International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 11, November-2015

A Review on Analysis, Monitoring and Detection of Weld Defect Products

Rajeev Kumar
M.E. Student,
Department of Mechanical Engg.,
NITTTR Bhopal-462002, INDIA

Dr. Vandana Somkuva
Associate Professor,
Department of Mechanical Engg.,
NITTTR Bhopal-462002, INDIA

Abstract- **Weld defects detection method is generally evaluated on the basis of weld defects, weld disturbances, welding parameters and welding process monitoring system. The importance of weld defects detection is to identify the weld defects and weld disturbance in the welding process. The weld defect detection methods or devices to identify and monitoring the weld defects like internal and external cracks, lack of fusion, lack of penetration, porosity, blow holes, slag inclusion, lamellar tear and deformation etc. There are many approach or techniques to detect the weld defects basically DPT, MPI, RT, UT and VI for various materials. Reviews of various approaches compare relative advantages main, features and limitations of welding process. This paper analyzes the development done in the area of defect detection methods and monitoring systems in welding process.**

Keywords: Weld defects detection, weld quality, Process monitoring

I. INTRODUCTION

Welding is a fabrication process that joins two or more than two materials usually metals and non- metals. It is also dependable, efficient and economic method for permanently joining similar as well as non-similar metals and plastic also. Welding is used extensively in all sectors of manufacturing industry. In recent years the number of different welding processes has grown. These processes differ greatly in the manner in which heat and pressure (when used) are applied, and in the type of equipment used. Many welding processes are accomplished by pressure with no external heat supplied, some type of welding accomplished by combination of heat and pressure, and some type of welding accomplished by heat alone with no pressure applied.
Welding used in different areas like Bridges, pressure vessels, building structures, aircraft, Automobile, Railway tract and Railway coach factories, Nuclear installations, defense industries, Pipe lines, Electrical & Electronic etc.

Welding defect is defined as any flaw that compromises the usefulness of any products. It is also defined as irregularities in the weld metal produced due to incorrect welding parameters or wrong welding procedures or wrong combination of metal and non-metal plates. Weld defect may also be the variation from the intended weld bead shape, size and desired quality. In the welding process there are many wear or defects occur. If wear reaches extreme level, the job can break. These wear factor may include oversize work piece, casting blow holes in the work piece, thermal and mechanical properties, and variation of different metal work piece hardness. According to the American Society of Mechanical Engineers (ASME), welding defect causes are as follows: 45 percent poor process conditions, 32 percent operator error, 12 percent wrong technique, 10 percent incorrect consumables, and 5 percent bad weld grooves. Welding defects are classified according to ISO 6520.

The weld defects are major problem of fabrication industry. The Weld Defects occur during welding due to the complexities of the welding processes, moisture in the air and the unpredictable factors. Therefore, welds must be inspected manually or by welding defect detection techniques along the joint to be sure that the weld is free from weld defects and the weld structure can meet the demand product and strength.

II. WELDING DEFECTS DETECTION METHOD

There are many approaches are used to detect and identify the weld defects. They are as follows:

- *Dye Penetrant Testing (DPT):*

It is also called liquid penetrant inspection (LPI) or Penetrant Testing (PT) is a method used to locate the surface-cracking defects in all non-porous materials. This method is mainly used for testing of non-magnetic materials. The penetrant may also be applied to all ferrous and non-ferrous materials. This Test method covers procedures of Heat Effected Zone (HAZ) of weld materials for penetrant examination. Liquid penetrant inspection is used to detect welding surface defects such as hairline cracks, surface porosity, leaks in new products, and fatigue cracks on the products. In this method, a red colored dye penetrant is applied on the surface of the component by dipping, spraying, or brushing. This dye enters crack interfaces through capillary action. After some times the excess penetrant is removed and a developer is applied to detect the weld defects. There are five stages of Dye Penetrant Testing (DPT) are as follows:

- Pre-cleaning
- Application of Penetrant
- Excess Penetrant Removal
- Application of Developer
- Inspection

- *Magnetic particle inspection(MPI):*

Magnetic particle Inspection (MPI) is a non-destructive testing (NDT) process to detect the weld discontinuities and weld defects in magnetic materials like iron, nickel, cobalt, and their alloys. To directly magnetize the product, the electric current is passed through the test products and a magnetic field is formed in the tested material, and if product is indirectly magnetized, then a magnetic field is applied from an outside source. These magnetic forces are perpendicular to the direction of the electric current. Any magnetic material, the line of force exits or enters the magnet is called a pole, the line of force exits the magnet is called a north pole and a line of force enters the magnet is called a south pole.

If the magnetic materials are just cracked, not broken in two parts a north and south pole will form at each edge of the crack. If iron particles are sprinkled on a cracked magnetic material, the particles will be attracted the poles at the ends of the magnetic material and the poles at the edges of the crack.

- *Radiographic testing method (RT):*

The radiographic testing method is a nondestructive testing (NDT) method used for the detection of internal weld defects or weld discontinuities in many different materials and configurations. It is based on using short wavelength electromagnetic radiation passing through the material. The radiation passing through the material forms an image on a photographic film (radiograph).

- *Ultrasonic Testing (UT):*

Ultrasonic Testing (UT) is a non-destructive method used for material thickness measurement as well as flaw detection of welding. It is high frequency sound waves travels in different speeds at different materials. Most ultrasonic inspection is above the range of human hearing (20 Hz to 20 KHz), those frequencies between 0.5 and 20 MHz to measure geometric and physical properties in materials. An ultrasound transducer connected to a diagnostic machine, it is separate from the test object by a couplant (such as oil) or by water. Transducer performs both sending and the receiving sound waves. The sound energy is propagates through the materials in the form of waves. Reflected ultrasound comes from the back wall of the product or from an imperfection within the product like cracks or porosity. The reflected wave signal is receive by the transducer and is displayed on a screen.

- *Visual inspection:*

Visual inspection is a nondestructive examination (NDE) technique used for the quality control, data acquisition, and data analysis. Visual inspection is also used for determine whether the part was fabricated to the correct size, the part is complete, or all of the parts have been appropriately incorporated into the device.

Visual testing is classified as remote visual testing, direct visual testing and translucent visual testing..

III. EXISTING RESEARCH EFFORTS

Yauso Suga et. al. [1] studied that the x-ray radiographic testing method is used for detecting weld defects. If small weld defects difficult to identify from the X-ray film then skilled laborers should be trained. The image processing system allows detect weld defects by the using X-ray radiography in the presence of background noise. The CCD camera capture image in the welding process, and detects the weld defects like pores, slag inclusions and cracks etc.

David Naso et. al. [2] describes the real time weld defect detection in gas metal arc welding processes by the using of optical sensor and fuzzy logic. The sensor measures the radiations emitted by the plasma arc welding, and analyze the information in real time to determine the weld defects and weld quality and fuzzy system is able to detect the risk of specific problems like current, voltage, speed of the arc, holes etc. and the position of defects along the welding line.

N. Nacereddine et. al. [3] described that the identification and evaluation of discontinuities in welded joints, or weld defects, such as porosity, cracks and foreign inclusions found in welding by the using of Industrial radiography. It is developed and implements digital image processing based on local approaches and global for the purpose of automatic weld defect detection by the radiographic images. If the radiographic images are poor quality, it is due to small size of the weld defects as well as physical nature of radiography.

Stephen W. Kercel et. al. [4] discussed in tailor-welded blanks the on-line monitoring of weld quality and weld defects detection by the Laser-based ultrasonic (LBU) measurement. Tailor-welded blanks are steel plates for differing thickness are used in automobile manufacturing, plates, bodies, frame etc. Laser-based ultrasonic (LBU) is used for the purpose of generate the ultrasound and a continuous wave (CW) laser to detects weld defects.

Reza Nejatpour et. al. [5] evaluates the Visual Test of the weld defects detection using image processing and CAD methods. The image captured by CCD camera and stored in the computer which analyses the weld such as size, position, surface smoothness and cracks, etc. These images captured continuously from different sections of the weld metals for the purpose of 3D model of the weld are achieved and detect the weld defects.

Yan Hanbing et. al. [6] described the radiographic testing for the purpose of weld defect identification and classification on the basis of binary decision tree. Binary decision tree can recognize one kind of weld defect from the others defect according to their features. The welding image captures and stored in the computer by the radiographic testing to identify and detect the weld defects as well as satisfactory performance for defect classification.

Daniel Bebiano et. al. [7] evaluate that the monitoring and controlling of GTA welding process by using of spectroscopy and some algorithms. In the welding process there are many radiation emitted by the electric arc, these radiation emitted by the welding, input parameters and disturbances of welding capture by the sensor spectroscopy, and algorithm were ability to pointing out simulated welding defects in the signal alight by the sensor. The algorithms can be applied in the welding process in real time to online monitoring system to detect weld defect and improve weld quality.

Sergio Saludes Rodil et. al. [8] discussed the laser welding process evaluated by formation of an electron-free plasma, these radiation used for the detection of weld defects. These weld defects detect by two different approaches, first is based on the power spectrums of a photodiode-generated signal which is correlate between welding defects and second is based on plasma electronic temperature. These both detection methods are capable to inspect the whole CO2 welding process without increasing the welding time.

Ioannis Valavanis et. ai. [9] Evaluate the radiography for the purpose of defect detection and classification of welding using geometrical and structural. Through the radiography capture the images for the welding process and detect the weld defects such as porosity, lack of fusion, worm holes, cracks and linear slag inclusion etc., these weld defects were classified by the using of multi-class Support Vector Machine (SVM) and Neural Network. For this also investigated the feature selection of weld defects and disturbances.

Xianglin Zhan et. al. [10] described that the ultrasonic is used for external and internal cracks layer detection of pipeline girth welding process. For the ultrasonic array the transducer is capable of electronic steering to improving weld defects detection efficiency, the weld defects detection precision and sensitivity are decided by the characteristics of the ultrasonic transducer.

R. Kafieh et. al. [11] evaluate the non-destructive infrared imaging testing method for the purpose of weld defects detection and weld disturbance detection or error-detection of welding polyethylene pipes. In welding process the camera may have a capability of making a complete rotation around the welding pipe. Infrared images method captures images of the welded pipes in a welding time of the cooling process and algorithm was compared to current burst and crush detection in welding process.

Domingo Mery [12] evaluate an approach to detection and classification of welding defects are automatically best on X-ray imaging in continuous welding process. The sliding-windows and novel features are the local binary patterns from saliency maps. The real X-ray images in the welding process showing high effectiveness, and detection of weld defects or weld disturbance.

Alireza Azari Moghaddam et. al. [13] proposed that the radiographic images can be used for the purpose of detection of weld defects. The weld defects detection method is used for two dimensional left filters for de-noising the radiographic images. The Non-Destructive Testing (NDT) method reduces human working effort and increases the weld defect detection efficiency and identifies different types of weld defects.

J. Hassan et. al. [14] described the radiographic images Non-Destructive Testing (NDT) method is used for the purpose of detect weld defects in the welding process. This is the geometric features of weld defect detection and classification of welding process. The radiographic images contain noise of welding process due to several effects and algorithm used to detecting and classifying of weld defects.

Tong Tong et. al. [15] described the detection of complexity weld defects using iterative threshold algorithm and multi-scale mathematical morphology. The mathematical morphology theories are detects small size of weld defects to the image segmentation. The conventional image processing methods is used to detect weld defects in the welding process by the capture the images of welding process.

B M Abdullah et. al. [16] described that the weld bead monitoring system, weld defects detection and identified using an electromagnetic sensor. The sensor scans the weld bead surface for detect the weld defects and identified the size and type of defects like undercutting and excess penetration. Every types of defects has its own signature, hence an appropriate weld monitoring system can be taken to reform the defective section. This Electromagnetic (EM) sensor is economical because electromagnetic waves are travel in the vacuum at the speed of light.

M. Loman et. al. [17] investigate the acoustic emission technology for the purpose of detect the weld defects on steel metals. The piezoelectric sensor is located on the welding surface of welding products and pressurized to promote welding cracks or other types of weld defects. The acoustic emission signatures were find weld defects and weld disturbance using the AE signals, the signal were analyses and verify the weld defects. It is also show that differences between defects and without defects in the welding specimen.

N. Ramou et. al. [18] evaluates the radiographic images for the purpose of on line detects weld defects in the welding products. The image segmentation method are capture the weld process images to detects weld defects, in higher order accuracy of weld in the temporal discretization using Total Variation Diminishing (TVD) Runge Kutta (RK) methods.

IV. CONCLUSION

Literature survey evaluates the areas were several non-destructive testing methods are used to identify the weld defects like DPT, MPI, RT, UT and VI etc.

The online weld defect detection and monitoring is performed by the using of sensor and suitable value of welding current, welding voltage, nozzle angle, nagged diameter, temperature and pressure etc. Online defect identification and quality monitoring methods like statistical weld process monitoring system SPC, signature image processing, neural network, and fuzzy logic are used.

Based on the findings of the literature, most of the work is specific to single defect and various parameters ……

Human behavior, working environment, equipment condition, maintenance, worker expertise, type of work -high product volume productivity and quality requirements; Need for flexibility.

REFERENCES

[1] Yauso Suga*, Kouichiro Kojima and Tetsuro Tominaga, "Detection of Weld Defects by Computer-Aided X-Ray Radiography Image Processing" International Journal of Offshore and Polar Engineering Vol. 5, No.2, June 1995 (ISSN 1053-5381)

[2] David Naso, Biagio Turchiano, "A Fuzzy-Logic Based Optical Sensor for Online Weld Defect-Detection" IEEE Transactions on Industrial Informatics, Vol. 1, No. 4, November 2005

[3] N. Nacereddine, M. Zelmat, S. S. Belaïfa and M. Tridi, "Weld defect detection in industrial radiography based digital image processing" International Conference: Sciences of Electronic, Technologies of Information And Telecommunications March 27-31, 2005 – Tunisia

[4] Stephen W. Kercel, Roger A. Kisnera, Marvin B. Kleinb, G. David Bacherb, Bruno Pouetb, "In-process detection of weld defects using laser-based ultrasound" Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge

[5] Reza Nejatpour, Ali Asmari Sadabad, Ali Akbar Akbari, "Automated Weld Defects Detection Using Image Processing And Cad Methods" ASME International Mechanical Engineering Congress And Exposition October 31-November 6, 2008, Boston, Massachusetts, USA

[6] Yan Hanbing, Zhao Lina, Ju Hui, "Research on SVM Based Classification for Welding Defects in Radiographic Testing" 978-1-4244-4131-0/09/2009 IEEE

[7] Daniel Bebiano and Sadek C. A. Alfaro, "A Weld Defects Detection System Based on a Spectrometer" ISSN 1424-8220, Sensors 2009, 9, 2851-2861; doi:10.3390/s90402851

[8] Sergio Saludes Rodil, Roberto Arnanz Gómez, "Laser welding defects detection in automotive industry based on radiation and spectroscopical measurements" Int J Adv Manuf Technol (2010) 49:133–145

[9] Ioannis Valavanis, Dimitrios Kosmopoulos, "Multiclass defect detection and classification in weld radiographic images using geometric and texture features" Contents lists available at Science Direct, 0957-4174/ front matter _ 2010 Elsevier Ltd. All rights reserved.

[10] Xianglin Zhan, Jian Li, and Shijiu Jin, "Research on Ultrasonic Phased Array System for Automatic Defect Detection of Pipeline Girth Welds" World Congress on Intelligent Control and Automation July 6-9 2010, IEEE

[11] R. Kafieh, T. Lotfi , Rassoul Amirfattahi, "Automatic detection of defects on polyethylene pipe welding using thermal infrared imaging" Infrared Physics & Technology 54 (2011) 317–325

[12] Domingo Mery, "Automated Detection of Welding Defects without Segmentation" Av. Vicuna Mackenna 4860(143), Santiago de Chile.

[13] Alireza Azari Moghaddam, Lalitha Rangarajan, "A method for detection welding defects in radiographic images" International Journal of Machine Intelligence ISSN: 0975–2927 & E-ISSN: 0975–9166, Volume 3, Issue 4, 2011.

[14] J. Hassan, A. Majid Awan, A. Jalil, "Welding Defect Detection and Classification Using Geometric Features" International Conference on Frontiers of Information Technology, 2012 IEEE.

[15] Tong Tong, Cai Yan, Sun Dawei, "Defects Detection Of Weld Image Based On Mathematical Morphology and Thresholding Segmentation" 978-1-61284-683-5/12, 2012 IEEE.

[16] B M Abdullah, A Mason and A Al-Shamma, "Defect detection of the weld bead based on electromagnetic sensing" Journal of Physics: Conference Series 450 (2013) 012039

[17] M. Loman, C.K.E. Nizwan, and N.M. Yusof, "Defect Detection on Welding Joint using Acoustic Emission Technology" International Conference on Innovations in Engineering and Technology (ICIET'2013) Dec. 25-26

[18] N. Ramou, M. Halimi, "Extraction of weld defect from radiographic images using the level set segmentation without reinitialization" , 978-1-4673-5285-7/13/2013 IEEE.