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Study the Recovery of Zinc from Its Different Sources in to the Commercial Pure Aluminium

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ABSTRACT: The idea of present work is to study the recovery of zinc in to commercial pure aluminium. Different sources of zinc like Zn Powder, ZnO Powder, ZnSO₄.7H₂O Powder, Zn(CN)₂ Powder & finally Zn solid were added into commercial pure aluminium. Out of various sources, in case of solid zinc, % recovery of Zn is highest with a value of 94%. With a 94 % recovery of zinc, offers, tensile strength value 158 N/mm². Additions of Zn in powder forms also give quite high recovery of zinc that is around 72%. In rest of the sources, recovery is around 3 to 13%. All the addition of zinc source in to commercial pure aluminum further evaluated by change in microstructure, hardness & electrical conductivity values.

KEYWORDS: Recovery, Sources of zinc, Mechanical properties, Microstructure

I. INTRODUCTION

Aluminum, the second most plentiful metallic element on earth, became an economic competitor in engineering. The demand for aluminium & its alloy grows rapidly because of its unique combination of properties like appearance, light weight, fabricability, physical properties, mechanical properties, and corrosion resistance.^[1,2] The properties of commercial aluminium alloys depend on the amount of elements like magnesium, copper, silicon, zinc and other alloying elements present in them. A variation in the composition of these elements has a significant impact on the mechanical properties of the resultant alloy^[3]. Among all the aluminum alloys, Aluminum-Zinc alloy is first commercial alloy of that has highest mechanical strength among all age-hardenable alloys.^[4] This alloys are playing very important role in aerospace and automobile industries due to their high specific strength & other valuable properties.^[5] The combination of zinc and magnesium which makes the 7XXX alloys heat-treatable and gives rise to their very high strength. The strength of this alloy generally increase with the concentration of Zinc & Magnesium.^[6] In these alloy, Zn is the main component for strength and copper added, to improve strength, but mainly to reduce hot shortness and improve castability and stress corrosion resistance.^[3] Retrogression and re-aging heat treatment can also improves the strength.^[7] High Zn : Mg ratio produce the best strength and response to heat treatment, together with the highest susceptibility to stress corrosion; low ratio produce the best weld ability and the lowest quench sensitivity. Hence Zn play major role in Al-Zn base alloys. Thus, the recovery of Zn is very important. However, recovery of Zn from its different source is not discusses anywhere in Literature. Hence, this research activity tries to find out the relationship between addition of Zn and its actual recovery.

II. MATERIALS AND METHODS

The commercially pure grade of aluminium melted in a graphite crucible by using resistance-heating furnace. The different sources of Zn added into the liquid commercially pure aluminum melt at 700°C. The amount of addition was 5wt% fixed. The Zn sources added melt, poured into a permanent metallic die. The microstructures of samples characterize by using a Neophote 2 optical microscope. The static tensile test carried out using a Monsanto tensile

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testing machine with 0.05 strain rate. Averages of three reading considered as a result. The Brinell hardness tester used to measure hardness. An average of six reading consider as final hardness value.[6,7,8]. Electrical conductivity test were performed to check the variation of Zn concentration

III. RESULTS & DISCUSSION

3.1 Chemical Analysis of Raw material

Following table 1 indicate chemical analysis of all raw materials like commercially pure aluminum, Zinc solid, Zinc powder, Zn oxide powder, Zinc sulphate powder and Zinc cyanide powder.

Table 1 Chemical composition of raw material

Raw material	%O	%Mg	%Al	%Si	%Fe	%Zn	%S	%C	%Cl	%N	Total
Commercially pure Aluminum	2.60	0.43	95.92	0.64	0.33	0.08	-	-	-	-	100.0
Zinc solid	21.09	-	-	-	-	78.91	-	-	-	-	100.0
Zinc powder	10.19	-	-	-	-	89.81	-	-	-	-	100.0
Zn oxide powder	20.18	-	-	-	-	79.82	-	-	-	-	100.0
Zinc sulphate powder	46.85	-	-	-	-	37.80	15.35	-	-	-	100.0
Zinc cyanide powder	7.44	-	-	-	-	53.50	-	17.98	1.51	19.57	100.0

Above table 1 indicate commercially pure aluminum with 0.08 % Zn and others impurities amount are in the range of 0.32-0.65%. Total amount of elemental impurities are in the range of 1.4-1.5%. Around 2.5% oxygen indicate the presence of oxide layer on the surface of commercially pure aluminum. Zn solid indicate, Zn amount is around 79% & oxygen is 21%. Zinc powder has amount of Zn around 90% with oxygen 10%. Zinc oxide has amount of Zn around 80% with oxygen 20%. Zinc sulphate has amount of Zn around 37.80% with oxygen 46.85% & it also contain 15.35% sulfur. Zinc cyanide consist of Zn around 53% with carbon & nitrogen approximately 20% & 20% respectively and it also contain oxygen around 7%.

3.2 Chemical Analysis of Zinc Added system

By the addition of Zinc total five systems has been developed. Following table 2, indicate amount of Zinc recovery by addition of different sources of Zinc.

Table 2 Recovery of Zinc in all systems

Sr. No.	Systems	% Recovery
1	CPA + 5% Zn solid	92.85
2	CPA + 5% Zn powder	71.69
3	CPA + 5% ZnO powder	-
4	CPA + 5% ZnSO ₄ .7H ₂ O powder	2.66
5	CPA + 5% Zn(CN) ₂ powder	6.20

* CPA = commercially pure Aluminum

Recovery of Zn varies with sources. In case of Zn oxide & Zn sulphate recovery of Zinc is nil. In case of Zn cyanide % recovery is around 6%. In case of Zn powder even though amount of %Zn is approximately 90% & % recovery of the Zn becomes 72%. It is due to the higher loss of Zn in the form of powder than the Zn solid. In case of Zn solid, highest

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% recovery is around 93%.thus, to maintain the complete chemistry as per the requirement of standard alloy development 7% compensation should be required.

3.3 Mechanical Properties Measurements

Following table 3 indicate changes in the mechanical properties like hardness and tensile strength by changing the Zn source.

Table 3 Mechanical properties of developed alloys

Sr. No.	System	Tensile strength N/mm ²	Hardness BHN
1	CPA	90	45
2	CPA + 5% Zn solid	158	49
3	CPA + 5% Zn powder	145	48
4	CPA + 5% ZnO powder	136	46
5	CPA + 5% ZnSO ₄ .7H ₂ O powder	130	47
6	CPA + 5% Zn(CN) ₂ powder	116	46

Above table 3 indicate variation in mechanical properties with addition of different source of Zn. In case of solid Zn we get highest mechanical properties with value of tensile strength 158 N/mm² which is 40% higher compare to raw material & hardness is 49 BHN. Zn addition enhance the solution strengthening mechanism finally improves the mechanical properties of aluminium zinc base alloy.

3.4 Microstructural observation

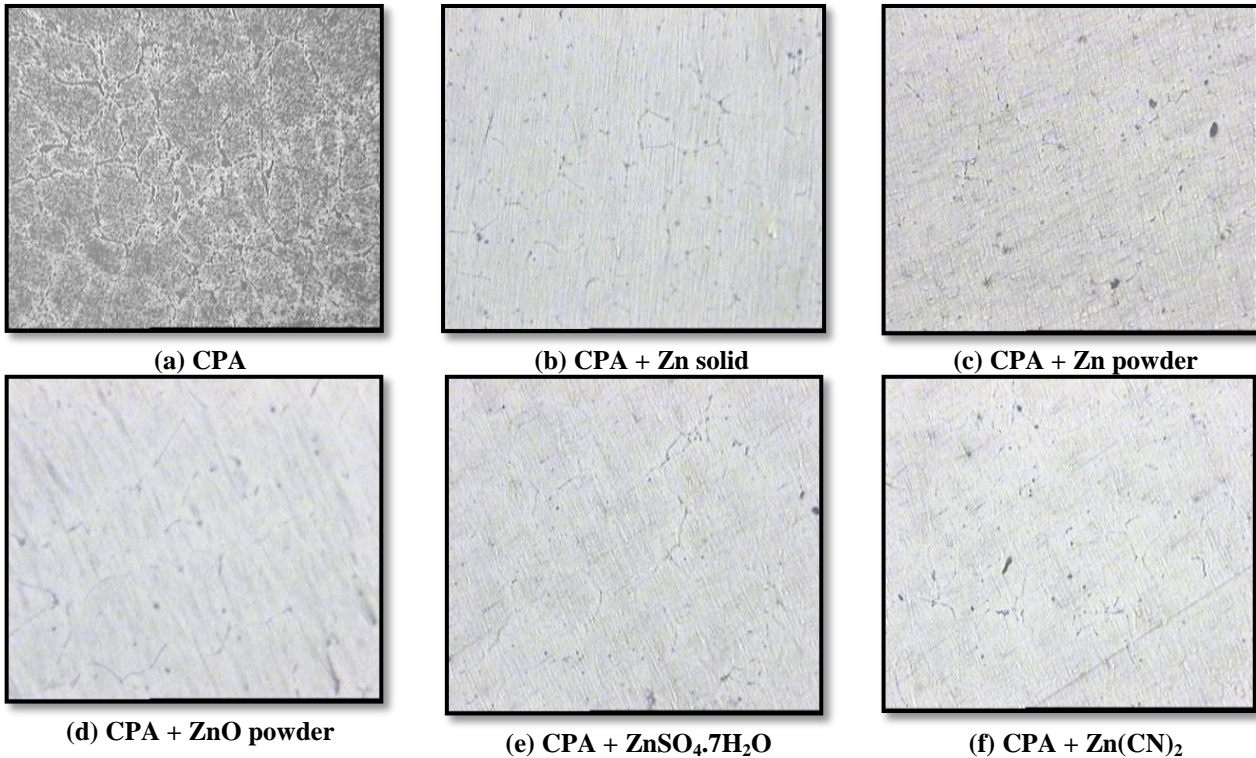


Fig 1 Optical Micrograph of various system at 100X(without Etching){CPA=commercially pure aluminium}

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Optical micrograph indicates presence of Zn due to the addition of different sources of Zn. In case of oxide & sulphate system where recovery is less presence of Zn is nil structure is like commercially pure aluminum. In case of Zn cyanide system due to 6% recovery of Zn, the presence of Zn highlighted & gathered at grain boundary in the form of black small dots. In case of Zn powder system thick grain boundary observed due to segregation, Zn along with very small black dots the center of grain. As the % of Zn recovery which is highest in case of Zn solid very thick & little large size Zn present observed both along the grain boundary & inside the grains.

3.5 Electrical Conductivity Measurement

To check the presence of Zn electrical conductivity measurement was done and presented in following table 4.

Table 4 Electrical conductivity of developed system

Sr. No.	System	Electrical Conductivity % IACS
1	CPA	47
2	CPA + 5% Zn solid	34
3	CPA + 5% Zn powder	38
4	CPA + 5% ZnO powder	40
5	CPA + 5% ZnSO ₄ .7H ₂ O powder	45
6	CPA + 5% Zn(CN) ₂ powder	45

Table 4 indicates reduction of electrical conductivity is highest in case of Zn solid source. It means successful alloying is possible by addition of Zinc solid into the commercially pure aluminium. In other sources hence recovery is very less reduction in electrical conductivity is also less.

IV. CONCLUSIONS

- Maximum 93% recovery obtained in case of solid Zinc.
- Recovery of Zinc from the other sources like Oxide, Sulphate and Cyanide is very less (3 -13%).
- Solid form of Zinc offers highest mechanical properties with tensile strength value of 151 N/mm² that is 40% higher compare to commercial pure aluminum & hardness value is 48 BHN which is 7% higher compare to commercial pure aluminum.
- Solid form of zinc offer lowest electrical conductivity with a value 35 IACS that is 28% lower compare to commercially pure aluminum.

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