ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Impact Factor: 2.114

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

WELD CRACK RECTIFICATION IN CATALYTIC CONVERTER BY FABRICATION OF CUSTOMIZED JIG PLATES

A. Vignesh*, P. Kritin Ram
[1*] B.E. Production Engineering, Government College of Technology, India
[2] B.E. Mechanical Engineering, Sri Krishna College of Technology, India
avignesh_ca@yahoo.com

ABSTRACT
The main objective of this paper is to "rectify the weld cracks by the fabrication of customized jig plates". In the engine section of the industry, there were frequent rejections of the catalytic converters due to weld cracks. When the catalytic converter assembly line was inspected, tiny cracks in the weld were found visually. Then they were tested through bench magnifiers and dye penetration test for confirmation and it was confirmed to have cracks in the weld. The crack was found in the casting to shell joint of the catalytic converter. Then the casting was tested for its contaminants which could also cause cracks in the weld. The DED (double end drive) welding jig plate setup was also checked thoroughly for any defects. In order to check whether the type of welding used gives better penetration and strength, weld penetration test was done. Finally, after several inspections of the welding process it was found that the crack was due to the biasing of the axis of jig plates. Then, finally the biasing was avoided by fabricating a new jig plate. Thus the entire defect is drastically reduced by minimizing the cracks and thus maintaining the efficiency of the engine.

KEYWORDS: Jigs, Solid works, Penetration, Biasing, Efficiency.

INTRODUCTION
A catalytic converter is a vehicle emissions control device that converts toxic pollutants in the exhaust gas to less toxic pollutants by catalyzing a redox reaction (oxidation or reduction). Catalytic converters are used with internal combustion engines fueled by either petrol (gasoline) or diesel—including lean burn engines. A Catalyst is one which speeds up a chemical reaction, takes part in the reaction but does not undergo change in its structure and properties. [1]

Jigs and fixtures are special purpose tools which are used to facilitate production (machining, assembling and inspection operations) when work pieces are to be produced on a mass scale. The mass production of work pieces is based on the concept of interchangeability according to which every part will be produced within an established tolerance. Jigs and fixtures provide a means of manufacturing interchangeable parts since they establish a relation, with predetermined tolerances, between the work and the cutting tool. They eliminate the necessity of a special set up for each individual part. Once a jig or fixture is properly set up, any number of duplicate parts may be readily produced without additional setup. Hence jigs and fixtures are used. The main purpose of a fixture is to locate and in the cases hold a workpiece during an operation. A jig may be defined as a device which holds and positions the work, locates or guides the cutting tool relative to the work piece and usually is not fixed to the machine table. It is usually lighter in construction. A fixture is a work holding device which only holds and positions the work but does not in itself guide locate or position the cutting tool. [2]

PROBLEM DEFINITION
The weld cracks are formed in the catalytic converter (shell to cast joint) due to the misalignment in the axis of the jig plates in the DED welding setup. The misalignment is due to the wear of the plates. The term misalignment during the process is termed as biasing. When the biasing occurs the cast part gets deviated down the central axis. Biasing of the plates is the major reason for the formation of the cracks in the catalytic converter weld joint. Hence the weld

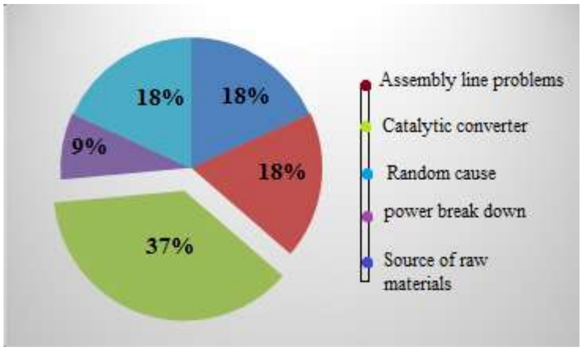
ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Impact Factor: 2.114

penetration test should be done in order to know whether the used weld has good penetration. This test serves two purposes as to know the penetration of the weld and also the depending on the penetration the strength can be found. A complete redesign of the jig plate setup is done in order to solve the problem of misalignment.

PROBLEM ANALYSIS

However the process flows in a correct path, there may be some factors which will lead to the production loss in terms of raw materials, time, cost, assembly line etc. The problem was analyzed in the engine shop where the production loss occurred due to problems in the catalytic converter. The following are the some main factors which will lead to the production loss in our industry shown in the Fig. 1. They are listed as below:

- Break- Down of Power
- Assembly line problems
- Source of Raw Materials
- Random Cause
- Cracks in catalytic converter



Causes of problems

PROBLEM IDENTIFICATION

The problem was found in the catalytic converter shell to cast weld. The type of weld used here is MIG (METAL INERT GAS WELDING). The problem was identified during the assembly of catalytic converter to the exhaust manifold of the engine through visual inspection and then sent for leak test and dye penetration test for confirmation of the crack. They were also tested through bench magnifiers at several stages during the manufacturing process in order to reduce the cracks.

STEPS IN IDENTIFICATION

The problem was first identified through visual inspection and then bench magnifiers were used to confirm the cracks. In order to locate the cracks and to find the strength and penetration of the weld used the following tests were conducted,

- Dye penetration test
- Weld penetration test

Visual Inspection

The catalytic converter weld area was inspected visually through naked eyes. Tiny cracks could be seen. For confirmation of the cracks, it was sent for several other tests such as bench magnifier test and dye penetration test.

Bench Magnifier Inspection

The bench magnifier test consists of a simple bench and lens setup for closer viewing of the surface which helps in revealing the cracks in the surface. It is a very effective means of identifying the surface cracks. This method was used as it was a very easy and effective test and also can be done at a very low initial cost. The bench magnifier test results showed that cracks were present in the weld. Then in order to locate the cracks dye penetration test was done.

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Impact Factor: 2.114

Dye Penetration Inspection

Dye penetrant inspection (**DPI**), also called **liquid penetrant inspection** (**LPI**) or **penetrant testing** (**PT**), is a widely applied and low-cost inspection method used to locate surface-breaking defects in all non-porous materials (metals, plastics or ceramics). [3] The penetrant may be applied to all non-ferrous materials and ferrous materials. Although for ferrous components, magnetic particle inspection is often used instead for its subsurface detection capability. LPI is used to detect casting, forging and welding surface defects such as hairline cracks, surface porosity, leaks in new products, and fatigue cracks on in-service components. [4] The catalytic converter which is tested for cracks is shown below in the Figure.

Figure:

Penetrant Coated Catalytic Converter

Results of Dye Penetration Inspection

The catalytic converter sent for dye penetration test was confirmed to have cracks and the area of cracks can be seen in red color in the Figure below. The red color is due to the developer coating which was given on the penetrant.

Figure:

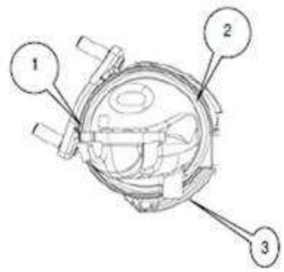
Result of Dye Penetration test

WELD PENETRATION TEST

In order to know the quality of the weld, weld penetration test was done. The weld penetration test also shows the strength of the weld. If the required quality of the weld is not achieved with this type of welding, then the changes have to be made in the welding process. [5]

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Impact Factor: 2.114

Figure:

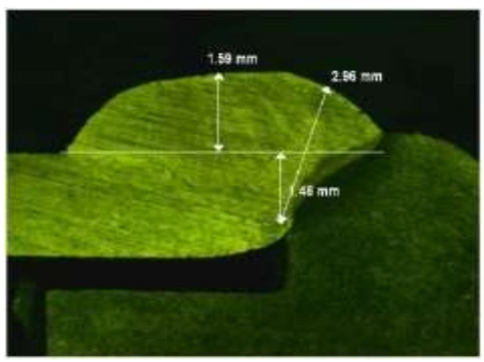


Top view of catalytic converter showing 3 weld zones

The above Figure Shows the top view of the catalytic converter in which all the three welding areas can be seen. The welding areas are divided into three zones and the three zones are inspected individually. The results of the three zones are tabulated below,

Weld Penetration Inspection Report

Figure:



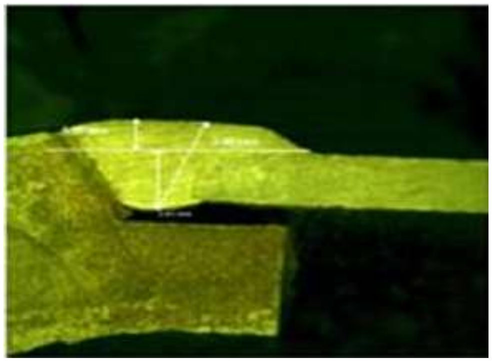
Weld penetration specifications

Table 1 Weld Penetration Specifications

Input parameters	Specifications	Actual
Current (a)	200-240 amps	215amps
Voltage (v)	20-22 volts	20.5volts
Gas flow rate (LPM)	14-20lpm	18-20lpm
Stick out length (gauge)	10-15mm	14mm
Drive speed	65	65
Weld wire diameter	1.2mm	1.18mm
Weld wire grade	308l	308l

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Impact Factor: 2.114

Figure:



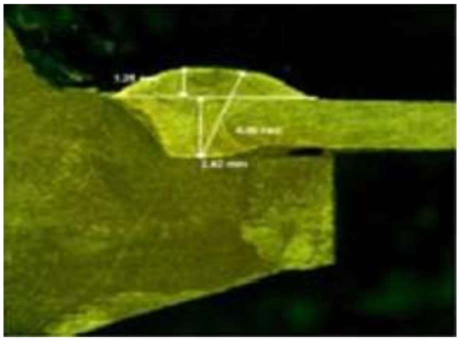
Zone 1 Weld (Microscopic view)

Table 2 zone 1 results

Sl. No	Characteristics	Spec- min	Spec t=2. 01	Observation
1.	Penetration-P	0.2*T	0.40	2.41
2.	P+R	P+R ≥ T1	2.01	3.7
3.	Min. Section Dimension	≥ 0.75*T1	1.51	3.89

JUDGEMENT: OK

Figure:



Zone 2 Weld (Microscopic view)

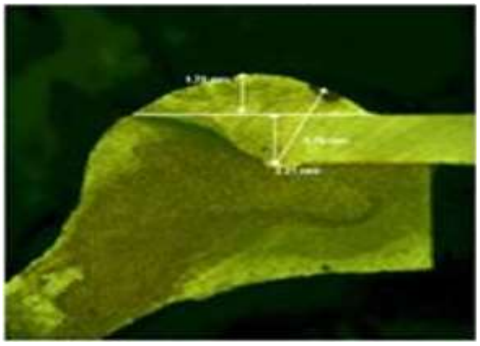
Table 3 zone2 results

Sl. no	Characteristics	Spec- min	Spec t=2. 01	Obser vation
1.	Penetration-P	0.2*T	0.40	2.62
2.	P+R	P+R ≥ T1	2.01	3.87
3.	Min. Section Dimension	≥ 0.75*T1	1.51	4

JUDGEMENT: OK

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Impact Factor: 2.114

Figure:



Zone 3 Weld (Microscopic view)

Table 3 zone 3 results

Sl.no	Characteristics	Spec- min	Spec- max	Spec t=2. 01	Observation
1.	Penetration-P	0.2*T	*	0.40	2.21
2.	P+R	P+R ≥ T1	*	2.01	3.91
3.	Min. Section Dimension	≥ 0.75*T1	*	1.51	3.76
4.	Undercut depth 20% max thickness of thinner sheet	*	0.3 mm Max	0.3	0
5.	Weld slag	*	3m	3	0
	1. Slag size 3mm Max of each slag allowed 2. 3 slags Max in a bead length of 25mm		m Max		

JUDGEMENT: OK

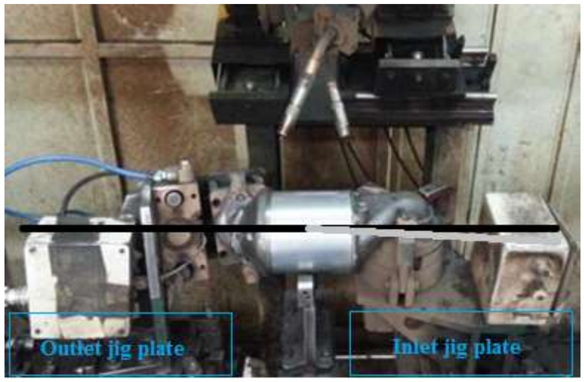
Weld Penetration Test results

The results of the weld penetration test were tabulated and the results were found to be ok (required penetration was achieved). This confirms that the strength of the weld is good. Thus, the required penetration can be achieved with this type of welding.

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Impact Factor: 2.114

EXISTING DESIGN SETUP

Figure:

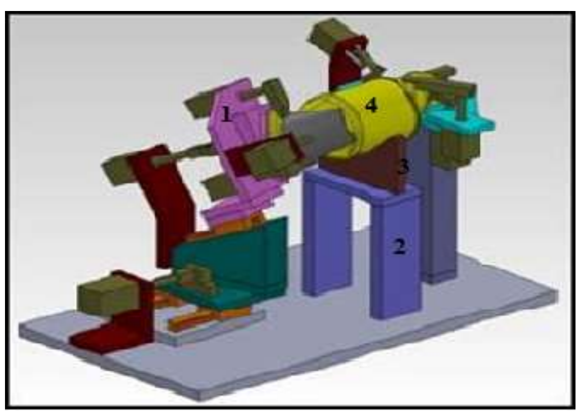


Existing Jig Plate design

This figure shows the existing design setup which has two jig plates for holding the inlet and the outlet flanges of the catalytic converter. In this setup the workpiece will rotate and the and the tool will be held in place. When the tool rotates, the inertial force which is developed causes the loosening of the joints in the jig plates which ultimately leads to the wear of the plates.The axis line (black) in the Fig. 8 indicates the central axis of the jig plates. The other line (grey) marked on the figure indicates the misalignment of the inlet jig with the outlet jig. The misalignment is due to the wear of the plates. The term misalignment during the process is termed as biasing. When the biasing occurs the cast part gets deviated down the central axis. Biasing causes vibrations of the plates and is the major reason for the formation of the cracks in the catalytic converter (shell to cast) weld joint. In order to avoid the misalignment and prevent the frequent wear of the jig plates, new jig plate setup has been designed which helps in preventing frequent wear of the jig plates and the misalignment of the plates which ultimately leads to the failure of the catalytic converter can be avoided. The new design was done using SOLIDWORKS 13. There were several constraints which were taken into consideration before designing the jig plates.

CUSTOMIZED JIG PLATE DESIGN

Figure:



Solid Works model of new design

The Figure shows the following components,

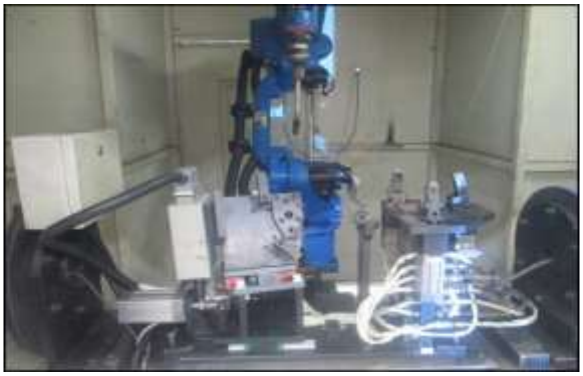
- Jig plates
- Supports
- Locator

- Catalytic convertor

This figure shows the customized jig plate design which was done using SOLID WORKS 13. In this design, the workpiece will be held constant and the weld tool moves along the weld the workpiece. The locators, fixtures and the clamping were redesigned by taking into account that they are designed with minimum material usage and maximum strength. [2] Proximity sensors were used for the proper positioning of the catalytic converter. The design was thoroughly evaluated and then taken for fabrication. A number of materials were analysed for mechanical properties out of which mild steel was chosen.[6]

FABRICATED NEW DESIGN

Figure:



Fabricated new design

CONCLUSION

Thus, the above specified jig plate has been designed and fabricated. SOLID WORKS 13 was employed in designing the entire setup. Mild steel which was used in fabricating the jig plates which made the setup more economical. The weld cracks were finally avoided by eliminating the biasing due to the rotation of the jig plates. Therefore, the production rate is gradually increased by reducing the rejection and reworks of catalytic converters and also maintaining the efficiency of the engine due to leakage.

REFERENCES

1. http://en.wikipedia.org/wiki/Catalytic_converter.
2. “Design and Finite Element Analysis of JIGS and Fixtures for Manufacturing of Chassis Bracket” International Journal of Research in Advent Technology, Vol.2, No.2, February 2014 E-ISSN: 2321-9637.
3. http://en.wikipedia.org/wiki/Dye_penetrant_ inspection.
4. McMaster, R.C., 1982, Liquid Penetrant Tests. Columbus, OH: American Society for Nondestructive Testing.
5. K.Y. Benyounis, et al. “ Effect of welding parameters on heat input and weld bead profile ’’,Journal of Materials Processing Technology , 15 May 2005 , Vol.164-165, pp. 978-985, (AMPT/AMME05 part 2).
6. Materials Science and Engineering Paperback – 2010 by Donald Askeland (Author) published by Cengage Learning India Pvt Ltd.
7. Hellier, C.J., 2001, Handbook of Nondestructive Evaluation New York: McGraw-Hall.
8. Z. Smati, “Automatic pulsed MIG welding”, Metal Construction, Jan. 1986, pp. 38R-44R.