following table represent the comparison of value we get after the analysis, by comparing results of both the processes (Brazing and Welding), we can take a decision to replace Brazing by Welding or not ?

	Equivalent stresses (MPa)		**Deformation (mm)**	
	Min.	**Max.**	**Min.**	**Max.**
Brazing	**0.067**	**1028.2**	**0.00**	**0.913**
Welding	**0.051**	**906.49**	**0.00**	**0.781**
Difference (in %)	**23.88**	**11.84**	**0.00**	**14.45**

VIII. CONCLUSION

As per value getting from table, we can say that welding at 913.31 degree Celsius having less stresses and deformation compare to brazing at 902.98 degree Celsius. So as per this results welding is applicable instead of brazing. So one solution is that if brazing generate large HAZ then it can be replaced by welding.

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REFERENCE

[1] R. Raguram,"Problem Solving Methodology", Middle-East Journal of Scientific Research, IDOSI Publications, 2014
[2] A. Thirugnanam, Manish kumar and Lenin Rakesh, "Analysis of Stress in Welded Joint in Bending And in Torsion Using Ansys", Middle-East Journal of Scientific Research, IDOSI Publications, 2014
[3] Vishnu V.S, Nadeera M, Joy Varghese V.M, "Numerical Analysis of Effect of Process Parameters on Residual Stress in a Double Side TIG Welded Low Carbon Steel Plate", International Conference on Advances in Engineering & Technology – 2014
[4] Dattatray Dilip Giripunje, Prof. Dr. Vilas B. Shinde, Swapnil S. Kulkarni,"thermal analysis for motor-bike exhaust silencer for ensuring reduction in hot spots through design enhancement", International Journal of Advanced Engineering Research and Studies, July-Sept., 2013
[5] Rajlaxmi N. Mhetre & S.G. Jadhav, "Finite element analysis of welded joints", International Journal of Instrumentation, Control and Automation (IJICA),2012
[6] K.Ashok Kumar, T.N.Charyulu, Dr. CH.Srinivasa Rao, P. Surendra Babu, "Free Expansion and Thermal Stress Analysis of a Corner Welded Joint by Finite Element Method", International Journal of Modern Engineering Research (IJMER), Nov-Dec. 2012
[7] Mr. Harshal K. Chavan, Mr. Gunwant D. Shelake, Dr. M. S. Kadam, "finite element model to predict residual stresses in mig welding", international journal of mechanical engineering and technology (IJMET), 2012
[8] Peter Bernasovsky, "Failure analysis of welded components – importance for technical practice", IIW International Congress in Central and East European Region Slovakia, oct-2009.
[9] Naeem Ullah Dar, Ejaz M. Qureshi, M.M.I Hammouda1, "Analysis of weld-induced residual stresses and distortions in thin-walled cylinders", Journal of Mechanical Science and Technology 23 (2009)
[10] R. Melicher, J. Mesko, P. Novak, M. Zmindak, "Residual stress simulation of circumferential welded joints", Applied and Computational Mechanics, oct-2007 www.wikipedia.com
[11] "Production technology", R.K.Jain, 6th edition, khanna publishers.
[12] "Fabrication Technology", Mr. H. S. Jariwala and Mr. H. K. Desai, Atul prakashan.

