International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 02 | Feb -2020 ISSN: 2582-3930

WELDMENT DEFECTS STUDY OVER MILD STEEL THROUGH NDT

I.S.N.V.R.PRASANTH[1] K.Avinashreddy[2] B.Shiva krishna[2] K.Manikanta[2]

[1]Assistant Professor, [2]UG Scholar

[1,2]Department of Mechanical Engineering, Guru Nanak Institute of Technology, Rangareddy, Telangana, India

ABSRTACT

Non-destructive testing is a different kind of tests which are used to learn about the physical properties of specimens. By the other techniques like tensile testing and hardness testing the specimen is destructed after the experiment but in this testing type the specimen is not destructed. There are eight different NDT methods: Visual Inspection, Microscopy, Radiography, Dye penetrate, Ultrasonic, Magnetic Particle, Eddy Current and Acoustic Emission. These methods are only seperated in application technique. We used two different types of methods for our testing, Liquid penetration test and Magnetic particle testing.Non-destructive Testing is one part of the function of Quality Control and is Complementary to other long established methods. By definition non-destructive testing is the testing of materials, for surface or internal flaws or metallurgical condition, without interfering in any way with the integrity of the material or its suitability for service.

1.INTRODUCTION

A general definition of non destructive testing (NDT) is an examination, test, or evaluation performed on any type of test object without changing or altering that object in any way, in order to determine the absence or presence of conditions or discontinuities that may have an effect on the usefulness or serviceability of that object. Non destructive tests may also be conducted to measure other test object characteristics, such as size; dimension; configuration; or structure, including alloy content, hardness, grain size, etc. The simplest of all definitions is basically an examination that is performed on an object of any type, size, shape or material to determine the presence or absence of discontinuities, or to evaluate other material characteristics.

Non destructive examination (NDE), non destructive inspection (NDI), and non destructive evaluation (NDE) are also expressions commonly used to describe this technology. Although this technology has been effectively in use for decades, it is still generally unknown by the average person, who takes it for granted that buildings will not collapse, planes will not crash, and products will not fail.

Although NDT cannot guarantee that failures will not occur, it plays a significant role in minimizing the possibilities of failure. Other variables, such as inadequate design and improper application of the object, may contribute to failure even when NDT is appropriately applied.

NDT, as a technology, has seen significant growth and unique innovation over the past 25 years. It is, in fact, considered today to be one of the fastest growing technologies from the standpoint of uniqueness and innovation. Recent equipment improvements and modifications, as well as a more thorough understanding of materials and the use of various products and systems, have all contributed to a technology that is very significant and one that has found widespread use and acceptance throughout many industries.

2. LITERATURE SURVEY

Ranganayakulu et al. (2015) studied about TIG welded EN-08 steel specimen by the use of Non-Destructive Evaluation. The work describes the correlation of different NDT methods for identifying intensity of flaw, accuracy of orientation and position of flaw in same specimen is carried out. Liquid penetration process is relatively simple, low capital cost the arrangement of discontinuities is not a limitation but it has its own limitations as it can inspect depth up to 2 mm. The defects need to open to the surface. This testing produce offer low reliability and moderate sensitivity and requiring considerably high degree of operator skill. Mild steel is most widely used material in manufacturing. EN-08 is usually supplied untreated material which can also be supplied in the normalized or finally heat treated, quenched and tempered which is adequate for a wide range of applications. As the test specimen is mild steel magnetic particle inspection is also possible, fluorescent magnetic particle are chosen for better sensitivity of inspection. According to the studies surface defects are discontinuous that are detected through liquid penetrant test and magnetic particle inspection .

Jitesh Kumar Singh et al. (2015) conducted Non-destructive testing (NDT) on welded metal to enhance the quality of material. Welding is a common joining process used extensively in automobile, aerospace, machinery manufacturing industries and various other fields. For every manufacturing there may be a chance of occurring defects in it. The understanding of various defects , remedies can help to ensure higher quality and longer lasting welds. NDT is a mechanism which helps in finding out of defects of any item like weld before major harm to item without affecting its usefulness. The primary purpose of NDT is to determine the quality of material with a view to acceptance or rejection.

MohitBector et al (2014) compared the various NDT techniques by using them on v- butt welded joint on stainless steel cylinder by means of time consumption, flaw detection, crack depth detection, safety and cost. According to the authors point of view in order to check whether there is any defect in the joint there may be use Non-destructive technique to check it. Gas Tungsten Arc welded (GTAW) stainless steel used for comparison of different parameters, it s checked for defects by using different NDT techniques. NDT is used to find defects in various types of metals and non-metals. In case of metals there may be chance of occur defects at joints and joint surroundings. Most of metals are joined by welding process but in welding process if there is any moisture content on electrode it leads to occur defects. Author uses GTAW welding for preparation of sample for comparison this welding process is slag inclusion, spatter free. After Inspection it is concluded that magnetic particle test show defect free for same material ultrasonic test show the defects because magnetic particle test depends on the relative absorption of iron powder near the surface or sub surface. Time consumption for liquid penetrant test is less compared to ultrasonic test and magnetic particle test. Flaw detection and crack depth detection is excellent in ultrasonic test. Magnetic particle test is hazardous compared to ultrasonic test and liquid penetrant test .

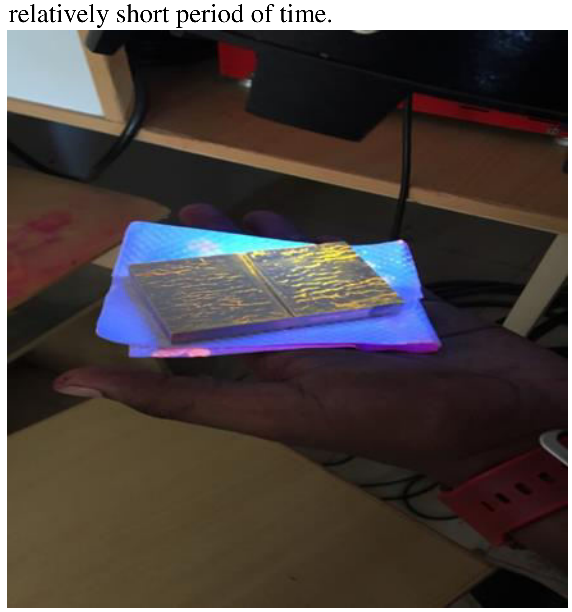
Ranganayakuluetal.(2017) studied characterization of weldments defects through Non-destructive Evaluation techniques. NDT testing methods are valuable tools in quality assurance of weldments in engineering and technology. The author took Aluminum, Titanium, D3 tool steel for characterization of these aerospace and industrial application metals. These sample are prepared by using GTAW welding. Defects which are open to the surface and sub surface defects up to 6 mm depth are detected by Visual inspection, Liquid penetrant test, Magnetic particle inspection and the thickness of the defects are characterized by Ultrasonic test, orientation of weldments were detected by using Gamma rays and Ultrasonic test. The effect of various parameters such as accuracy precision and sensitivity guide line that influence the selection of NDT technique were determined. Liquid penetrant test identifies surface discontinuities in all the weldments. Radiography test shows the orientation and magnitude of defects.

3. METHODOLOGY

3.1 Process Involved In Methodology

3.1.1 Liquid Penetrant Testing

Liquid Penetrant testing (LPT) is one of the most widely used nondestructive testing methods for the detection of surface discontinuities in nonporous solid materials. It is almost certainly the most commonly used surface NDT method today because it can be applied to virtually any magnetic or nonmagnetic material. LPT provides industry with a wide range of sensitivities and techniques that make it especially adaptable to a broad range of sizes and shapes. It is extremely useful for examinations that are conducted in remote field locations, since it is extremely portable. The method is also very appropriate in a production type environment where many smaller parts can be processed in a relatively short period of time.



3.2Equipment used in Liquid Penetrant Test

3.2.1 PRECLEANERS

Precleaning is an essential first step in the penetrant process. The surface must be thoroughly
cleaned to assure that all contaminants and other materials that may prohibit or restrict the entry of the penetrant into

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 02 | Feb -2020 ISSN: 2582-3930

surface openings are removed. Thorough cleaning is essential if the examination results are to be reliable.

Fig 1: Precleaner

3.2.2PENETRANT

Penetrant Equipment systems range from simple portable kits to large, complex in-line test systems. The kits contain pressurized cans of the penetrant, cleaner/remover, solvent, and developer and, in some cases, brushes, swabs, and cloths. A larger fluorescent penetrant kit will include a black light. These kits are used when examinations are to be conducted in remote areas, in the field, or for a small area of a test surface. In contrast to these portable penetrant kits, there are a number of diverse stationary-type systems. These range from a manually operated penetrant line with a number of tanks, to very expensive automated lines, in which most steps in the process are performed automatically.

Fig 2: Penetrant

3.2.3 EMULSIFIERS/REMOVERS

The purpose of the emulsifiers used in penetrant testing is to emulsify or break down the excess surface penetrant material. In order for these emulsifiers to be effective, they should also possess certain characteristics, including: The reaction of the emulsifier with any entrapped penetrant in a discontinuity should be minimal in order to assure that maximum sensitivity is achieved. The emulsifier must be compatible with the penetrant. The emulsifier must readily mix with and emulsify this excess surface penetrant. The emulsifier mixed with the surface penetrant should be readily removable from the surface with a water spray.

3.2.4 Application of Developer

After excess penetrant has been removed, a white developer is applied to the sample. Several developer types are available, including: non-aqueous wet developer, dry powder, water-suspendable, and water-soluble. Choice of developer is governed by penetrant compatibility (one can't use water-soluble or -suspendable developer with water-washable penetrant), and by inspection conditions. When using non-aqueous wet developer (NAWD) or dry powder, the sample must be dried prior to application, while soluble and suspendable developers are applied with the part still wet from the previous step. NAWD is commercially available in aerosol spray cans, andmay employ acetone, isopropyl alcohol, or a propellant that is a combination of the two. Developer should form a semi-transparent, even coating on the surface.

The developer draws penetrant from defects out onto the surface to form a visible indication, commonly known as bleed-out. Any areas that bleed out can indicate the location, orientation and possible types of defects on the surface. Interpreting the results and characterizing defects from the indications found may require some training and/or experience.

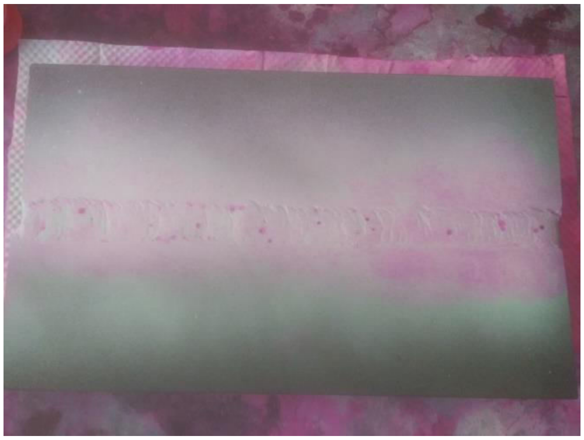


Fig 3:Application of developer

3.2.5Inspection

The inspector will use visible light with adequate intensity (100 foot-candles or 1100 lux is typical) for visible dye penetrant. Ultraviolet (UV-A) radiation of adequate intensity (1,000 micro-watts per centimeter squared is common), along with low ambient light levels (less than 2 foot-candles) for fluorescent penetrant examinations. Inspection of the test surface should take place after 10- to 30-minute development time, and is dependent on the penetrant and developer used. This time delay allows the blotting action to occur. The inspector may observe the sample for indication formation when using visible dye. It is also good practice to observe indications as they form because the characteristics of the bleed out are a significant part of interpretation characterization of flaws

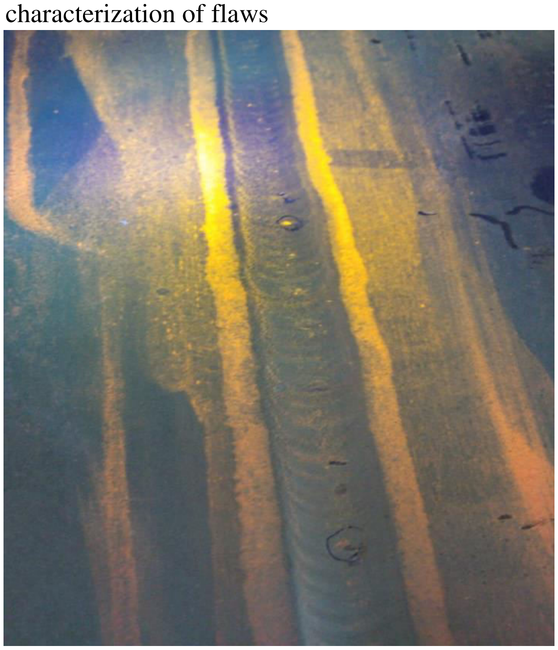


Fig 4:Inspection

3.2.6 Post Cleaning

The test surface is often cleaned after inspection and recording of defects, especially if post-inspection coating processes are scheduled.

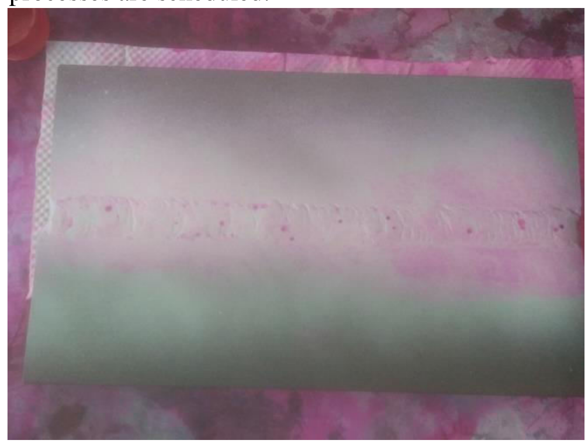


Fig 5:Post Cleaning

4. MAGNETIC PARTICLE TESTING

Magnetic particle testing (MT) is a non destructive testing (NDT) method for detecting discontinuities that are primarily linear and located at or near the surface of ferromagnetic components and structures. MT is governed by the laws of magnetism and is therefore restricted to the inspection of materials that can support magnetic flux lines.

Metals can be classified as ferromagnetic, paramagnetic, or diamagnetic. Ferromagnetic metals are those that are strongly attracted to a magnet and can become easily magnetized. Examples include iron, nickel, and cobalt. Paramagnetic metals such as austenitic stainless steel are very weakly attracted by magnetic forces of attraction and cannot be magnetized.

Diamagnetic metals are very slightly repelled by a magnet and cannot be magnetized. Examples include bismuth, gold, and antimony. Only those metals classified as ferromagnetic can be effectively inspected by MT. In order to understand MT, one should have a basic understanding of magnetism and electromagnetism.

4.1 Principles of Magnetism

4.1.1 Magnetic Forces

When the north pole of one magnetized rod is placed close to the south pole of another, it will be observed that they attract one another. The closer they come together, the stronger the force of attraction. Conversely, if two north poles or two south poles are placed close together, they will repel each other. This can be summarized as “like poles repel, unlike poles attract.” One way of defining the phenomenon of magnetism could be: “a mechanical force of attraction or repulsion that one body has upon another,” especially those that are ferromagnetic.

4.1.2 Magnetic Field

The simple observations of attracting and repelling indicate that some force field surrounds the magnetized rod. Although invisible, this force field is clearly three-dimensional because the attraction or repulsion can be experienced all around the rod. A two-dimensional slice through this field can be made visible by placing a sheet of plain white paper over a bar magnet and sprinkling ferromagnetic particles onto it. The particles will collect around the lines of force in the magnetic field, producing an image. This image is called a “magnetograph” and the lines of force are referred to as lines of “magnetic flux.” Lines of magnetic flux will flow in unbroken paths that do not cross each other. Each line of force forms a closed loop that flows through and around the magnet.

4.1.3 Flux Density

The flowing force of magnetism is called “magnetic flux.” The magnetograph image does not show the direction of flux flow, but it can be seen from the magnetograph that the area of maximum flux concentration (flux density) is at the poles. Flux density is defined as “the number of lines of force per unit area.” The unit area referred to is a slice taken perpendicular to the lines of force. Flux density is measured in Gauss or Tesla, the Tesla being the current unit, and flux density is given the symbol “” (beta).

4.1.4 Magnetizing Force

The total number of lines of force making up a magnetic field determines the strength of the force of attraction or repulsion that can be exerted by the magnet and is known as the “magnetizing force” and given the symbol “H.”

4.2 EQUIPMENTS USED IN MPT

4.2.1 Stationary Units

A stationary unit is referred to as a wet horizontal unit and usually has capabilities for producing longitudinal and circular fields. Some units will also be capable of demagnetizing the parts, although this is usually accomplished with a separate demagnetizer.

4.2.2 Electromagnetic Yoke

Even greater portability can be achieved by using an electromagnetic yoke, which is referred to as an AC yoke or contour probe. This unit can be used with AC and is also available in a battery pack version, which further increases its portability by eliminating the need for an AC power source.

4.2.3 Black Lights

The use of fluorescent particles requires a black light. One type of blacklight contains a regulated current ballast transformer to limit the current drawn by the arc in the mercury vapor bulb. The light produced may also contain some white light and harmful UV radiation.

4.2.4 Pie Gauge

Its is a one type of flux direction indicator .This is one of the most commonly used devices in MT. It consists of eight low-carbon steel segments, furnace brazed together, to form an octagonal flat plate that is then copper plated on one side to hide the joint lines. The gauge is placed on the test specimen during magnetization, with its copper face up.

4.2.5 Ferrous powder

It contains an powder particles of iron cobalt and nickel. They are used to sprinkle over the magnetised duplex steel. These ferrous particles get attracted towards the cracks and defects on the sub surface of the duplex stainless steel. Hence defects on the duplex steel are clearly visible due to these ferrous powder.

4.3 MAGNETIC PARTICLE PROCEDURE

4.3.1 Pre-Cleaning

Oil, paint, rust and other foreign materials on the surface to be inspected not only prevent attraction of magnetic particles to the flux leakage, but also lead to form a false indication Therefore such materials will be cleaned chemically or mechanically before magnetization process.

5.5.2Magnetization

The workpiece is magnetized as direction of magnetic flux is orthogonal to direction of a flaw.

Following method is applied for proper magnetization.

1.Axial current method : To pass electric current longitudinal direction of the workpiece.

2.Cross current method : To pass electric current cross direction of axis of the workpiece.
3.Prod method : To pass electric current between two prods contacted inspection area of the workpiece.
4.Through conductor method : To pass electrical current through the hole of the workpiece.
5.Coil method : Put the workpiece in a magnetizing coil.
6.Yoke method : Put the workpiece between magnetic poles.
7.Through flux method : To pass magnetic flux through the hole of the workpiece.

5.5.3Applying magnetic particle

1.Types of magnetic particle

Easy magnetization and migration to flux leakage and discriminative flaw indication are required for performance of magnetic particle.
There are two types of magnetic particle, one is non-fluorescent particle (white, red, black) for observation under visible light, and the other is fluorescent magnetic particle for observation under UV light.
Dry method, magnetic particle is applied to the surface as it stands, and wet method, magnetic particle is dispersed in oil or water, are applied.
2.Applying timing of magnetic particle

There are two methods. Magnetic particle is applied during magnetization of the workpiece, or applied after ceasing magnetization. In later case residual magnetism is utilized for forming flaw indication.

5.5.4Observation

UV light is used for observation of the workpiece under dark environment in case of using fluorescent magnetic particle for inspection.

5.5.5Post-cleaning

Demagnetization, removing residual magnetic particle and rust proofing of the workpiece are done if required.

5.6 Classification of Indications

Once detected, the indications should be classified as either "false," "nonrelevant," or "relevant" before final evaluation.

5.6.1False Indications

False indications can be produced by improper handling and do not relate to the part's condition or use. An example is "magnetic writing." This is typically produced by the formation of indications at local poles that are created when the part comes in contact with another magnetized part prior to or during inspection. This can be eliminated by demagnetization and repeating the inspection. Magnetic writing is most likely to occur when using the residual method, through poor handling that allows the individual parts to touch. The continuous technique may require the demagnetization of parts before the next inspection to preclude the possibility of magnetized components touching. This type of false indication can be eliminated through careful handling. Other sources of false indications may be caused through the use of excessively high magnetizing currents or inadequate Precleaning of the parts to remove oil, grease, corrosion products, and other surface contaminants.

5.6.2Nonrelevant Indications

These are the result of flux leakage due to geometrical or permeability changes in the part. Examples of geometric causes include splines, thread roots, gear teeth, keyways, or abrupt section changes. A concern with these conditions is that they may also be stress risers and could be the origin for fatigue-induced cracks. These conditions are therefore some of the most critical; the possibility that one of these nonrelevant indications can conceal a crack must be considered. Other potential sources of nonrelevant indications include localized permeability changes in the part, which may be due to localized heat treatment or variations in hardness, and may also occur at the fusion zone of a weld.

5.6.3Relevant Indications

These are produced by flux leakages due to discontinuities in the part. When these discontinuities are not in compliance with a code, they are classified as rejectable. If they meet the acceptance criteria they are considered to be acceptable discontinuities. Discontinuities that do not permit the part to be used for its original purpose or can potentially cause the part or fail are classified as defects

5. RESULTS AND DISCUSSIONS

Non Destructive Testing (NDT) is a technique for damage assessment, disaster prediction and quality control, to detect the defects without affecting the internal structure. This project presents novel approaches for the improvement of discontinuities or defects in welding. The result shows that these above techniques provide a good detection rate for different types of weld flaws. The future scope of this research work lies in the field of pre-processing, segmentation and feature extraction. We did testing on the weld region of mild steel. By testing we found indication of two types of defects, linear and volumetric defects mainly of small cracks and porosity defects. From this technique of testings we found out that these testing techniques have vast applications in quality control in industries.

REFERENCES

1. Cartz, Louis (1995). Nondestructive Testing.A S M International. ISBN 978-0-87170-517-4.
2. Charles Hellier (2003). Handbook of NondestructiveEvaluation.McGraw-Hill. p. 1.1. ISBN 978-0-07-028121-9.
3. "Introduction to Nondestructive Testing". asnt.org.
4. Bridges, Andrew. "High Speed Cameras for Non-Destructive Testing".NASA TechBriefs.Retrieved 1 November 2013.
5. Blitz, Jack; G. Simpson (1991). Ultrasonic Methods of Non-Destructive Testing. Springer-Verlag New York, LLC. ISBN 978-0-412-60470-6.