International Journal of Engineering Sciences Paradigms and Researches (IJESPR)
Volume 46, Issue: Special Issue of December 2017
An Indexed, Referred and Peer Reviewed Journal with ISSN (Online): 2319-6564
www.ijesonline.com

ENVIRONMENTAL FRIENDLY METHOD FOR PREPARATION OF Al-Mg ALLOYS USED IN STRUCTURAL APPLICATIONS

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ABSTRACT

Aluminum magnesium alloys are the suitable material used in Composite manufacturing, Automobile, Structural Applications and also aero-space Industries. Here the Environment friendly materials i.e. Al-Mg alloy is manufactured by modified stir casting method using a plunger rod. It can be used for brake shoes and composite manufacturing. In this method of manufacturing, the loss of Magnesium is minimum. The result shows that the recovery of Mg is more that 90% & the hardness of the said alloy also increases. The addition of Mg improves the mechanical properties of Al-Mg Alloys. The effect of furnace temperature during the preparation of Al- Mg Alloys has been studied and it was found 800^0C gives the optimum result.

***Key Words** – Al-Mg alloy, furnace temperature, Mg recovery, hardness*

I.INTRODUCTION

In the structural application high strength with minimum weight materials are always required. In this contest Aluminum-Magnesium alloys are the suitable materials for the applications. It provides good mechanical strength and better manufacturing quality [1-3]. In the preparation of Aluminum-Magnesium alloys the recovery of Magnesium is less because of volatile nature of Magnesium. So plunger technique used for alloy preparation provides high recovery of Magnesium in the prepared alloys. Addition of Magnesium decreases the alloy density which is very useful in structural applications also the strength of the alloys increases and corrosion resistance improves [4-5]. The plunger technique used for alloy preparation is low cost and environment friendly. Addition of the volatile Magnesium material is much easier and effective by Plunger technique for alloy preparation [6-7].

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In this work a new method (plunger technique) was used for Aluminum-Magnesium alloy preparation. Here Magnesium chips are used for alloy preparation which cost is less. Because the boiling point of Magnesium is less, the recovery of Magnesium in the alloy is also less. The present investigation was an attempt to develop a process for obtaining Al-Mg alloys by the casting route utilizing cheap magnesium turnings [8-9]. The plunger technique was helpful in reducing magnesium loss in liquid route achieving a high recovery of Mg in the alloy. More than 90% of magnesium was recovered even though the magnesium was in the form of turnings. It was felt that this technique will be helpful in making additions alloying elements with high volatility and large density difference. The recovery of Magnesium in the alloy are in high value which reduces the Magnesium lose in the alloys prepare [9-11]. Different furnace temperature i.e. 700^0c, 800^0c, 900^0c were used to produce the Al-Mg Alloys and these are tested for hardness.

II.EXPERIMENTAL PROCEDURE

The plunger technique apparatus was used to produce the required Aluminum-Magnesium alloys. Here the solid shaft of the stir rod was converted to hollow one as shown in figure(Figure 2.1), where the required quantity of Magnesium through Plunger rod are introduce to the Aluminum melt. The different percentage of Magnesium i.e. 1, 3, 5, 7, 10 by weight are used for the alloy preparation.

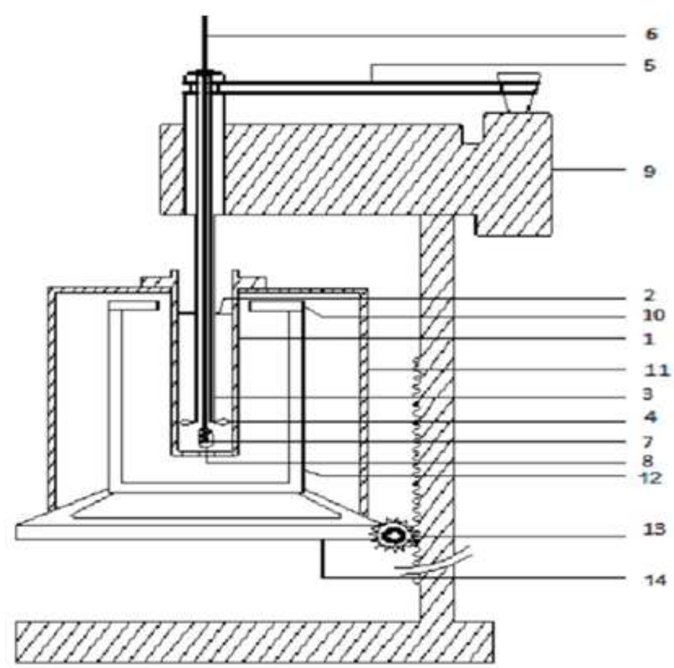

Fig.2.1: Diagram of Plunger Technique Apparatus to Prepare Aluminium-Magnesium Alloys

1. Heating pot
2. Melt Level
3. Hollow Spindle
4. Impeller Blade
5. V-belt Drive
6. Plunger Rod
7. Capsule
8. Mg turnings Particle
9. Gear Assembly and Motor
10. Split Cover
11. Crucible Holder
12. Electric Furnace
13. Rack and Pinion Arrangement
14. Base Plate

2.1. Materials:

Commercial Al ingots were used to prepare Al-Mg Alloys, the composition of the Al ingot is tabulated in Table-2.1.

Table-2.1: Chemical contains of Aluminum ingot.

Cu	V	Mn	Si	Fe	Al
0.001	0.006	0.003	0.08	0.15	99.76

The chemical composition of Magnesium turning are represented in Table-2.2

Table- 2.2: Magnesium Chemical composition for preparation of alloys

Cu	Mn	Mg	Zn	Ni	Al	Si	Pb	Fe
0.005	0.1	99.68	0.005	0.005	0.05	0.1	0.005	0.05

2.2. Methodology:

Aluminium metal matrix as liquid form was taken in a cast iron crucible .A hollow spindle having three stirred blades fixed at the lower end was used for mixing. A screw feeder assembly was introduced through the hollow spindle for delivering the additions below the agitating blades (Figure-2.1). Mg turnings were taken into the plunger rods to feed it into the Al melts. Aluminum melts at 660^0C, so furnace temperature is maintained above 700^0c and the plunger rod containing Mg particulates wrapped with Al foil are used to feed into the Liquid Al melts. Then the liquid Al-Mg alloys poured into the mould to get the casting. After cooling, samples are collected & cut to size for different sizes for testing.

Figure 2.2: Photograph of perforated mild steel capsule welded to plunger rod, Mg particles inside the capsule shown wrapped with Al foil.

III. RESULTS AND DISCUSSION

Prepared alloys samples are collected to get the chemical analysis. Magnesium content was measured to calculate magnesium recovery. ASTM-E-1251-2007 method was followed.

The results are given in Table-3.1. Magnesium recovery was calculated for percentage of magnesium added.

Table-3.1: % of Mg added vs. % of Mg recovery at furnace temperature 700^0c

%of Mg added	1	3	5	7	10
%of Mg recovery	94	93.5	92	89	84

Table-3.2: % of Mg added vs. % of Mg recovery at furnace temperature 800^0c

%of Mg added	1	3	5	7	10
%of Mg recovery	95	95	94	90	87

Table-3.3: % of Mg added vs. % of Mg recovery at furnace temperature 900^0c

%of Mg added	1	3	5	7	10
%of Mg recovery	94	93	91	87	84

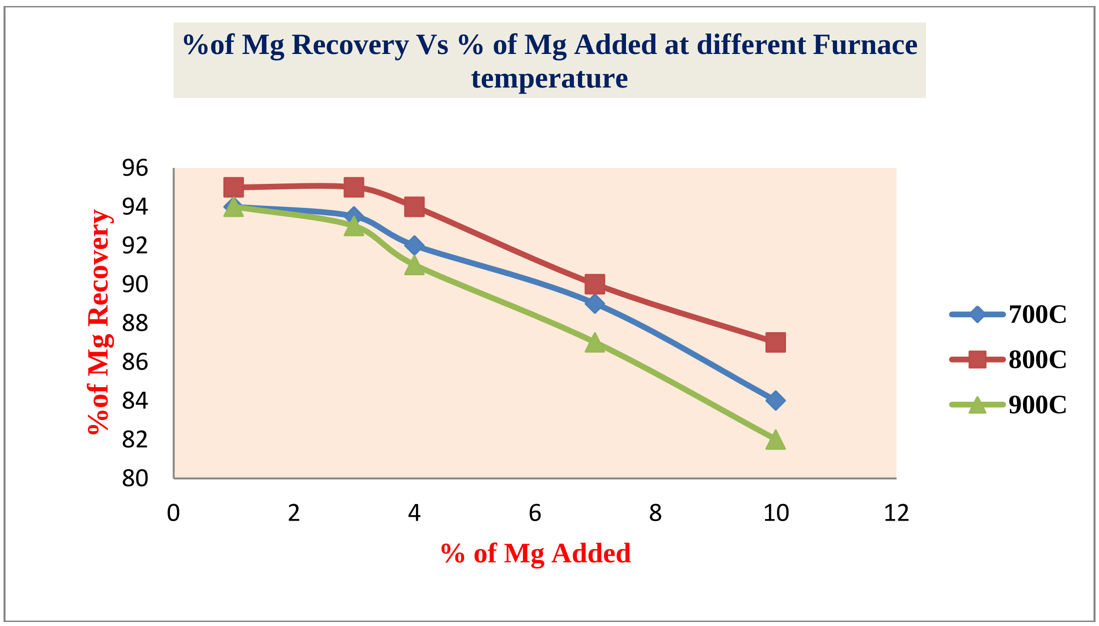

Fig.3.1: % of Mg Recovery VS % of Mg added

Hardness:

To begin with mechanical strength property indicator, hardness parameter determination was made for laboratory scale and tabulated. The hardness of the casting sample was measured in the middle of the casting. The measured hardness (VHN) data were tabulated in following tables.

Table-3.4: Hardness of castings at furnace temperature of 700^0C

%of Mg added	1	3	5	7	10
Hardness (VHN)	71.9	73.26	77.13	83.54	86.69

Table-3.5: Hardness of casting furnace temperature of 800^0C

%of Mg added	1	3	5	7	10
Hardness (VHN)	74.7	76.59	80.38	86.16	89.04

Table -3.6: Hardness of casting at furnace temperature of 900^0C

%of Mg added	1	3	5	7	10
Hardness (VHN)	73.25	75.93	78.62	85.36	87.58

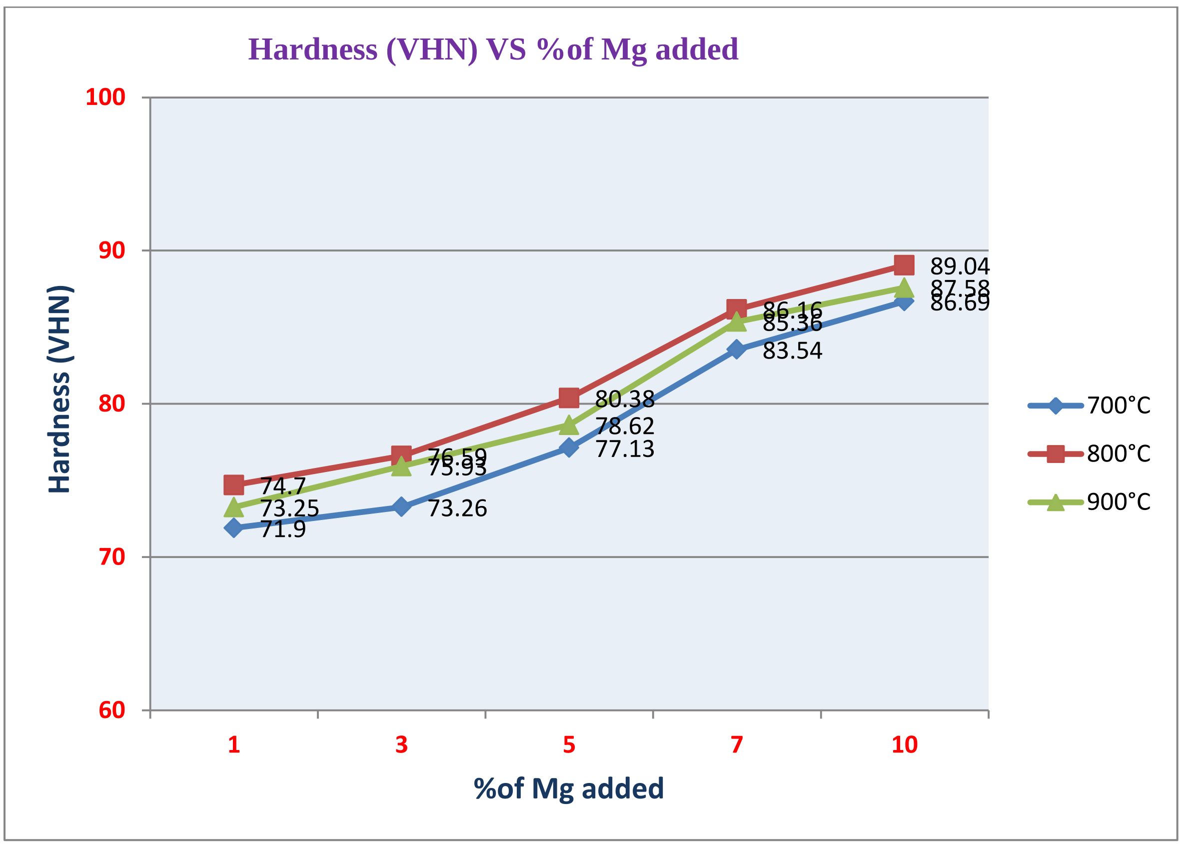

Fig.3.2: Graph between Hardness and % of Mg added at different furnace temperatures.

IV. CONCLUSIONS

The recovery of Magnesium using the plunger technique from the cast Magnesium alloys produced were more than 90%. The data revealed from Fig.3.1, the furnace temperature has great effect of

Magnesium recovery .Mg recovery is highest at the temperature of 800^0c. With the increasing percentage of Magnesium addition the recovery decreases with all the work out furnace temperature. The Al-Mg alloys provide recovery of magnesium with high percentage produced by Plunger technique is the low cost and high effective technique for alloys preparation. Accordingly hardness value has increased considerably compare to base metal Aluminum. The figure 3.2 shows that the hardness is higher at the furnace temperature of 800^0C. Also it shows that as the Mg content increases in the alloy, hardness also increases.

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