Corrosion Studies On Heat Treated A356.0 Alloy

Anzil jose[1], Ashwin Vijayan[2], Prashantha Kumar ST[3]

[1]UG Scholar, Department of Mechanical Engineering, Vijaya Vittala Institute of Technology, Bengaluru
ansu_jp@yahoo.com

[2]UG Scholar, Department of Mechanical Engineering, Vijaya Vittala Institute of Technology, Bengaluru
ashwin.v41@gmail.com

[3]Assistant Professor, Department of Mechanical Engineering, Vijaya Vittala Institute of Technology, Bengaluru
kumarprashanthst@gmail.com

Abstract- *In this study, the corrosion behaviour of heat treated (T6) A356.0 alloy subjected to immersion testing in a 3.5% sodium chloride solution for varied periods of immersion were made. The corroded surfaces after removing the products of corrosion were photographed using LOM. The results of test were compared with that of as-cast alloys. It was found that heat treated alloys offered better resistance to corrosion compared to as-cast alloys due to spherodisation of silicon particles and increased hardness.*

Keywords: *Heat treated (T6) A356.0, LOM, Spherodisation and Hardness.*

I. INTRODUCTION

Aluminum-Silicon alloys possess light weight, high specific strength and good heat transfer ability which makes them suitable materials to replace components made of ferrous alloys. Al-Si alloys are widely used in all types of internal combustion engines such as cylinder blocks, cylinder heads and Pistons. A356.0 alloys find applications in aircraft pump parts, aircraft structure and control parts, automotive transmission, aircraft fittings, water cooled cylinder blocks and nuclear energy installations. Both hypo-eutectic and hypereutectic alloys can be used as useful engine block materials on account of their adequate wear resistance and high strength to weight ratio. There are sufficiently good number of studies made on tribological behavior of Al-Si alloys.

2. EXPERIMENTAL DETAILS

2.1 MATERIALS

A356.0 alloys were sand cast in the form of cylindrical bars of length 300mm and diameter 25mm. The chemical composition of the alloy shown in Table-I was obtained using Optical Emission Spectrometer (Baird-Dv6E).

Table IChemical composition of A356.0 alloy (weight %)

Si	7.25
Mg	0.45
Fe	0.086
Cu	0.010
Mn	0.018
Ni	0.025
Zinc	0.005
Others	0.028
Al	Balance

The conventional heat treatment adopted for Aluminum alloys is precipitation heat treatment involving solution treatment, followed by quenching and age hardening. The solution treatment involved the solution of soluble phases to form the solid solution with maximum concentration of solute in solvent. Quenching was done to retain super saturation. Age hardening resulted in the formation of particles of second phase in the original phase matrix.

The heat treatment process was carried out as follows. One set of alloys were solutionised at 500, 520 and 540oC for 9 hours followed by water quenching (at 600C) and age hardened at 1700C for 5 hours. The above alloys were designated as 500-5h, 520-5h, and 540-5h where 500, 520 and 540 represent the solution temperature and 5h indicate 5 hours of age hardening. The second set of alloys was solutionised at 5400C for 9 hours followed by water quenching (at 600C) and age hardened to 1700C for 4, 5 and 6 hours. This set of specimen were designated as 540-4h, 540-5h and 540-6 hours where 540 represents the solution temperature in degree Celsius and 4h, 5h, 6h indicate the duration of age hardening in hours.

2.2 HARDNESS TEST

The hardness tests were conducted on the alloy as per ASTM E10 norms using Rockwell Hardness tester (using 1/16 inch ball diameter and 100 kg load). Hardness tests were performed at randomly selected places on the surface of the samples by providing sufficient spacing between indentations and distance from the edge of specimen. The hardness values of as cast and heat treated alloys is shown in Table II.

Table II

Alloy designation	Hardness(RB)
As cast	84
500-5h	85
520-5h	88
540-5h	90
540-4h	86
540-6h	92

2.3 MICROSTRUCTURE

Figure 1: Light Optical Microscope

The corroded surfaces of specimens after removing the products of corrosion were photographed using Light Optical Microscope (LOM).

Figure 2: Initiation of corrosion pits on the lateral Surface of as-cast specimen tested for 1 month

Fig-2 shows the initiation of corrosion pits on the lateral surface of as-cast alloy for 30 days of immersion in 3.5% Nacl solution. In fig-3 is shown the corrosion pits formed on the flat surface for the same period.

Figure 3: Corrosion pits on the flat surface of as-cast specimen tested for 1 month.

Figures 4 and 5 show the corroded surfaces of peak solution treated and peak aged alloys after 3 months of immersion indicating advanced stage of pitting.

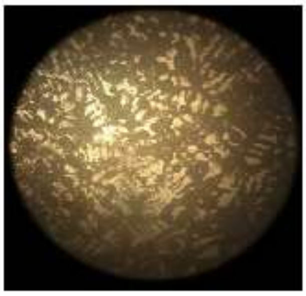

Figure 4

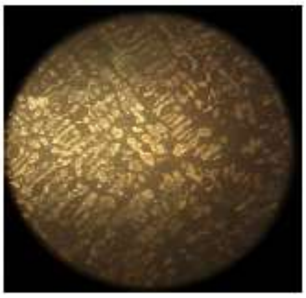

Figure 5

Figures 6 and 7 are shown the corroded surfaces of peak solution treated and peak aged alloys tested for 9 months.

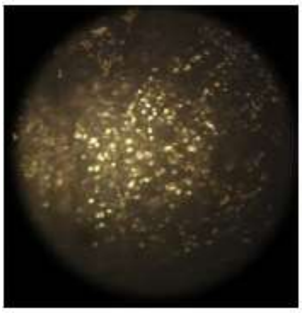

Figure 6

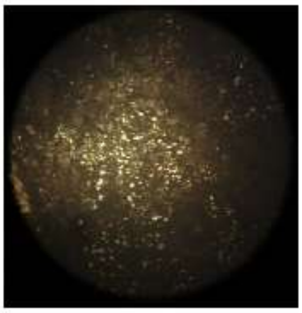

Figure 7

3.1: EFFECT OF DURATION OF IMMERSION ON CORROSION RATE OF AS-CAST AND AGE HARDENED ALLOYS.

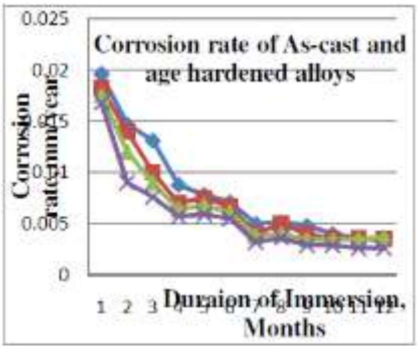

Figure 8: Plot of corrosion rate of as-cast and age hardened alloys versus duration of immersion.

Fig 8 shows the plot of corrosion rate versus duration of immersion of as-cast and age hardened alloys where, corrosion rate decreases with duration of immersion, reaches a transition value and thereafter it remains nearly constant for the remaining period of immersion. This decreasing trend is observed for both as-cast and solution treated alloys.

For as-cast alloys, the corrosion rate decreased from 0.0196 to 0.005 mm/year for a period of 7 months indicating 74.5% decrease. It further decreased from 0.005 to 0.033 mm/year over a period of 5 months indicating 34% decrease in wear rate. Similarly, for alloys aged to6 hours, the corrosion rate decreased from0.0168 to 0.0032 for the same period resulting in 80.95% decrease. It further decreased from 0.0032 to 0.0026 showing 18.75% decrease. Peak aged alloys were proved to be more corrosion resistant compared to as-cast alloys.

3.2: EFFECT OF DURATION OF IMMERSION ON CORROSION RATE OF AS-CAST AND SOLUTION TREATED ALLOYS

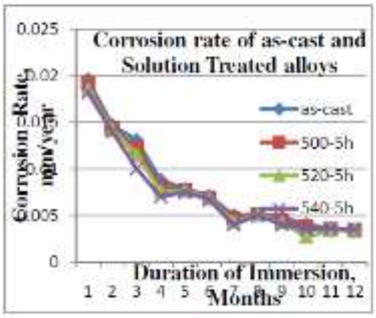

Figure 9: Plot of corrosion rate of as-cast and solution treated alloys versus duration of immersion

For as-cast alloys, the corrosion rate decreased from 0.0196 to 0.004 mm/year for a period of 10 months indicating 80% decrease. It further decreased from 0.004 to 0.033 mm/year over a period of 2 months indicating 17.5% decrease. Similarly, for solution treated alloys, the corrosion rate decreased from 0.0182 to 0.004 for the same period resulting in 78% decrease. It further decreased from 0.004to 0.0035 showing 12.5 % decrease. Solution treated alloys were proved to be more corrosion resistant compared to as-cast alloys.

3.3: EFFECT OF DURATION OF IMMERSION ON CORROSION RATE OF ALLOYS AGED TO VARIED AGEING TEMPERATURES

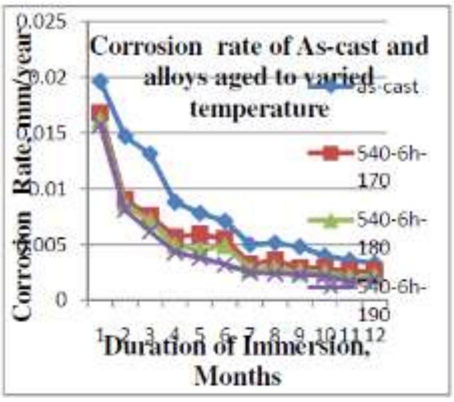

Figure 10: Plot of corrosion rate of as-cast and alloys aged to varied ageing temperatures versus duration of Immersion

Fig 10 shows the plot of corrosion rate versus duration of immersion of as-cast and alloys aged to varied ageing temperatures where, corrosion rate decreases with duration of immersion, reaches a transition value and thereafter it remains nearly constant for the remaining period of immersion. This decreasing trend is observed for both as-cast and alloys aged to varied ageing temperatures.

For as-cast alloys, the corrosion rate decreased from 0.0196 to 0.005 mm/year over a period of 7 months indicating 74.5% decrease. It further decreased from 0.005 to 0.033 mm/year over a period of 5 months indicating 34% decrease. Similarly, for alloys, aged to 1900C, the corrosion rate decreased from 0.0157 to 0.0025 for the same period resulting in 84.1% decrease. It further decreased from 0.0025 to 0.0019 showing 24 % decrease. Alloys aged to higher ageing temperature proved to be more corrosion resistant compared to as-cast alloys.

4. CONCLUSIONS

Corrosion increases with period of exposure for both as-cast and heat treated alloys up to a critical duration of immersion and thereafter it decreases. The decreased corrosion rate with increased duration of immersion of heat treated alloys can be attributed to hardness achieved and spherodisation of needle shaped silicon particles, and their nearly uniform distribution in the alloy since needle shaped Si morphology is more prone to corrosion compared to spheroidal morphology observed in heat treated alloys. The decreased corrosion rate with increased duration of immersion can be attributed to the formation of corrosive products on the surface of the specimens which act as barriers resulting in reduced attack by corrosion.

5.0: REFERENCES

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