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Experimental investigation of Magnesium recovery and Tensile properties of Alloys made of Aluminum-Magnesium with variation of temperature in the furnace using Plunger Technique

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ABSTRACT

The less density, increased manufacturability, good thermal conductivity and high specific strength makes Aluminum-Magnesium alloys very useful. In this work a new method for production of alloys made of Aluminum and Magnesium was developed using Magnesium from machine scrap. A new technique, where plunger rods are used to add Magnesium of the required quantity to produce the Aluminum-Magnesium alloys. Because of less boiling point of magnesium the contents of magnesium in the alloy is poor. The present investigation is an attempt to develop a process for obtaining Al-Mg alloys by the casting route utilizing magnesium cheap from turnings. In this process plunger rod containing Magnesium is fed to the Aluminum melt for production of alloys. The plunger technique was helpful in reducing magnesium loss on melt achieving a high recovery of Mg in the alloys. More than 90% of magnesium was recovered even though the magnesium was in the form of turnings. Different furnace temperatures i.e. 700^0c, 800^0c, 900^0c were taken for Alloy manufacturing then its Mg recovery and tensile properties are investigated.

Keywords: *Alloys, Stir casting, Mg recovery, Tensile strength*

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1. 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. 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. 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.

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 less . Some attempts to produce Aluminum-Magnesium alloys using chips through the metallurgical powder route but casting route has not been followed due to the obvious reason of high loss of magnesium. The present investigation was an attempt to develop a process for obtaining Al-Mg alloys by the casting route utilizing cheap magnesium turnings [17-20]. The plunger technique was helpful in reducing magnesium loss on melting 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. Different furnace temperature i.e. 700^0c, 800^0c, 900^0c were used to produce the Al-Mg Alloys and these are tested for tensile strength.

2. 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. 1,3,5,10, by weight are used for the alloy preparation.

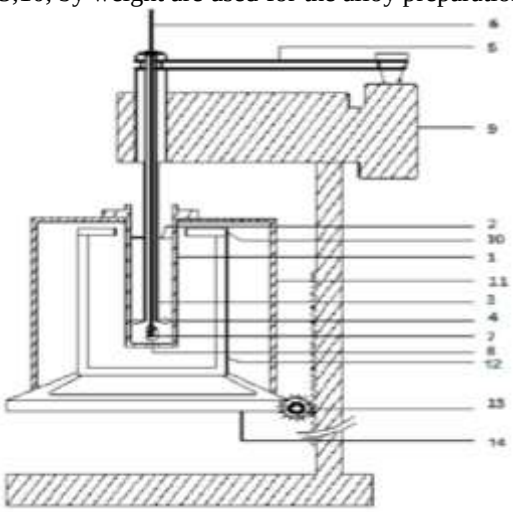

Fig.2.1: Diagram of Plunger Technique Apparatus To Prepare Aluminium-Magnesium Alloys

1. Heating pot
8. Mg turnings and SiC Particle

2. Melt Level
3. Hollow Spindle
4. Impeller Blade
5. V-belt Drive
6. Plunger Rod
7. Capsule
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-1.

Table-2.1: Chemical contain 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

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. Tensile strength:

Tensile specimens of dimensions shown in the Fig. 3.8 were machined as per ASTM-E8M standard from different alloys and composites. Tensile testing was done by INSTRON 8801 machine.

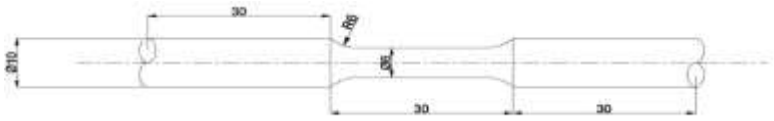

Fig 2.2: Specimen for Tensile test (dimensions are taken in milimeter)

3. Discussion and Results:

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

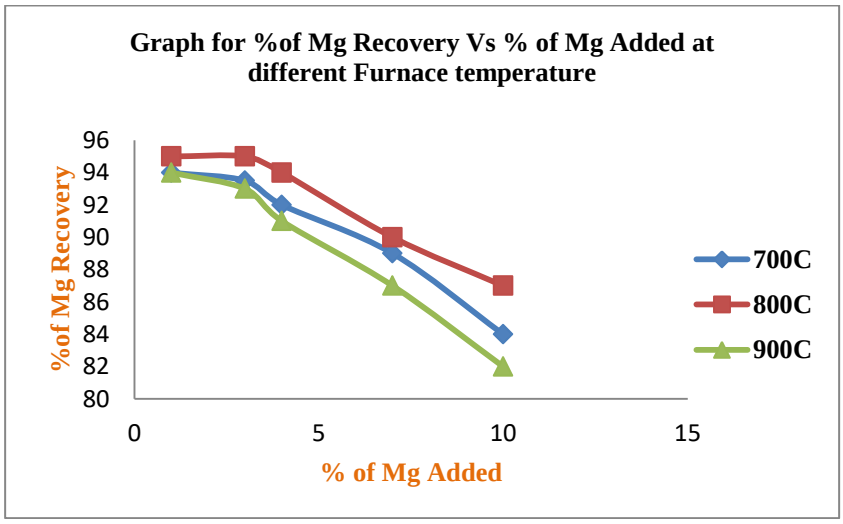

Fig.3.1: % of Mg Recovery VS % of Mg added

Following Tables shows the Tensile Strength of alloys at different furnace temperatures.

Table: 3.4 (Tensile Strength of different alloys at furnace temperature of 700^0C

ALLOYS	**1%Mg alloy**	**3%Mg alloy**	**5%Mg alloy**	**7%Mg alloy**	**10%Mg alloy**
TENSILE STRENGTH(MPa)	175	216	228	237	249

Table: 3.5 (Tensile Strength of different alloys at furnace temperature of 800^0C)

ALLOYS	**1%Mg alloy**	**3%Mg alloy**	**5%Mg alloy**	**7%Mg alloy**	**10%Mg alloy**

TENSILE STRENGTH(MPa)	176	224	234	243	259

Table:3.6 (Tensile Strength of different alloys at furnace temperature of 900^0C)

ALLOYS	**1%Mg alloy**	**3%Mg alloy**	**5%Mg alloy**	**7%Mg alloy**	**10%Mg alloy**
TENSILE STRENGTH(MPa)	176	217	229	239	251

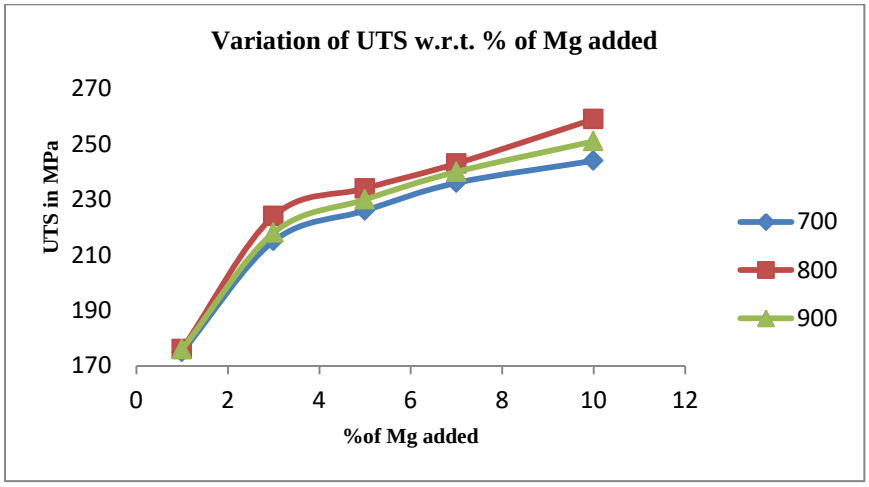

Fig.3.2: UTS in MPa VS % of Mg added

4. Conclusion:

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.

The ultimate tensile strength (UTS) is the important material parameter for industrial use. The furnace temperature has great impact on the Ultimate tensile strength of alloys produced by plunger Technique. At temperature of 800^0C, the Ultimate tensile strength of alloys produced provides maximum value as per Fig.3.2. The Ultimate tensile strength of alloys produced decreases as Magnesium addition percentage increases. The low cost plunger technique is highly effective for the alloys preparation with improvement of tensile properties.

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