Recycling of Aluminum Solid Waste in Diyala Company for Electrical Industries

Mustafa A. Rijab
Department of Mechanical Engineering
Technical Institute of Baquba
Diyala, IRAQ

Ali I.Al-Mosawi
Department of Mechanical Engineering
Free Consultation
Babylon, IRAQ

Shaymaa Abbas Abdulsada
Free Consultation
Department of Materials
College of Engineering, Kufa University
Kufa, IRAQ

Muhannad A. Rijab
Asia Cell Company
Diyala, IRAQ

***Abstract*—This research represents a solution for a practical problem that faces most industrial intersperses which produced large quantities of metallic solid wastes as by-products. So the possibility of using these test originated at one of the largest companies in the country (Diyala company for electrical industries) in the reinforcement of some structural sections was evaluated through this research. The results had referred to found that the microstructure of industrial waste , was a needle - shaped particles within the floor of the structure, and therefore that add an element titanium (Ti) leads to a partial modification of the microscopic structure while increasing this component be enough to get the modification process effectively. The results also show that the thermal homogenizing change the shape of the silicon needle or fibrous to spherical shape clearly through the process of homogenizing.**

Keywords—Aluminum solid waste, Recycling

I. INTRODUCTION

The solid waste is a form of pollution that where there is human activity is a complex composition and heterogeneous materials, whether Vezaoya or chemically created and vary greatly in composition and ingredients with geographical location and from time to time depending on the behavior of citizens and their level of living, and are classified as solid waste SW [1]according to a source generated and nature of the waste municipalities and agricultural, industrial and hazardous cannot give the specific features of the solid waste industry, because each industry solid waste depends primarily the basis of the type of inputs for industry input Material and type of production and manufacturing technique as it is not reasonable to similar solid waste generated from the sugar industry and metallurgical industries Oalencijah or Construction or other of the vast number of industries [2].

Leaving the solid waste generated at sites as it is without any action has many adverse environmental effects which can be summarized health effects and other aesthetic and socio-economic effects. In this sense, the disposal of developed countries, a large proportion of the annual budget on solid waste management and to achieve an efficient program in waste management and control of the generation point to the final money to waste includes solid waste management system home series of events is as follows[3]:

A solid waste generated Sw Generation
B. solid waste storage on site "SW Storage in Situ
C. solid waste collection Collecting SW
D. and convert solid waste SW Transfer & Transport transfer.

Its solid waste treatment SW Treatment The eutectic morphology ranges from plate-like to lamellar like in as cast condition to a circular like after modification or rapid cooling [1]. When Al-Si alloys are solidified the eutectic silicon is seen to consist of coarse plates in the sharp edges. These are detrimental to the mechanical properties [2]. However, soon afterwards the effect of modification was found. Al-Si casting alloys are particularly of great importance as they offer well casting properties, good corrosion resistance, in addition to improved wear resistance [3, 4]. However, the morphology of Si eutectic in these alloys is of great significance on controlling their properties, as it is usually grows in lamellar or fibrous or spheroid zed form [3]. In many situations, like those in Iraq have gone through, when shortage of fresh Al happens, remelting of scrapped castings becomes unavoidable to obtain new castings. However, non-homogenous microstructure and low mechanical properties are characteristic of these castings obtained by remelting, especially when the scrapped materials are made from modified alloys [5, 6].

Homogenization treatments, originally designed for Al-Si cast alloys, also has an effect on the Si particles morphology, as it changes their shape from lamellar to spheroid [7, 8]. Al-Si casting alloys are known for their good casting properties and a great number of researches have been conducted on their refining and/or modification to optimize its mechanical properties [4, 7]. The addition of elements like Na, Sr, Sb, and Ti was found to induce an effect on the microstructure of the eutectic alloy depending on their addition procedure and amount. Both modes of refinement of (Ti) and modification of Na, Sr, Sb have an effect on microstructure, but in a rather different way, as the first control the nucleation rate rather than the morphology of the second phase [8,9]. Aluminum casting alloys are gaining wide popularity, as they combine several attractive properties such as low density, high stiffness, good casting characteristics, as well as improved properties if the alloy microstructure is refined or modified. The effect of modification has been attributed to both affecting nucleation and Si morphology through prohibiting its growth [10]. While modification alters the shape of the Si phase. Some other external factors like vibration or rapid solidification cause an alternation in the morphology of the Si eutectic [9, 10, 11].

II. EXPERIMENTAL PROCEDURE

The solid waste generated in the company (see Fig.1), most (more than 95% of metal waste (iron and other minerals) and take these wastes various forms some of which is a bar and what is in plates perforated and what is a cut irregular as well as the waste differ in terms of the type of metal and the thickness of the piece depending on the manufacturing process, which takes place on raw materials in different laboratories and certainly the solid waste generated from fans lab, for example, are different in nature from those resulting from iron plant and also vary for other wastes resulting from the spark mug lab or the ability and shape adapters (1) represents photographs of a mixture of waste produced by the company in the study site . Solid waste generated from plants and sections of the company in the study site environmental problem clearly visible through the accumulation of garbage heaps in most of the vacant space, a waste generated proceeds over several years.

The experimental program of this work consisted of producing a number of castings (6) by remelting scrapped castings made of Al-12%Si alloy in a gas furnace. The melt was refined by adding Ti in the range 0.1-0.3% Ti. The melt composition was controlled by adding fresh Al. the Ti was added in an elemental form, weighted and wrapped with Al foil. The Ti-wrapped in foil was laid in the bottom of an alumina crucible and the molten metal was poured over it. The whole melt was held afterwards for 15 min in the gas furnace for melt homogenization. The molten metal was poured at 620 °C in a preheated steel mould. The cast pieces were homogenized at 400 °C for different durations 10, 25, 50 ,75, 100, hrs. Table.1 represent the Chemical Composition of Aluminum solid waste.

	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Pb	Sn	AL
AL-12%Si	12.00	0.25	0.019	0.17	0.006	0.027	0.04	0.011	0.005	0.011	0.0018	Rem
AL-12%Si-0.08%Ti	12.00	0.248	0.023	0.18	0.007	0.029	0.08	0.013	0.005	0.013	0.002	Rem
AL-12%Si-0.22%Ti	12.00	0.245	0.018	0.191	0.005	0.028	0.22	0.012	0.004	0.012	0.003	Rem

Table 1: Chemical Composition of Aluminum solid Waste

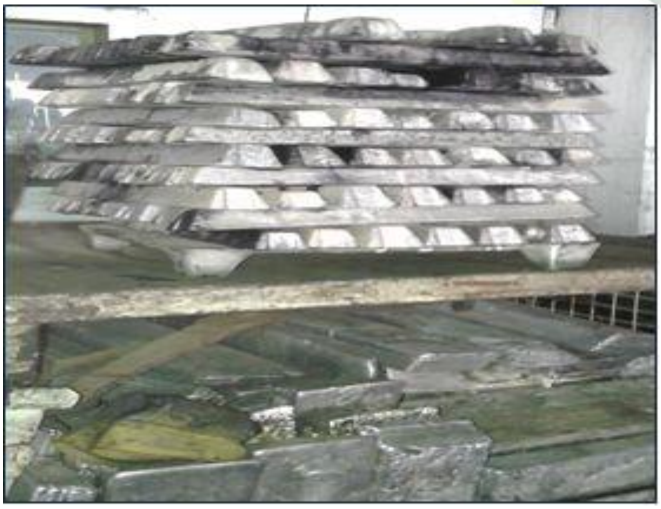

Fig. 1: Aluminum solid waste

III. RESULT AND DISCUSSIONS

Figures.2,3,4,5,6 represent of microstructure for Aluminum solid waste .The depicted changes in microstructure reveals that the Si-eutectic changes its morphology by heating at 410°C through five stages; nucleation, fragmentation, spherodization, growth, and finally stabilization. The first stage after 20 hr, is a stage where growth of the Si starts by diffusion of Si from the matrix to the particles. After 30 hrs. The Si starts to diffuse out of the Si-eutectic particles and fragmentation of these particles happens changing their morphology. After that the Si particles becomes spheroid zed for both alloys without Ti and with 0.3%Ti, whereas, only partial spherodization happens in the alloy containing 0.08%Ti. The spherodized particles start to grow, growth of the Si particles proceed with holding time till these grown particles reach a stable state of their size and changes only happen to their shape. The microstructure as of the Al-12%Si cast alloys without Ti and with 0.08%Ti & 0.22%Ti, respectively, is seen to consist of two phases mainly, which are primary α- Al and eutectic Si. Adding the 0.08%Ti is seeing to modify the Si-eutectic morphology slightly but has no effect on refining the primaryα. While, 0.22%Ti modifies the Si-eutectic morphology greatly and changes the primary α to have a fine dendritic structure. This effect is believed to be due to the role of Ti in reducing the melting point of the alloy, thus giving a higher chance for nucleation of the primaryα Al relative to the Si-eutectic, this is in turn refines the primary (α) phase and inhibits the Si growth.

The microstructure of the studied alloys after homogenization at 410 °C for 20, 30, 40, 50, 100 hrs. respectively. It is a worth mentioning that recent references [9, 11] have pointed out that the addition of Titanium in various forms to aluminum Alloys have a strong effect on nucleating the primary aluminum phase. These studies have shown that Ti in solution in the liquid metal even below the 0.08% , determined by equilibrium data from the phase diagram, and as low as 0.08% would be expected to precipitate ($TiAl_3$), which is an active nucleus for aluminum. The different surging times of heat treatment aims to detecting the changes that happens with the microstructure refinancing. It is worth noticing that the time necessary for stabilization changes from alloy to alloy, as stabilization happens after 100 hrs for the alloy without Ti & with 0.3%Ti, while it happens after 100 hrs for the alloy containing 0.08%Ti.

This stable size of the Si-particles ranges from 6-12 μm. The measured hardness of all the studied alloys in as cast and homogenized conditions .The data shows that adding Ti to Al-Si eutectic cast alloys increase their hardness in as cast condition. This effect might be explained by an increase in the eutectic content or the formation of (TiSi) particles [11], which is not investigated in this study. Homogenization, of these alloys cause a significant drop in hardness of all alloys and this drop continues with homogenization time. The possible causes behind this drop in hardness are stress-relief and change in Si-eutectic morphology. However, these studies have recorded that ($TiAl_3$) was present on (TiB_2) crystals at the lower levels of Ti than that expected from the phase diagram (0.22%Ti) [11]. Some of these studies reported a poisoning effect of Si on the grain refinement action of Ti when Si% is high due to the possibility of formation of TiSi [10].

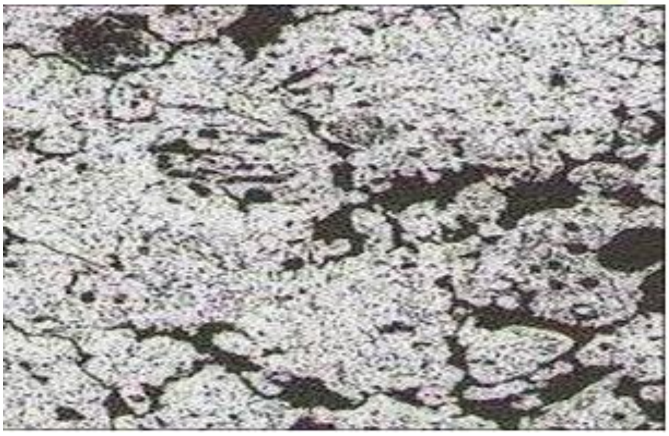

Fig.1: Microstructure of As Cast and Modified Alloys (45 mμ)

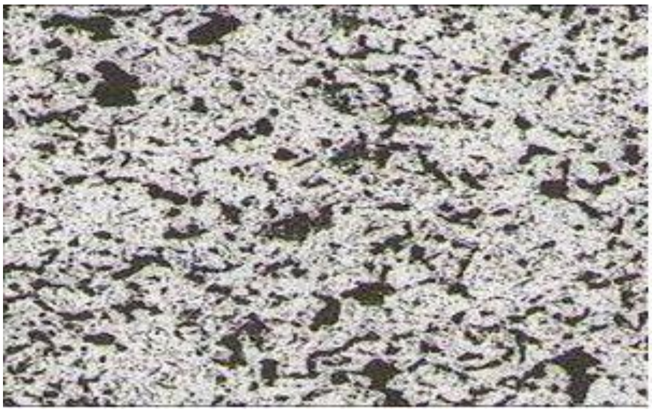

Fig.2: Microstructure of Homogenized Alloys with(20)hrs. At 410 C°(45 mμ)

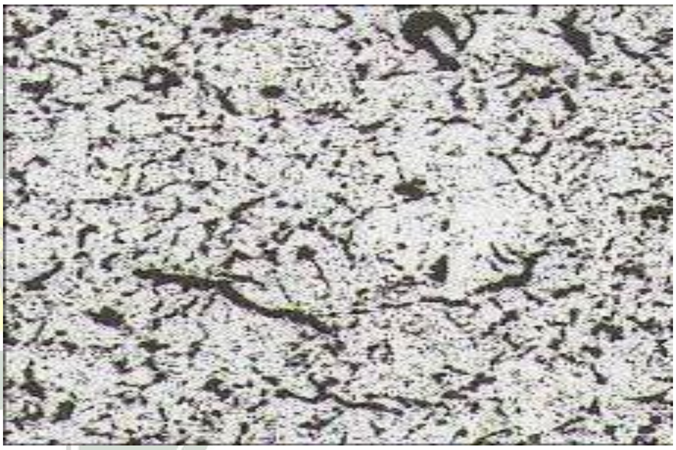

Fig.(3)Microstructure of Homogenized Alloys with (30)hrs. At 410 C°(45 mμ)

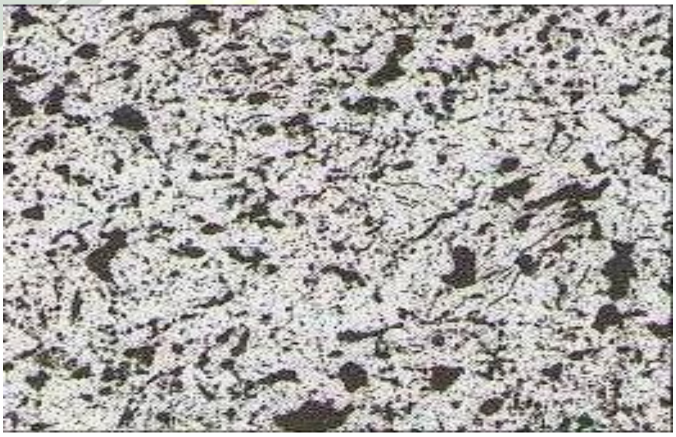

Fig.4: Microstructure of Homogenized Alloys with (40)hrs. At 410 C°(45 mμ)

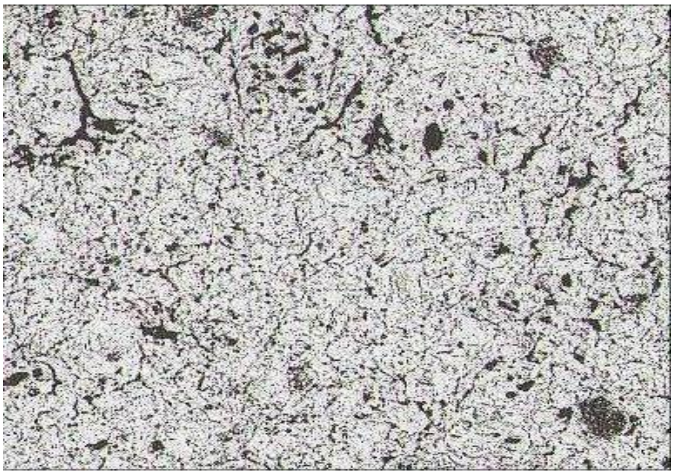

Fig.5: Microstructure of Homogenized Alloys with (50)hrs. At 410 C°(45 mµ)

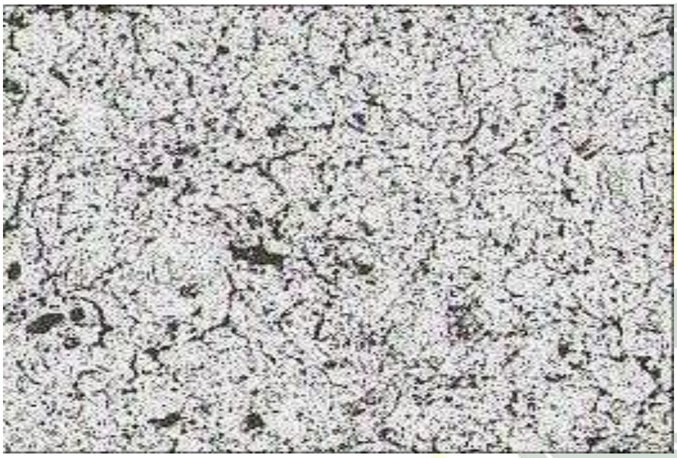

Fig.6: Microstructure of Homogenized Alloys with (100)hrs. At 410 C°(45 mµ)

Conclusions:

One of the main conclusions reached from this research is to provide the costs and represents a scaled environmental impact of the launch of the solid waste Therefore, the current trend is towards the possibility of using waste Again SW Reuse or extracting useful, including Material Recovery For the industrial sector constitutes solid waste is a real problem, because the waste generated represent waste in the industry for the cost of raw materials economies used in industry on the one hand and limited vamp geography of industrial activity (lack of space Cafe accommodate generated waste) on the other hand . If the special character such as mining industry or electric industries produce waste hard metal, the problem will be the biggest fact that this waste is the kind of non-degradable and so the need to be continuous areas landfill extra, and from this point of this study towards the use of solid waste outputs occasional activities in one of the leading industrial companies in the country.

Adding elemental Ti (0.08%) to Al-12%Si alloy causes partial modification of the Si eutectic, and as Ti content reaches 0.3% maximum modification is gained. Homogenization treatment of Al-12%Si cast alloys with or without Ti causes a modification in the Si eutectic morphology through 6 stages. When Ti content reaches 0.22% the mechanisms for modification of Si eutectic through homogenization becomes similar to those of the alloy without Ti. Adding Ti to Al-12%Si cast alloys causes an increase in their hardness. The stabilization state is reached after (100) hrs. for the alloy with 0.08%Ti, while it is reached after (50) hrs. for the alloys without or with 0.22% Ti

References

[1] Ali I. Al-Mosawi, Shaymaa Abbas Abdulsada, Mustafa A. Rijab "Waste Processing: Technical Solutions" , LAP LAMBERT Academic Publishing. 2015.ISBN: 978-3-659-45126-3.

[2] Shaymaa Abbas Abdulsada "Preparation of Aluminum Alloy from Recycling Cans Wastes" , International Journal of Current Engineering and Technology, 3(4), 2013.

[3] Sharma A. , yilmaz B.F. " Silicon crystals in aluminum – Silicon alloys ", Aluminum, , part 3, 2005, pp..338

[4] Shimizu Y. , y. Kato , S. Hashimoto and N.Tsuchiya " Influence of phosphate and Sodium Halides on the structure of hyper eutectic AL-Si casting alloys " , Aluminum , 62 , 1986, pp. . 276 .

[5] Das A.A. "Some Observations on the effect of the pressure on the solidification of AL-Si eutectic alloys " , part 2, Brit . foundryman , 34, 2011, pp..201 .

[6] Shivkumar S. , Wang L. and Apelian D. " Molten Metal Processing of advanced cast aluminum alloys " , J. Met . Jan , 1991,pp. 26 .

[7] Sharma A. " Heat Treatment : Principles and Techniques " , part 3 , Prentice Hall of India , Private Ltd ,2008.

[8] Grugel R.N. , 1999, " Evaluation of Primary Dendrite Trunk diameters in directionally Solidified AL-Si alloys ", Mater . Character . 18 ,1999, pp.313 .

[9] Reddy A. Somi , Bai B.Npramila , Murthy K.s.s and Biswas S.K. , " Mechanism of seizure of aluminum Silicon alloys sliding against steel " , wear , 181 , pp.658 .

[10] Mustafa S.F. " wear and wear Mechanisms of AL –20%Si/AL2O3 Composite ", , part 2, wear , 155 , 1995, pp.77 .