## CHAPTER 4

### 4.0 RESULTS AND DISCUSSION

**Table of Contents**

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>RESULTS AND DISCUSSION</td>
<td>63</td>
</tr>
<tr>
<td>4.1</td>
<td>Microstructural analysis</td>
<td>66</td>
</tr>
<tr>
<td>4.1.1</td>
<td>Effect of age hardening time on silicon morphology and grain size of sand cast specimen</td>
<td>66</td>
</tr>
<tr>
<td>4.1.2</td>
<td>Effect of age hardening time on silicon morphology and grain size of permanent mould specimen</td>
<td>69</td>
</tr>
<tr>
<td>4.1.3</td>
<td>Effect of modification on Si morphology of sand cast specimen</td>
<td>71</td>
</tr>
<tr>
<td>4.1.4</td>
<td>Effect of casting method on microstructure</td>
<td>73</td>
</tr>
<tr>
<td>4.1.5</td>
<td>Effect of modification and casting method on dendritic cell (grain)size.</td>
<td>75</td>
</tr>
<tr>
<td>4.1.6</td>
<td>Effect of age hardening time on dendritic cell (grain)size.</td>
<td>75</td>
</tr>
<tr>
<td>4.2</td>
<td>Hardness test results</td>
<td>77</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Effect of modification on hardness of sand cast specimen</td>
<td>77</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Effect of modification on hardness of permanent mould cast specimen</td>
<td>77</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Effect of casting method on hardness of modified specimen</td>
<td>78</td>
</tr>
<tr>
<td>4.2.4</td>
<td>Effect of age hardening time on hardness of sand cast specimen</td>
<td>79</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>4.2.5</td>
<td>Effect of age hardening time on hardness of permanent mould specimen</td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td><strong>Tensile test results</strong></td>
<td></td>
</tr>
<tr>
<td>4.3.1</td>
<td>Effect of modification on tensile strength of sand cast specimen</td>
<td></td>
</tr>
<tr>
<td>4.3.2</td>
<td>Effect of modification on tensile strength of permanent mould specimen</td>
<td></td>
</tr>
<tr>
<td>4.3.3</td>
<td>Effect of casting method on UTS of modified specimen</td>
<td></td>
</tr>
<tr>
<td>4.3.4</td>
<td>Effect of age hardening time on tensile strength of sand cast specimen</td>
<td></td>
</tr>
<tr>
<td>4.3.5</td>
<td>Effect of age hardening time on tensile strength of permanent mould specimen</td>
<td></td>
</tr>
<tr>
<td>4.3.6</td>
<td>Effect of age hardening time on UTS of sand cast and permanent mould cast specimen</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td><strong>Izod (impact) test results</strong></td>
<td></td>
</tr>
<tr>
<td>4.4.1</td>
<td>Effect of modification on impact energy of sand cast specimen</td>
<td></td>
</tr>
<tr>
<td>4.4.2</td>
<td>Effect of modification on impact energy of permanent mould specimen</td>
<td></td>
</tr>
<tr>
<td>4.4.3</td>
<td>Effect of age hardening time on impact energy of sand cast specimen</td>
<td></td>
</tr>
<tr>
<td>4.4.4</td>
<td>Effect of age hardening time on impact energy of permanent mould cast specimen</td>
<td></td>
</tr>
</tbody>
</table>
4.4.5 : Effect of aging time and modification on impact energy of A357 alloy

4.5 : Wear test results

4.5.1. : Effect of speed on wear of modified specimen

4.5.2 : Effect of speed on wear of solutionized and age hardened specimen

4.5.3 : Effect of load on wear of modified specimen

4.5.4 : Effect of load on wear of solutionized and age hardened specimen

4.5.5 : Effect of modification on wear

4.5.6 : Effect of age hardening time on wear

4.5.7 : Effect of casting method on wear

4.6 : Machinability results

4.6.1 : Effect of feed, speed and depth of cut on machinability of as cast and modified A357 alloy

4.6.2 : Effect of solutionization age hardening on machinability

4.7 : Corrosion test results

4.7.1 : Effect of age hardening time on corrosion rate

4.7.2 : Effect of casting method and modification on corrosion rate

4.7.3 : Effect of casting method and age hardening time on corrosion rate

4.7.4 : Effect of time on corrosion rate
4.0. RESULTS AND DISCUSSION

4.1. MICROSTRUCTURAL ANALYSIS

Photographs of A357 alloy specimen tested for different testing conditions are taken using metallurgical microscope and the results are shown below.

4.1.1. Effect of age hardening time on silicon morphology and grain size of sand cast specimen.

a) Without Modification

Plate 4.1.1 As cast
Plate 4.1.2 540-6hr
Plate 4.1.3 540-8hr
Plate 4.1.4 540-10hr
ii) Na Modified

Plate 4.1.5 As cast
Plate 4.1.6 540-6hr

Plate 4.1.7 540-8hr
Plate 4.1.8 540-10hr

iii) Sr Modified

Plate 4.1.9 As cast
Plate 4.1.10 540-6hr
Plate 4.1.11 540-8hr  Plate 4.1.12 540-10hr

Microstructure of Plate 4.1.1 shows dendritic morphology of the conventional cast sample. In Plate 4.1. 2, 3, 4, 6, 7, 8, 10, 11, 12 the large white objects are the primary aluminum globules. The surrounding matrix is composed of fine primary aluminum dendrites (White) and the eutectic phase (Dark). A357 is a heat-treatable alloy. Strength can be enhanced by precipitation of Mg₂Si in the supersaturated Al solid solution. At the solution treatment temperature, the lamellar eutectic Si underwent spheroidization which eliminated the continuous eutectic network in the as-cast condition. It is understandable that a uniform dispersion of fine and spherical Si particles would be more ductile than a eutectic network. Artificial aging enhanced strength but reduced ductility of the primary Al particles. Solution treatment under the T6 condition led to substantial grain growth, which in turn resulted in a decrease in ductility. This was more prominent as the age hardening time increased.
4.1.2. Effect of age hardening time on silicon morphology and grain size of permanent mould specimen.

i) Without Modification

Plate 4.1.13 As cast  
Plate 4.1.14 540-

Plate 4.1.15 540-8hr  
Plate 4.1.16 540-10hr

ii) Na Modified

Plate 4.1.17 As cast  
Plate 4.4.1.18 540-6hr
Plate 4.1.19 540-8hr          Plate 4.1.20 540-10hr

iii) Sr Modified

Plate 4.1.21 As cast          Plate 4.1.22 540-6hr

Plate 4.1.23 540-8hr          Plate 4.1.24 540-10hr
Microstructure of Plate 4.1.13 shows of dendritic morphology of the conventional cast sample. Compared to sand cast specimen these dendrites are more uniform and smaller. This can be due to difference in cooling rates. Mg₂Si precipitation is also more globular and more finer in solutionized specimen(Plate no4.13,14,15,16,18,19,20,22,23,24). Eutectic phase is surrounded the primary α Phase. The size of the grains increased as the age hardening time increased resulting in increase in strength and hardness with marginal decrease in ductility.

4.1.3. Effect of modification on Si morphology of sand cast specimen

Plate 4.1.25 As cast
Plate 4.1.26 Na modified

Plate 4.1.27 Sr modified
Sr or Na addition in A357 alloys (Plate 4.1.26, 27, 29, 30) depressed the growth of α-Al dendrite and Al-Si eutectic and influenced their growth mechanism. This effect is more significant with higher cooling rate as in case of permanent mould casting. Due to addition of these modifiers primary α-Al dendrites have become more equiaxed and Al-Si eutectic much finer. The microstructure shows the primary α Al phase and the eutectic distributed among the globular grains of primary phase. These additions to hypoeutectic aluminum-silicon alloys resulted in a finer lamellar or fibrous eutectic network. The increased solidification rates are useful in providing a
finer distribution of lamellae relative to the growth of the eutectic. The Modification has given better results with Sr addition than Na. Silicon needles are coarser and more acicular in Sodium modified specimen than Sr modified specimen.

4.1.4. Effect of casting method on microstructure

Plate 4.1.31 Sand cast

Plate 4.1.32 Permanent mould cast

Plate 4.1.33 Sand cast, as cast

Plate 4.1.34 Permanent mould, as cast
The microstructures of the specimen (Plate 4.1.31, 32, 33 and 34) consist of dendrites of primary $\alpha$-Al phase and eutectic. The eutectic is more or less uniformly distributed among the grains of the primary phase. It is observed the size of dendrites size and interdendritic arm spacing is less in case of gravity die cast specimen than sand cast specimen. This can be attributed to faster cooling rate in case of die casting than the sand casting. The same trend is observed with modification treatment and solutionization treatment.
4.1.5. Effect of modification and casting method on dendritic cell (grain) size.

From the above graph it can be observed that dendritic cell size of permanent cast specimen is much smaller than the sand cast specimen (Table 4.1). The decrease in grain size was about 24%. This could be due to faster cooling rates in Permanent mould casting. Modification also slightly decreased the grain size. It is 1.2% in case of Sr modified (sand cast) specimen and 4.46% in permanent mould, Sr modified specimen. This could be due to action of modifiers on growth mechanism of phases.

4.1.6. Effect of age hardening time on dendritic cell (grain) size.

Fig. 4.2 Plot of dendritic cell (grain) size vs aging time
Solution treatment under the T6 condition led to substantial grain growth, this is more prominent as the age hardening time increased. When compared to as cast condition the increase in grain size for 540-6hr specimen is 2.7% and 8.375 % for 540-10hr (Sand cast) specimen. This could be due to availability of sufficient time for grain growth. The same trend was observed for all the other testing conditions.
4.2. HARDNESS TEST RESULTS

4.2.1. Effect of Modification on Hardness of Sand Cast Specimen:

Brinell hardness test results of sand cast and permanent mould cast specimen under various testing conditions are tabulated (Table 4.2 and 4.3) and graphs are plotted (Fig 4.3 and 4.4).

Fig. 4.3 BHN of sand cast specimen

4.2.2. Effect of Modification on Hardness of Permanent Mould Cast Specimen:

Fig. 4.4 BHN of permanent mould specimen
It is seen from the above two graphs that the A357 alloy specimen that are modified with strontium exhibit highest hardness when compared to as cast and sodium modified specimen. It is also observed that with addition of little amount (0.01%) of sodium or strontium to A357 alloy improves the hardness of the material. The increase in hardness is 59BHN to 84 BHN (42%) for sand cast specimen and it was 64BHN to88 BHN (37.5%) in case of permanent mould specimen. This could be due to Al-Si morphology. The improvement in hardness generally has been attributed to the variations of the Si morphology and size of the eutectic silicon phase particles.

4.2.3. Effect of Casting Method on Hardness of Modified Specimen.

![Graph showing the effect of casting method on hardness](image)

Fig. 4.5 Effect of casting method on hardness

From the above graph it can be observed that permanent mould cast specimen have shown better hardness values than sand cast specimen for all the testing conditions (5 to 8%). This could be due to cooling rate during solidification and which affected the microstructure and grain size of the specimen hence the hardness.
4.2.4. Effect of Age Hardening Time on Hardness of Sand Cast Specimen

Brinell hardness test results of sand cast specimen and permanent mould cast specimen in as cast condition, age hardened for 6hr, 8hr and 10hr are tabulated (Table 4.4 and 4.5) and graphs are plotted (Fig 4.6 and 4.7).

![Graph 4.6](image1)

**Fig. 4.6** Variation of hardness with age hardening time of sand cast specimen

4.2.5. Effect of Age hardening Time on Hardness of Permanent Mould Specimen

![Graph 4.7](image2)

**Fig. 4.7** Variation of hardness with age hardening time of Permanent mould cast specimen
Results of BHN (fig 4.4, 4.5, 4.6) show considerable increase in hardness with heat treatment. The maximum increase is 62.7% for sand cast unmodified 540-10h specimen and 54.7% for Permanent mould unmodified 540-10h specimen. This could be due to precipitation of solute atoms. This mechanism of strengthening by precipitation hardening can be explained by coherent lattice theory. After solution treatment and quenching, the alloy will be in a supersaturated condition, with the solute atoms distributed at random in the lattice structure. During aging, these clusters form an intermediate crystallographic plate, forming cluster or embryos of the precipitate. This could have been increased the hardness. The same trend is observed in case of Sr modified or Na modified specimen.
4.3. TENSILE TEST RESULTS

4.3.1. Effect of Modification on Tensile Strength of Sand Cast Specimen

Fig. 4.9 Stress -Strain curves of as cast, sodium modified and strontium modified Sand cast specimen.

Fig. 4.9a. Proof Stress versus Modification

Fig. 4.9b. UTS versus Modification
4.3.2. Effect of Modification on Tensile Strength of Permanent Mould Specimen

Fig. 4.10. Stress - Strain curves of as cast, sodium modified and strontium modified permanent mould cast specimen.

Fig. 4.10a. Proof Stress versus Modification
From the above graphs (Fig 4.9, 4.9a, 4.9b, 4.9c, 4.10, 4.10a, 4.10b, 4.10c) it can observed that modification increased ultimate tensile strength and ductility considerably. The increase in UTS and YS are 12.5% & 13.2% respectively for sand cast specimen and 23.55% & 13.9% for Permanent mould cast specimen. The improvement in ductility is from 5.1% (as cast) to 6.0% (Sr modified) for sand castings and from 5.0% to 6.5% for permanent casts. The improvement in tensile properties can be attributed to the variations of the morphology and size of the eutectic silicon phase particles. The large, brittle flakes of silicon present in unmodified alloys might have caused brittle fracture and poor ductility.
4.3.3. Effect of Casting Method on UTSo of Modified Specimen.

From the above results it can be observed that permanent mould cast specimen have shown better results than sand cast specimen. The increase is about 3% in UTS for all the conditions. This can be attributed to difference in cooling rates which affected the Silicon morphology hence tensile properties.

4.3.4. Effect of Age Hardening Time on Tensile Strength of Sand Cast Specimen.

Fig. 4.11 UTS versus Casting method

Fig. 4.12. Stress- Strain curves of Sand cast A357 specimen aged for different aging times.
4.3.5. Effect of Age Hardening Time on Tensile Strength of Permanent Mould Specimen.

Fig. 4.12a. UTS versus Age hardening time

Fig. 4.12b. %Elongation versus Age hardening time.

Fig. 4.13. Stress-Strain curves of permanent cast A357 aged for different aging times.
The mechanical properties are more dependent on the heat treatment. After solution treatment and quenching, the alloy is in a supersaturated condition, with the solute atoms distributed at random in the lattice structure. During aging, these clusters form an intermediate crystallographic plate, and precipitate. The aging treatments enable solute atoms to diffuse together to form discrete strengthening precipitates and several metastable phases may form during the process. They act as obstacles to the plastic deformation of the material. This could be the reason for increase in the Tensile strength for both the casting methods which was shown in Fig 4.12, 4.12a and 4.13, 4.13a.
Tensile strength and hardness of solutionized and 10 hr age hardened alloy is highest, followed by 8hr, 6hr age hardened and as cast alloy. The increase in UTS from as cast to 10 hr aged was 25.6% for sand cast specimen it was about 30% for permanent mould specimen. This indicates that increase in age hardening time increases Ultimate tensile strength of the alloy.

Solution treatment under the T6 condition led to substantial grain growth, this could have resulted in decrease in ductility. This was more prominent as the age hardening time was increased. The same trend was observed both the casting methods as shown in fig 4.12b. 4.13b.

### 4.3.6. Effect of Age Hardening Time on UTS of Sand Cast and Permanent Mould Cast Specimen.

![Ultimate strength MPa](image)

**Fig.4.14UTS versus Age hardening time**

The Permanent mould cast specimens have shown better strength properties than sand cast specimen for all testing conditions. Tensile strength has increased with increase in aging time for both the casting methods. Permanent cast specimen have shown 3 to 6% increase in UTS than sand cast specimen and this could be due to difference in cooling rates, which led to fine grain structure and directional properties of permanent mould cast specimen.
4.4. IZOD (IMPACT) TEST RESULTS:

Variables Considered: 1. Modification, Casting Method, Age hardening Time

4.4.1. Effect of Modification on Impact Energy of Sand Cast Specimen

(Table 4.8)

![Impact energy of sand cast specimen](image1)

Fig. 4.27 Impact energy of sand cast specimen

4.4.2 Effect of Modification on Impact Energy of Permanent Mould Specimen

(Table 4.9)

![Impact energy of permanent mould specimen](image2)

Fig. 4.28 Impact energy of permanent mould specimen
4.4.3. Effect of Age Hardening Time on Impact Energy of Sand Cast Specimen

(Table 4.10, 4.11 and 4.12.)
4.4.4. Effect of Age Hardening Time on Impact energy of Permanent Mould Cast Specimen (Table 4.13, 4.14, 4.14)

![Impact energy versus Age hardening time for Sr modified specimen](image1)

![Impact energy versus Age hardening time for as cast specimen](image2)

![Impact energy versus Age hardening time for Na modified specimen](image3)
Fig. 4.35 Impact energy versus Age hardening time for Sr modified specimen

4.4.5 Effect Of Age Hardening Time and Modification on Impact Energy

Fig. 4.36 Impact energy versus Age hardening time
Impact energy increased with modification. Strontium modified specimen have shown better impact resistance. There was about 5.7 % increase in impact energy with modification for sand cast specimen and it was about 5.0% in case of permanent mould cast specimen. Impact energy increased with solutionization treatment and age hardening time. The increase in Impact energy with solutionization and aging was almost 90-92% (max) for both sand cast specimen and permanent cast specimen. Permanent mould cast specimens have shown better impact energy. The increase was about 15% for all the testing conditions. The dependency of impact energy on modification, casting method, solutionization treatment and aging time correlates with the increase in hardness and tensile strength.
4.5. WEAR TEST RESULTS

Variables Considered:
1. Speed (300rpm, 400rpm and 500rpm).
2. Load (5N, 10N, 15 N).
3. Modification (As Cast, Na Modified, Sr Modified).
4. Age hardening time (6hr, 8hr, and 10hr).
5. Casting method (sand Cast, permanent Mould).

4.5.1. Effect of Speed on Wear of Modified Specimen Case 1

Casting method: sand casting; Condition: as cast Load: 10 N,
Speed 500rpm, 400 rpm and 300 rpm

Fig. 4.37 Wear versus Time: As cast

Na modified

Fig. 4.38 Wear versus Time: Sodium modified, (sand cast)
B). Case 2: Casting method: Permanent mould casting. Condition: As cast Load 10 N

Fig. 4.39 Wear versus Time: As cast (permanent mould)

Na modified

Fig. 4.40 Wear versus Time: Na modified, (permanent mould)
Sr modified,

4.5.2. Effect of Speed on Wear of Solutionized & Age Hardened Specimen

CASTING METHOD: Sand casting, CONDITION: As cast, LOAD: 5 N

i) Age hardening time; 6 hr

Fig. 4.41 Wear versus Time: Sr modified, (permanent mould),

Fig. 4.42 Wear versus Time: S-540-8hr-155-6hr
ii). Age hardening time: 8 hr

Fig. 4.43 Wear versus Time: S-540-8hr-155-8hr

iii). Age hardening time: 10 hr

Fig. 4.44 Wear versus Time: S-540-8hr-155-10hr
4.5.3. Effect of Load on Wear of Modified Specimen

Casting method: sand casting, Condition: As cast  Speed: 500.rpm

Fig. 4.45 Wear versus Time: As cast (sand cast)

Na Modified

Fig. 4.46 Wear versus Time: Na modified (sand cast)
Sr Modified,

Fig. 4.47 Wear versus Time: Sr modified (sand cast)

CASTING METHOD: Permanent mould casting,
CONDITION    : As cast
SPEED       : 500 rpm

Na modified:

Fig. 4.48 Wear versus Time: As cast condition (permanent mould)
4.5.4. Effect of Load on Wear for Solutionized and Age Hardened specimen

CASTING METHOD: Sand casting, CONDITION: As cast, Speed 500 rpm
From the above figs from 4.37 to fig 4.48, it is observed that Wear loss increased as the sliding speed and normal load increased for all the conditions. The increase in wear is about 41.7% for permanent mould cast specimen and 28.7% for sand cast specimen with increase in sliding speed from 300rpm to 500 rpm. The increase in wear is 60.9% for permanent mould cast specimen and 70% for sand cast specimen with increase in normal load from 5N to 15N. The values of friction force generally decrease with sliding speed hence it could be the reason for decrease in wear loss.

**4.5.5. Effect of Modification on Wear**

CASTING METHOD: SAND CASTING, SPEED :400rpm, Load: 10 N
CASTING METHOD: Permanent mould casting, Speed: 400, Load: 1.0kg

Wear loss decreased with modification of A357 alloy (fig 4.48 and 4.49). The decrease in wear is about 27% for sand cast specimen and 14% for permanent mould
specimen. The decreased wear in modified specimen could be due to the formation of a stable mechanically mixed layer on the worn out surface. The A357 alloy that is modified with strontium exhibited less wear loss compared to A357 alloy modified with sodium. This increase in hardness with Sr modification can be attributed to the Si morphology.

4.5.6. Effect of Age Hardening Time on Wear

1) Load 10 N, Speed 400 rpm

Fig.4.54 Wear versus Time at various aging times (sand cast)

2). Load 5 N, Speed: 500rpm
4.5.7. Effect of casting method on Wear.

From Table 4.16, it can be observed that wear loss of permanent mould specimen is less than sand cast specimen under all the variable conditions. This can be attributed to the directional properties and increased hardness of the castings produced by permanent casting method.

4.6. MACHINABILITY TEST RESULTS
The machinability test on A357 alloy in as cast condition and with sodium & strontium modifications was carried out using center lathe with lathe tool dynamometer at different speed, feed and depth of cut conditions. The results are tabulated in Table 4.17, 4.18 & 4.19.

4.6.1. Effect of Feed, Speed and Depth of Cut on Machinability of As Cast and Modified A357 Alloy:

![Graph showing feed forces versus feed](image1)

*Fig. 4.56 Feed forces versus Feed*

![Graph showing cutting force versus feed](image2)

*Fig. 4.57 Cutting force versus Feed*
Fig. 4.58 Feed force versus Speed

Fig. 4.59 Cutting force versus Speed

Fig.4.60. Feed force versus Depth of cut
The cutting force and feed force increased with cutting parameters such as feed and depth of cut but cutting forces dropped with increase in cutting speed for all the conditions (fig4.53 to 4.58). Modification also increased cutting forces. Sr modified alloy has shown higher cutting force than the other two. This could be due to increase in toughness of the alloy with modification.

4.6.2. Effect of solutionization age hardening on machinability:

The machinability test results of A357 alloy in as cast condition and in 6 hr, 8hr and 10 hr age hardened conditions are tabulated in tables 4.20, 4.21 and 4.22, and graphs are plotted.
Fig. 4.62 Feed force versus Feed

Fig. 4.63 Cutting force versus Feed

Fig. 4.64 Feed force versus Speed
Fig. 4.65 Cutting force versus Speed

Fig. 4.66 Feed force versus Depth of cut

Fig. 4.67 Cutting force versus Depth of cut
Heat treatment which increased the hardness increased both cutting force and feed force but the build-up depth on the cutting edge decreased. 10 hr age hardened alloy has shown higher cutting force than the other three (As cast, 6 hr aged and 8 hr aged specimen). Increase in cutting forces indicates marginal decrease in machinability but reduction in the built-up-edge (BUE) on the cutting tool compensates that effect.
4.7. CORROSION TEST RESULTS

4.7.1. Effect of Age Hardening Time on Corrosion Rate (Tables 4.23, 4.24, 4.25, 4.26)

Fig. 4.68 Corrosion rate versus Age hardening time (Sand cast)

Fig. 4.69 Corrosion rate vs. Age hardening time (Permanent mould cast)
Corrosion rate decreased with increase in age hardening time. Inherent processing involved in heat treatment, modification led to change in grain boundary density, orientation and residual stresses. Ultimately, these surface changes have an impact on corrosion behavior and this could be the reason for decrease in corrosion susceptibility.

4.7.2. Effect of Casting method and Modification on corrosion rate

![Corrosion rate versus Modification](image)

Corrosion rate decreased with modification. Sr modified specimen have shown more susceptibility to corrosion than Na modified specimen. Sand cast specimen have shown better corrosion resistance than permanent mould specimen. The reason could be increase in grain size and decrease in grain boundary area.
4.7.3. Effect of Casting Method and Age Hardening Time on Corrosion Rate

Fig. 4.71 Corrosion rate versus Age hardening time

The inhomogeneity of microstructure could be responsible for the wide range in corrosion rates exhibited by the as cast specimen than modified specimen or age hardened specimen.

4.7.3. Effect of Time on Corrosion Rate. (Table 4.27)

Fig. 4.72 Corrosion rate versus Time
From the above graph it can be observed that corrosion rate has decreased with time for all the conditions. Aluminum owes its excellent corrosion resistance due to the barrier oxide film that is bonded strongly to its surface and, that if damaged, reforms immediately in most environments. This could be the reason for decreased corrosion rate with time.