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Detection of Weld Metal Defects using DT and NDT -A Review

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Abstract - *This paper shows the NDT review from different research papers which shows different NDT and DT testing used to find welding defect. In which the deflection of welding metal can be determined by using NDT for example MPI is useful for crack detection. This paper also covers the DT test in which it shows the use of exams as a band test, tensile test. Apart from this, useful topics of NDT and DT test have been covered from different research papers. This paper provides recent advances and research on non-destructive testing (NDT) methods for detective characterization in engineering materials and composites. The paper covers reviews on the capabilities of NDT applications such as Ultrasonic Testing (UT), Electromagnetic Testing (ET), further methods are use on the basis of their intrinsic characteristics and their applications. Often, NDT evaluators use only one non-destructive testing method to identify weld part testing.*

Key Words: Bend Test, Tensile Test, DPT, Ultrasonic Test, Welding, Weld Defects.

1. INTRODUCTION

Non-destructive testing (NDT) is a way to detect and evaluate flaws in materials. Within aerospace NDT plays a vital role in the design, manufacture and maintenance of aircraft. Non-destructive testing (NDT) is the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system. In other words, when the inspection or test is completed the part can still be used. In contrast to NDT, other tests are destructive in nature and are therefore done on a limited number of sample ("Lot sampling"), rather than on the materials, components or assemblies actually being put into service. These destructive tests are often used to determine the physical properties of materials such as impact resistance, ductility, yield and ultimate tensile strength, fracture toughness and fatigue strength, but discontinuities and differences in material characteristics are more effectively found by NDT. Today modern nondestructive tests are used in manufacturing, fabrication and in-service inspections to ensure product integrity and reliability, to control manufacturing processes, lower production costs and to maintain a uniform quality level. During construction, NDT is used to ensure the quality of materials and joining processes during the fabrication and erection phases, and in-service NDT inspections are used to ensure that the products in use continue to have the integrity necessary to ensure their usefulness and the safety of the public. It should be noted that while the medical field uses many of the same processes, the term "non-destructive testing" is generally not used to describe medical applications.

2. LITERATURE SURVEY

[1] Sandeep Kumar Dwivedia, Manish Vishwakarmab, Prof.Akhilesh Sonic investigated that visual inspections, microscopy, radiography, die penetrate test, ultrasonic test, magnetic particle test, eddy current test, acoustic test are used to detect defects in composite, material, and construction material (concrete). All above different NDT methods have different accuracy level and different defects detection facilities. The reliability and confidence level of non-destructive test is typically increased by using multiple test methods. For complex part examination ultrasonic technique is widely used in industry.

[2] Sanjay Kumar & Dalgobind Mahto investigated that NDT testing is useful to detect a weld defects but specific procedure is followed for the precise result. Lack of knowledge and skill in NDT, may give faulty result or may detect different types of defect which are not actually exist in weld part different technics and different procedure to be followed for detecting the different type of weld defect.

[3] S.Gholizadeh investigated that the various non-destructive testing (NDT) techniques to detect a weld defects for of composites. Composite tools are mostly used in critical-safety applications in aircraft primary construction. So to know the incipient faults in composite material, the non-destructive testing techniques are very much essential. Gholizadeh uses different NDT techniques such as visual inspection, ultrasonic technique, Thermography testing are used to detect weld defects.

[4] A.N., Kravcov, I.A., Shibae investigated about the use of laser ultrasonic structuroscopy, opens new opportunities to evaluate the quality of facing stones and the integrity of stone artworks. Precise measurement of elastic wave velocities with an error of 0.5% makes it possible, not only to visualize the internal structure of samples and evaluate the degree of their heterogeneity, but also to measure the local moduli of elasticity and porosity.

[5] T. Jay Kumar, B.P.C. Rao and S. Thirunavukkarasu a investigate modified or coating of the surface of any material is also done regularly NDT technique are being developed to improve the properties of automobiles, power, aerospace, and other industry to enhance corrosion, wear and resistance NDT techniques are most commonly used for deflection in the outer surface of the material and if there is a defect in the

inner surface and all techniques for the accuracy, capability and limitations of surface thickness and measurement are different

The role of NDT is becoming more and more accepted for use in industrial application and NDT systems. The characterization of material surface is expected to increase further in the near future.

[6] Hamza Zafer and Syed karrar Haider investigate about the tensile test is Part of DT Testing. In Tensile Testing We generally test the Material Strength. In this paper, Tensile testing of Stainless steel Grades: 316 and 201 have carried out at room temperature 500k. The Percentage elongation was measured 20% at Room Temperature And 26% at 500k in case of Grade 316. The Percentage elongation increasing with the increase of test Temperature Increase of Test Temperature.

3. DIFFERENT NDT AND DT TECHNIQUES

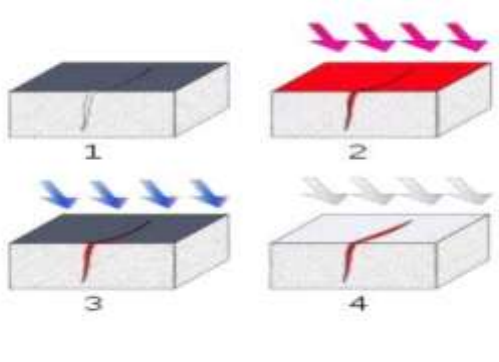
1. DYE PENETRATION TEST

Dye penetrant inspection (DP), is also called liquid penetrate inspection (LPI) or penetrant testing(PT), is a widely applied and low-cost inspection testing method used to check surface-breaking defects in all non-porous materials (metals, plastics, or ceramics) It is a method commonly used for detect the surface cracks or defects. Dye penetrant testing is one of the most widely used NDT method. DPT can be used to inspect almost any material provided that its surface is not extremely rough.

This technique is based on the ability of a liquid to be drawn into a "clean" surface breaking flaw by capillary action. Materials that are commonly inspected using DPT or LPI include metals (aluminum, steel, titanium, copper, etc.), glass, many ceramic materials, rubber, and plastics. The penetrant which is used in dye penetrate testing may be applied to all non-ferrous materials and ferrous materials; we also know that for ferrous components magnetic-particle inspection is often used.

DPT is used to detect defects in casting, forging and welding surface defects such as hairline cracks, surface Porosity, leaks in new products, and fatigue cracks on In-service or in operating components. LPI is based upon Capillary action, whereas low surface tension fluid penetrates into clean and dry surface-breaking discontinuities.

Penetrant may be applied to the test component or specimen by dipping, spraying, or brushing. After adequate Penetration time has been allowed, the excess penetrant is removed and a developer is applied. The main advantage of using a developer in DPT is that it helps to draw penetrant out of the flaw so that an unseen or invisible indication becomes visible to the inspector. Inspection is performed under ultraviolet or white light, depending on the type of dye used.



(Fig. Dye penetration Test)

Dye penetration test is filled in the developer in the defect and inside the cracks appear. Thus the dye penetration is used to find the defects inside.

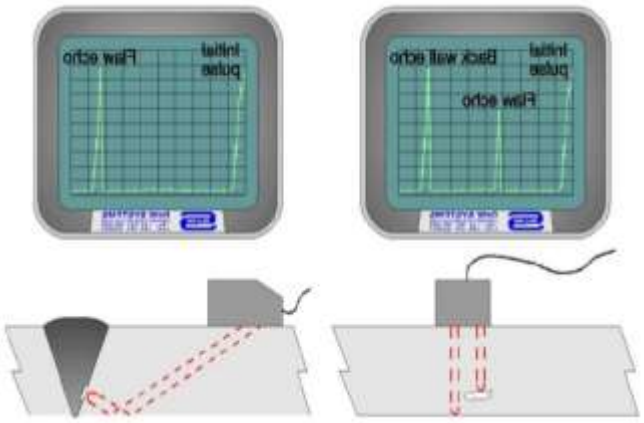
2. ULTRASONIC TEST

Ultrasonic Testing (UT) generally uses a high frequency sound energy to conduct examinations and make measurements of given frequency. Ultrasonic inspection can be used for flaw detection of weld defects. It can be used for evaluation, dimensional measurements, material characterization, and more. A typical UT inspection system consists of several functional units, such as the pulsar/receiver, transducer, and display devices. A pulsar/receiver is an electronic device that can produce high voltage electrical pulse. Driven by the pulse, the transducer of various types and shapes generates high frequency ultrasonic energy operating based on the piezoelectricity technology with using quartz, lithium sulfate, or various ceramics. Most inspections are carried out in the frequency range of 1 to 25MHz. Couplets are used to transmit the ultrasonic waves from the transducer to the test piece; typical couplets are water, oil, glycerin and grease.

The sound energy is introduced and propagates through the materials in the form of waves and reflected from the opposing surface. An internal defect such as crack or void interrupts the waves' propagation and reflects back a portion of the ultrasonic wave. The amplitude other energy and the time required for return indicate the presence and location of any flaws in the work-piece.

This technique is used for the detection of internal and surface (particularly distant surface) defects in sound conducting materials. The principle is in some respects similar to echo sounding. A short pulse of ultrasound is generated by means of an electric charge applied to a piezoelectric crystal, which vibrates for a very short period at a frequency related to the thickness of the crystal. In flaw detection this frequency is usually in the range of 1 MHz to 6 MHz Vibrations or sound waves at this frequency have the ability to travel a considerable distance in homogeneous elastic material, such as many metals with little attenuation. For example the velocity in steel is 5900 meters per second,

and in water 1400 meters per second. Ultrasonic testing employs an extremely diverse set of methods based upon the generation and detection of mechanical vibrations or waves within test objects. The standard method of presenting information in ultrasonic testing is by means of a cathode ray tube, in which horizontal movement of the spot from left to right represents time elapsed. The rate at which the spot moves is such that it gives the appearance of a horizontal line on the screen. The system is synchronized electronically so that at the instant the probe receives its electrical pulse the spot begins to traverse the screen. An upward deflection (peak) of the line on the left hand side of the screen is an indication of this occurrence.



(Fig.Ultrasonic Test)

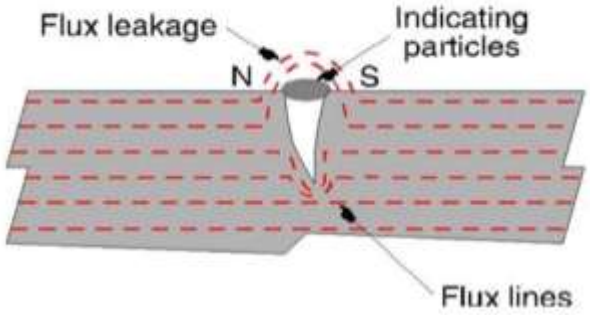
The Ultrasonic Test is finding the crack of the inside of the material. In which electric transducers find the defect of the material inside the Trans. In which electric rays are provided to the electrical radiation material by the electro transducers, and its back to the material, which gets the defect from Ultrasonic Rays. In which the cracks in it, there is a vacancy such as the vacancy has a vacation, a space by the wallet.

3. MAGNETIC PARTICLE TEST

The first part of magnetic particle testing is to magnetize the test component by the MPT equipment. If there are defects on the surface or near to the surface are present the defects will create a leakage filled. Then finally milled iron particles coated with a dye pigment are applied to the specimen. These particles are attracted to magnetic flux leakage fields and will cluster to form an indication directly over the defects. This indication can be visually detected under proper lighting conditions.

This method uses magnetic fields and small magnetic particles, such as iron filings to detect flaws in components. The only requirement from an inspect ability standpoint is that the component being inspected must be made of a ferromagnetic material such iron, nickel, cobalt, or some of their alloys, since these materials are materials that can be magnetized to a level that will allow the inspection to be effective. An electromagnet yoke is placed on the surface of the part to be examined, a kerosene-iron filling.

Suspension is poured on the surface and the electromagnet is energized. If there is a discontinuity such as a crack or a flaw on the surface of the part, magnetic flux will be broken from that place and a new south and North Pole will Form at each edge of the discontinuity. Then just like if iron particles are scattered on a cracked magnet, the particles will be attracted to and cluster at the pole ends of the magnet, the iron particles will also be attracted at the edges of the crack behaving poles of the magnet. This cluster of particles is much easier to see than the actual crack and this is the basis for magnetic particle inspection. This method is suitable for the detection of surface and near surface discontinuities in magnetic material, mainly ferrite steel and iron.



(Fig. Magnetic particle Test)

In MPI method. There are various techniques such as yoke method, coil method, etc. Small cracked can also be found from MPI method up to 2 mm.

4. BEND TEST

A bend test in which the test specimen or weld part is bent to a definite shape by using a jig. The bend test determines the quality a weld at the face and root of a welded joint. Face bend tests are made with the weld face in tension, root bend tests are used for test weld root in tension.

The three-point bending flexural test provides values for the modulus of elasticity in bending, flexural stress, flexural strain and the flexural stress–strain response of the material. The main advantage of a three-point flexural test is the ease of the specimen preparation and testing.

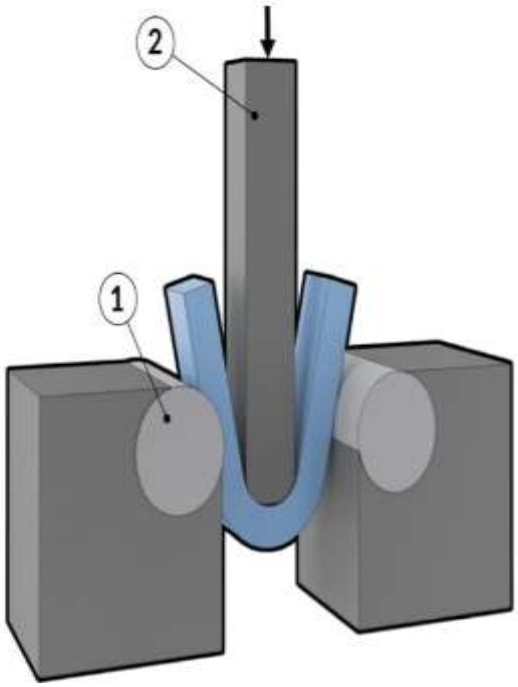


Fig. Bend test

The band test is used to find the fault in the Welding Material. The band test is more used to know the quality of the Welder and his skill. If the material band in the band test, crack is more than the 3 mm it shows that welder is not qualified for doing weld joint.

5. TENSILE TEST

Tensile testing, also known as tension testing, is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure.

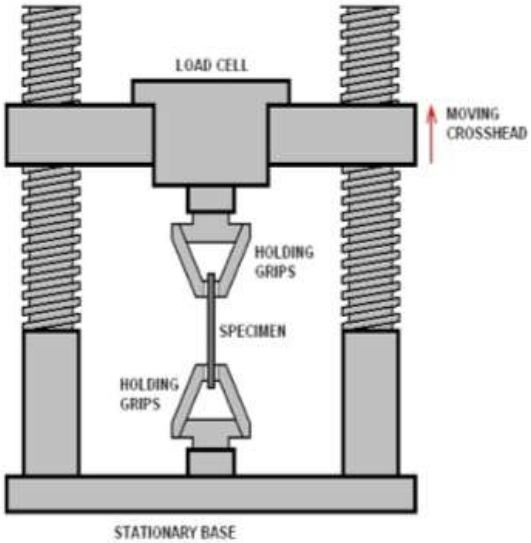


Fig. Tensile Test

This is one of the most common mechanical testing techniques and is used to find out how it is strong and also how much it can be stretched before it breaks. This test method is used to determine yield strength, ultimate tensile strength, and ductility, strain hardening characteristics, Young's modulus and Poisson's ratio.

Tensile test is also used for finding yield stress, percentage of elongation, material strength, reduction of area, etc. The process of the tensile test is performed on Universal Tensile Machine (UTM) up to 60 tonnage capacity. A UTM has ability and efficiency to perform standard tensile and compression test on specimen and components.

4. CONCLUSION

The role of DT and NDT is becoming more and more acceptable for use in industrial applications and NDT systems. DT and ND testing techniques are very useful to detect a different types of weld defects. All above techniques are own advantages and limitations. By using DT technique we can find strength, hardness properties of the weld metals. Different Non Destructive techniques can be used for deflection in the outer surface of the materials and in an inner surface. All ND techniques have different capability and limitations of defects detections in a weld joint surface. The characterization of the materials surface is expected to improve further in the area of research.

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