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# Investigation of Mechanical Properties on Magnesium Based Alloys: AZ31 and AZ80

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***Abstract*— The commercially available as-cast AZ31 and AZ80 mechanical properties were investigated. Initially, the magnesium and its alloy place a vital role in medical and all engineering based application. In order to investigate the mechanical properties of AZ31 & AZ80 tensile test were carried according to ASTM. The specimen were prepared by re-melting of commercially available as-cast materials. The specimens are prepared in controlled environment. The results of AZ31 as compared to AZ80 have significant improvement for yield tensile strength, ultimate tensile strength and also for percentage of elongation. Whereas for fracture strain percentage is compromising. The results validations, the utilization of AZ31 can be used for medical application due to higher mechanical properties. Magnesium alloys AZ31 can successfully replace Stainless steel and Titanium.**

***Keywords*— Magnesium alloys, AZ31, AZ80, Mechanical Prperties, Strain Rate.***

## I. INTRODUCTION

In present era, magnesium and its related alloys place a vital role in medical, automobile, aerospace structures. Magnesium based alloys possess an attractive combination of low density and high strength/weight/ratio which are quite useful in various engineering and medical applications. As it plays the major alloy of Mg-Al-Zn system. Magnesium & its alloy mechanical properties and processing performances still could not meet the needs of some important parts in Vehicles and other application fields. Therefore, many methods are being investigated in the world in order to improve mechanical properties and processing performances of Mg-Al-Zn system alloys. [1]

Pure Magnesium (Mg) is incompetent of providing the essential mechanical and corrosion properties required for a wide variety of implant applications. Therefore potential alloying elements need to be carefully considered. Common alloying elements for Mg include aluminium (Al), zinc (Zn), calcium (Ca), rare earths (RE), lithium (Li), manganese (Mn) and zirconium (Zr) [2]. Vojtech D et. al. [3] studied the effect of alloying elements on structure, mechanical and corrosion properties of biodegradable Mg alloys. All alloys were composed of α-Mg solid solution and interdendritic intermetallic phases. Hardness and tensile strength were observed to be increased with increasing the total amount of alloying elements. Alloying elements. Moreover rare earth elements showed better corrosion resistance and strong strengthening effect. Several studies have found few if any negative side effects when testing Al-containing Mg alloys both in vitro and in vivo. It must be considered though, that such studies were typically short-term and may have been heavily influenced by the corrosion of the alloy itself.

Khin S, et. al., [6], In the present study, AZ41 and AZ51 alloys were fabricated using disintegrated melt deposition technique followed by hot extrusion. AZ41/Yttria and AZ51/Yttria composites were prepared using 0.6 wt% yttria nano particles in the alloys using the same fabrication technique. From the tensile test results, both strengths (yield and tensile) and ductility were improved in AZ51 when compared to AZ41. In comparison with its alloy counterparts, the yield and tensile strengths were enhanced while maintaining the same ductility in AZ41/Yttria composite, but comparable strengths with decreased ductility were observed in AZ51/Yttria composite. Under compressive loading, an improvement in strengths with similar ductility was observed in AZ51 when compared to AZ41. The best combination of strengths and ductility was observed in AZ51/Yttria composites from compression test results. The obtained mechanical properties are correlated with the microstructure observations.

The present work aims to compare the mechanical properties of magnesium alloys such as AZ31, AZ-80 alloys, aiming to reinforce the progress to improvement in tensile properties [4-5].

## II. MATERIALS AND EXPERIMENTAL METHODOLOGY

### *A. Specimen Preparation & Testing*

The materials used in the present study, were commercial as cast commercial Mg alloys grade Mg (~99% pure) metal and as cast AZ31 (Al 3 wt%, Zn 1 wt%, balanced Mg) and AZ80 (Al 8 wt%, Zn 0 wt%, balanced Mg) alloys were investigated. For enhanced medical application, the percentage of alloying element is kept low. The commercial alloys AZ80 & AZ31 supplied by an industrial supplier were re-melted under argon to produce test specimen. The specimen

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were prepared of dimensions 150 X 300 X 10mm. the samples were polished with different grade of emery paper. However, Argon gas will be used to create a protective environment during melting of metal. The casting of the Mg alloys was made in the protective oxygen atmosphere. Molten metal will be poured at the temperature of 750ºC approximately.

Table 1. Chemical compositions of Magnesium alloys (Wt, %)

| Element | Mg | Al | Zn | Mn | Cu | Si | Fe | Ni |
|---|---|---|---|---|---|---|---|---|
| AZ31 | Reminder | 2.86 | 0.78 | 0.45 | 0.01 | 0.03 | <0.005 | <0.005 |
| AZ80 | Reminder | 8.92 | 0.28 | 0.29 | <0.005 | 0.03 | <0.005 | <0.005 |

When the melt temperature reached 730 °C approximately, the pure Al, pure Zn and the master alloys were added to the melt. After being held for 40 min at 700 °C, the melt was poured into a permanent mould in order to obtain a casting. Further the test specimens were machined to the dimensions required for tensile test as per the standards. Figure 1 shows that, size of the specimen for conducting tensile test. The table 1 lists the chemical compositions of the experimental alloys.

The samples of the experimental specimen were etched with 8% nitric acid distilled water solution before experimentation process.

Fig. 1. AZ31 Fractured specimen

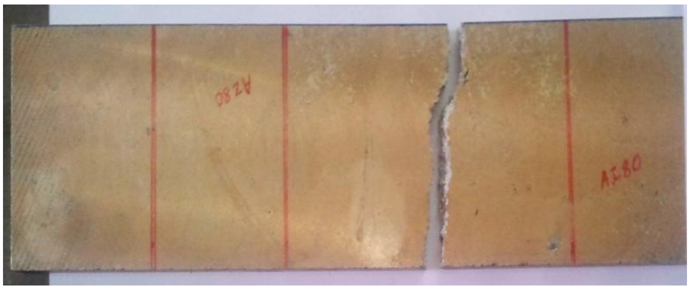

Fig. 2. AZ80 Fractured specimen

In order to determine the mechanical properties, tensile test were carried conferring to standards. Tensile tests were carried out as per IS-1608 using Universal Testing Machine (Make-Fine Spavy Group) at a constant load rate of 1 mm/min at room temperature. The tensile specimen were taken as cast and machined to the dimension- 75 X 300 X 10mm. the Yield Strength and elongation percentage were calculated from tensile test. Figure 1 show tensile test specimen.

## III. RESULTS AND DISCUSSION

### *A. Mechanical Properties*

Table 2. Shows the mechanical properties of three different Magnesium alloys- AZ-31, AZ-80. Magnesium alloys containing aluminum possess a high quality combination of mechanical properties. The physical properties of magnesium are affected by the amount of each alloying element added to it. Addition of aluminum has clearly shown the increment in yield strength and UTS. The alloy AZ-31 showed the maximum yield strength, UTS along with elongation amongst the group. Based on physical properties AZ-31 can be selected amongst all of three. The addition of aluminum and zinc showed increase in yield strength and ultimate tensile strength [4]. Figure1 shows that, stress and strain plot of AZ31 alloy. Figure 2 represents that, stress and strain ploy of AZ80 alloy.

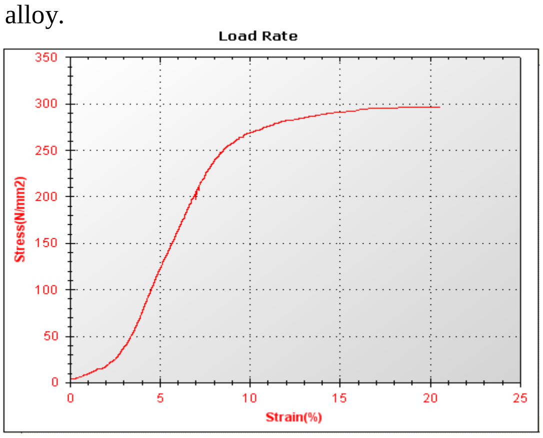


Fig.3. AZ31 Stress and Strain plot for tensile test.

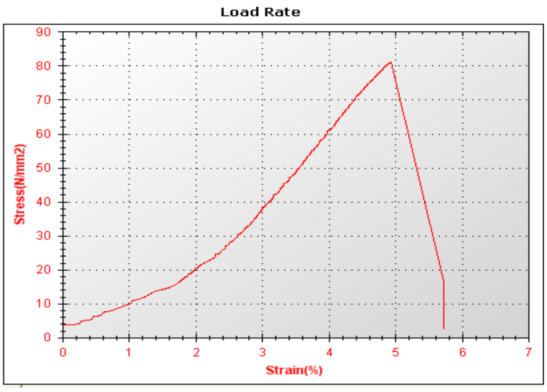


Fig.4. AZ80 Stress and Strain plot for tensile test.

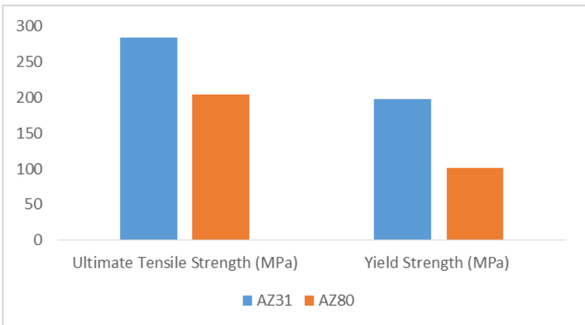


Fig. 5. Comparison plot of Tensile Strength (MPa) and Yield Strength (MPa) for AZ31 & AZ80

Table-2. Mechanical properties of magnesium alloy

| Magnesium Alloy | Ultimate Tensile Strength (MPa) | Yield Strength (MPa) | Elongation (%) | Fracture Strain Rate (%) |
|---|---|---|---|---|
| AZ31 | 285 | 198 | 11.9 | 0.2 |
| AZ80 | 205 | 101 | 6.80 | 0.05 |

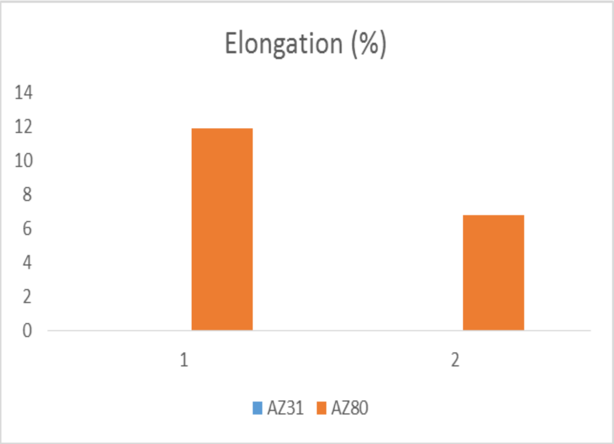


Fig. 5. Comparison plot on Percentage of Elongation for AZ31 & AZ80

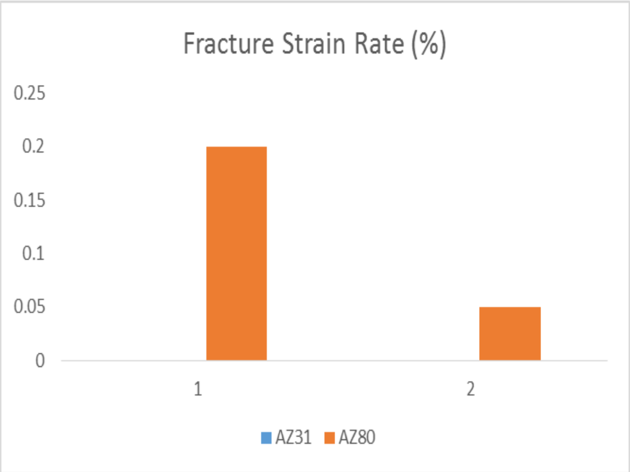


Fig. 6. Comparison plot of Tensile Strength (MPa) and Yield Strength (MPa) for AZ31 & AZ80

A comparison plots drawn for AZ31 & AZ80 for mechanical properties of Tensile Strength, yield Strength shown in figure 4. Also, Percentage of elongation shown in figure 5. For fracture strain Rate percentage has been shown in figure 6. Based on Plots AZ31 has shown significant mechanical properties compered to AZ80.

## IV. CONCLUSION

The aim of this study was to analyze the physical properties and chemical analysis of Mg-Al-Zn alloy with different alloying percentage. Mg-Al-Zn alloy is a promising alloy to be used as medical usage due to its better mechanical properties. For Mg-Al-Zn alloys, AZ-80 showed the enhanced fracture strain rate percentage. Whereas, AZ-31 showed the compromising results of Mechanical properties. As compare the results of both specimens, AZ31 has 28.07% higher for Ultimate Tensile Strength (MPa), 48.98 % of increase in Yield Strength (MPa), and percentage Elongation until the fracture of the specimen have more 42.8%. However, the Fracture strain rate resulted 75% compare to AZ80. Based on the results of physical properties and chemical analysis, especially AZ-31 can successfully replace Stainless steel and Titanium.

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