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Investigation on the Effect of Corrosion on Mechanical Properties of Al 6061 & Al 7075

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ABSTRACT

In this thesis we are going to analyze the Aluminium alloys of series Al 6061 and AL 7075 by conducting mechanical tests. And the mechanical properties differences are spotted in the corrosion test. ASTM Corrosion Testing is provided, including the ASTM B117 Salt Spray Test. For the initial work pieces and later hardness test is carried out for testing the hardness of the materials which is better. Here even the corrosion timing is also varied according to the 10, 20, 30 hours for the sample pieces. After that we have verified with the hardness test machine for the strength of the material using Rockwell tester machine. 3 samples have been taken for each alloy, so totally 6 samples have been tested and the results are verified.

INTRODUCTION

Corrosion is a regular procedure, which changes a refined metal to a more chemically-stable form, such as its oxide, hydroxide, or sulfide. It is the slow destruction of ingredients (generally metals) by chemical and/or electrochemical reaction by their atmosphere. Corrosion engineering is the field devoted to regulatory and stopping corrosion.

In the best common use of the word, this means electrochemical oxidation of metal in response with an oxidant such as oxygen or sulfur. Rusting, the creation of iron oxides is a well-known sample of electrochemical corrosion. This kind of destruction naturally produces oxide(s) or salt(s) of the original metal, and outcomes in a distinguishing orange coloration. Corrosion can also happen in materials additional than metals, such as ceramics or polymers, though in this environment, the term "degradation" is more common. Corrosion damages the valuable properties of materials and structures including strength, presence and penetrability to liquids and gases.

Many structural alloys corrode merely from exposure to moisture in air, but the process can be strongly affected by exposure to certain substances. Corrosion can be concentrated locally to form a pit or crack, or it can extend across a wide area more or less uniformly corroding the surface. Because corrosion is a diffusion-controlled process, it occurs on exposed surfaces. As a result, methods to reduce the activity of the exposed surface, such as passivation and chromate conversion, can increase a material's corrosion resistance. However, some corrosion mechanisms are less visible and less predictable.

GALVANIC CORROSION

Galvanic corrosion happens when two dissimilar metals have physical or electrical interaction with each other and are absorbed in a common electrolyte, or when the similar metal is uncovered to electrolyte with dissimilar absorptions. In a galvanic couple, the added active metal (the anode) corrodes at a faster rate and the more noble metal (the cathode) corrodes at a slower rate. When engrossed separately, each metal corrodes at its own proportion. What type of metal(s) to use is eagerly determined by following the galvanic series? For example, zinc is often considered as a sacrificial anode for steel structures. Galvanic corrosion is of main interest to the marine industry and too wherever water (containing salts) associate's pipes or metal structures.

Oxygen causes these electrons to rise up and form hydroxyl ions (OH). The hydroxyl ions react with the FE^{++} to form hydrous iron oxide (FeOH), better known as rust. Where the affected iron particles were, has now become a corrosion pit, and where they are now, is called the corrosion product (rust).

Corrosion can happen at any rate, depending on the environment that the metal is in. However, since atmospheric corrosion is so widespread, it is recommended to take effective precautionary measures when it comes to corrosion prevention.

WHAT IS COROSSION TEST

Corrosion testing refers to the processes conducted by laboratories in order to solve, prevent or mitigate problems related to corrosion. These processes can be applied in industrial materials and infrastructure products, and are often used in failure analysis.

All corrosion laboratories are composed of expert failure analysts, chemists and engineers that are all certified in corrosion testing. Such tests can provide useful information in order to make sound decisions regarding selection of materials, processing and treatment.

Corrosion laboratories can conduct a broad range of laboratory tests that are typically focused on areas such as:

- Electrochemical
- Corrosivity
- Heat transfer
- Immersion

Testing of various materials used in industrial applications is required to verify conformation to quality standards. One example is immersion testing, which is considered the most popular and simplest type of corrosion test. This test is used to assess different materials that are subjected to particular conditions. It is a very versatile process which can be personalized to meet specific needs regardless of application. In this test, the testing apparatus can expose the specimen to test solutions and then subject it to different physical or metallurgical situations, such as crevices and heat treatment.

Another test is the hot wall test, which is utilized to evaluate situations where metal vessels are hotter than bulk solutions. These are common in external heated vessels where corrosion is typically impacted by temperature. In this test, elevated temperatures signify high levels of corrosion activity.

SALT SPRAY TESTING

There are so many variables associated with salt spray tests that the results are even less reliable than humidity tests. The overall appearance is similar, except that salt spray cabinets are larger than humidity cabinets. With salt spray cabinets, there is a trough filled with water that wraps around the perimeter of

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the top lip where the lid prevents the salt fog from escaping. It works like this:
Water is added into a saturator tower and then transported by air and blown out through a nozzle located inside the cabinet. The nozzle is mounted on a siphoning valve, which aspirates a salt solution from a reservoir.

The salt solution is then mixed with the incoming water-saturated air, producing a salt fog in the cabinet. The fog is collected in a flask and tested according to the desired concentration. When conducting salt spray tests, **be sure the salt is free of iodine** and that the proper pH is produced when it's mixed with distilled water or de-ionized water. Some time ago, ASTM specifications were revised to incorporate automatic water level controls and to relocate the fogging nozzle to a tower located in the centre of the salt spray cabinet to improve salt fog distribution. Previously, the nozzle was located near the bottom and at one end of the cabinet.
How you inspect the panels has a direct impact on the results of the test:

1. The panels should be inspected as soon as they are removed from the cabinet — as you would for a humidity test.
2. Rinse panels vigorously with hot running water, or with gently-running cold water.
3. After rinsing, blow compressed air (40 psi) at the score line via a needle-type nozzle. Hold the nozzle very close to the panel. The distance between the nozzle and the score line, along with the angle of the nozzle when delivering the compressed air, can impact the quality of the test.

EXPERIMENTATION DETAILS OF CORROSION TEST

The samples of 2 different Aluminium materials have been taken in to consideration and then we have done the corrosion test (salt spray test)the concentrations used in the salt spray test is 5% NaCl (AR Grade) in the DM (DE Mineralized) water. The temperature maintained in this process is 35c. While doing this test, we have maintained the Ph as 7.1
The corrosion test is conducted for different hours of duration and the samples are verified for the rust verification. After observing all the test results, we have observed no rust formation on the components.

Material	Sample no	No of hours
Al 7075	A	10
Al 7075	AA	20
Al 7075	AAA	30
Al 6082	B	10
Al 6082	BB	20
Al 6082	BBB	30

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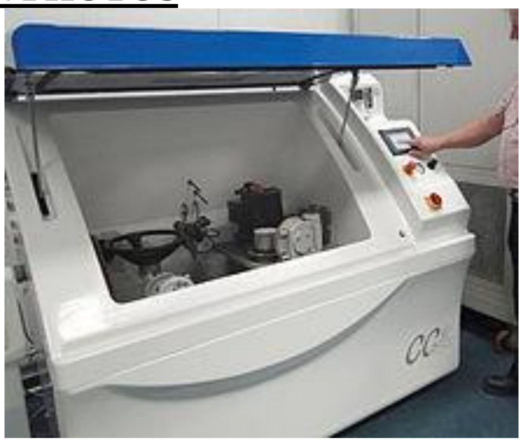
EXPERIMENTATION PHOTOS


A modified salt spray chamber in use


Internal view of corrosion machine


Machine display

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(a) Aluminium 7075 material tested for 10, 20, 30 hours respectively.

(b) Aluminium 6082material tested for 10, 20, 30 hours respectively

INTRODUCTION TO HARDNESS TEST

Hardness is a typical of a material, not a essential physical property. It is defined as the resistance to indentation, and it is determined by gauging the permanent depth of the indentation. More basically, when using a fixed force (load) and a assumed indenter, the smaller the indentation, the tougher the material.

The **Rockwell hardness test method**, as defined in ASTM E-18, is the most usually used hardness test method. You must attain a copy of this standard, read and recognize the standard completely before make an attempt on Rockwell test.

The Rockwell test is usually easier to complete, and added accurate than other categories of hardness testing methods. The Rockwell test method is used on all metals, except in condition where the test metal structure or surface environments would introduce too much differences; wherever the indentations would be too large for the submission; or where the sample size or sample shape prohibits its use.

The Rockwell method measures the permanent depth of indentation shaped by a force/load on an indenter. First, a initial test force (commonly referred to as preload or minor load) is applied to a sample using a diamond or ball indenter. These preload breakdowns through the surface to reduce the properties of surface finish. After holding the preliminary test force for a detailed dwell time, the baseline depth of indentation is measured.

After the preload, an additional load, call the major load, is added to reach the total required test load. This force is held for a predetermined amount of time (dwell time) to allow for elastic recovery. This major load is then released, returning to the preliminary load. After holding the preliminary test force for a specified dwell time, the final depth of indentation is measured. The Rockwell hardness value is derived from the difference in the baseline and final depth measurements. This distance is converted to a hardness number. The preliminary test force is removed and the indenter is removed from the test specimen.

Preliminary test loads (preloads) range from 3 kgf (used in the "Superficial" Rockwell scale) to 10 kgf (used in the "Regular" Rockwell scale). Total test forces range from 15kgf to 150 kgf (superficial and regular) to 500 to 3000 kgf(macro hardness).

Test Method Illustration

A = Depth reached by indenter after application of preload (minor load)
B = Position of indenter during Total load, Minor plus Major loads
C = Final position reached by indenter after elastic recovery of sample material
D = Distance measurement taken representing difference between preload and major load position. This distance is used to calculate the Rockwell Hardness Number.

EXPERIMENTATION ON HARDNESS TEST

Here after collecting the samples from the salt spray i.e. corrosion test, all the samples are sent to the hardness test, here in this thesis we have used Rockwell cum Brinell hardness tester machine ASTM A370-2013

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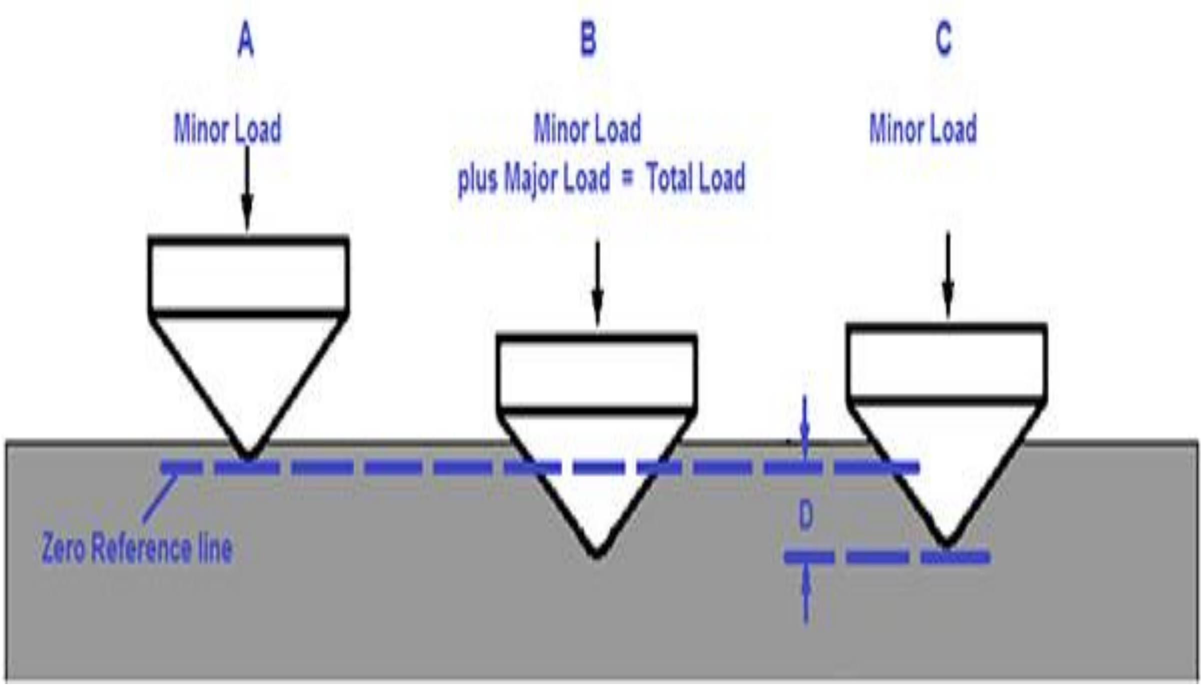
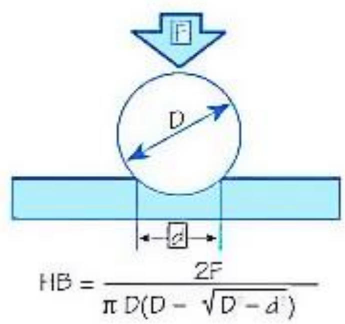


BRINELL HARDNESS TEST

Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation. More simply put, when using a fixed force (load) and a given indenter, the smaller the indentation, the harder the material. Indentation hardness value is obtained by measuring the depth or the area of the indentation using one of over 12 different test methods. Learn more about hardness testing basics here

The **Brinell hardness test method** as used to determine Brinell hardness is defined in ASTM E10. Most commonly it is used to test materials that have a structure that is too coarse or that have a surface that is too rough to be tested using another test method, e.g., castings and forgings. Brinell testing often use a very high test load (3000 kgf) and a 10mm diameter indenter so that the resulting indentation averages out most surface and sub-surface inconsistencies.



Test Method Illustration

D = Ball diameter

d = impression diameter

F = load

HB = Brinell result

Brinell units, which measure according to ASTM E103, measure the samples using Brinell hardness parameters together with a Rockwell hardness method. This method provides the most repeatable

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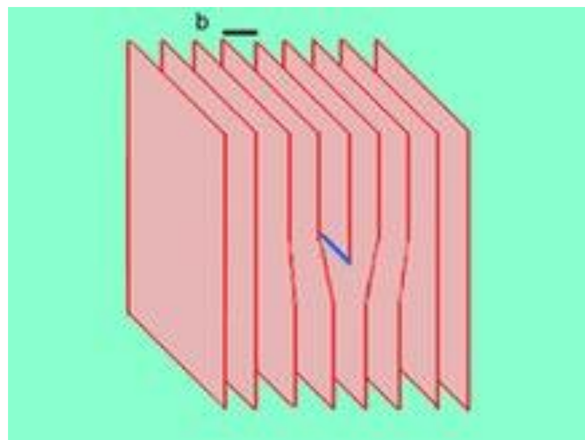
results (and greater speed) since the vagaries of optical interpretations are removed through the use of an automatic mechanical depth measurement.

Using this method, however, results may not be strictly consistent with Brinell results due to the different test methods – an offset to the results may be required for some materials. It is easy to establish the correct values in those cases where this may be a problem.

The key to understanding the mechanism behind hardness understands the metallic microstructure, or the structure and arrangement of the atoms at the atomic level. In fact, most important metallic properties critical to the manufacturing of today's goods are determined by the microstructure of a material. At the atomic level, the atoms in a metal are arranged in an orderly three-dimensional array called a crystal lattice. In reality, however, a given specimen of a metal likely never contains a consistent single crystal lattice. A given sample of metal will contain many grains, with each grain having a fairly consistent array pattern. At an even smaller scale, each grain contains irregularities.

There are two types of irregularities at the grain level of the microstructure that are responsible for the hardness of the material. These irregularities are point defects and line defects. A point defect is an irregularity located at a single lattice site inside of the overall three-dimensional lattice of the grain. There are three main point defects. If there is an atom missing from the array, a vacancy defect is formed. If there is a different type of atom at the lattice site that should normally be occupied by a metal atom, a substitution defect is formed. If there exists an atom in a site where there should normally not be, an interstitial defect is formed. This is possible because space exists between atoms in a crystal lattice. While point defects are irregularities at a single site in the crystal lattice, line defects are irregularities on a plane of atoms. Dislocations are a type of line defect involving the misalignment of these planes. In the case of an edge dislocation, a half plane of atoms is wedged between two planes of atoms. In the case of a screw dislocation two planes of atoms are offset with a helical array running between them.



Planes of atoms split by an edge dislocation.

The way to inhibit the movement of planes of atoms, and thus make them harder, involves the interaction of dislocations with each other and interstitial atoms. When a dislocation intersects with a second dislocation, it can no longer traverse through the crystal lattice. The intersection of dislocations creates an anchor point and does not allow the planes of atoms to continue to slip over one another a dislocation can also be anchored by the interaction with interstitial atoms. If a dislocation comes in contact with two or more interstitial atoms, the slip of the planes will again be disrupted. The interstitial atoms create anchor points, or pinning

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points, in the same manner as intersecting dislocations.

Brinell hardness is sometimes quoted in mega Pascal's; the Brinell hardness number is multiplied by the acceleration due to gravity, 9.80665 m/s^2, to convert it to mega Pascal's. The BHN can be converted into the ultimate tensile strength (UTS), although the relationship is dependent on the material, and therefore determined empirically. The relationship is based on Meyer's index (n) from Meyer's law. If Meyer's index is less than 2.2 then the ratio of UTS to BHN is 0.36. If Meyer's index is greater than 2.2, then the ratio increases.

EXPERIMENTATION PHOTOS

Hardness test machinery

The marking of the samples are been done and the testing is done, after the testing results we have tested 2 times and have taken the average value and the results are given in the tabular form

S no	Sample id	Hardness (BHN)	Average (BHN)
1	Al 7075	135, 138	136.5
2	Al 7075	132, 136	134.0
3	Al 7075	134, 136	135.0

4	Al 6082	73, 78	75.5
4	Al 6082	77, 82	79.5
6	Al 6082	72, 76	74.0

CONCLUSION

As in this experimentation we have done to verify the differences in the strength of different Aluminium alloys, so initially we have done the corrosion test for the samples weather there is any rust formations on the samples using salt spray machine.

Finally we have used Rockwell and Brinell hardness tester machine and have calculated the hardness of the components. So after verifying all the results

By observing the results in the above tabular format, we can see that the results of the hardness test for the same samples does not varied a lot, but the difference between the Al 7075 and Al 6082 have differentiated a lot, as if we want the higher strength material we have to finalize with the Al 7075.

As this material could be suggested to all the automobile industries for the manufacturing process to increase the strength of the components, and even this material is suggested as it is a light weight component.

REFERENCES

[1]. CORROSION TESTING FOR METAL FINISHING BY **V. E CARTER.**
[2]. James salt spray and immersion corrosion testing (journal).
[3]. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
[4]. ASTM G85 Annex A1- Acetic acid salt spray test.
[5]. ASTM G85 Annex A2- Cyclic Acidified salt Fog Testing.
[6]. ASTM G85 Annex A3- Solution of sea salt is used in place of the standard sodium chloride.
[7]. ASTM G85 Annex A4- Salt spray Fog with Addition of Sulphur Dioxide.
[8]. ASTM E10- Standard test method for Brinell hardness of metallic materials.
[9]. ASTM A370-2013- Standard Test Methods and definitions for Mechanical Testing of Steel products.
[10]. Image courtesy- Google and Wikipedia