THE PROCESS OF MAKING ECOLOGICAL ANTIFRICTION ALLOYS BY REMOVING CADMIUM (Cd) AND ARSENIC(As)

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ABSTRACT: This paper highlights different methods and technologies for recovering materials that can be reused. The main focus of the paper is on technologies for removing arsenic and cadmium from reusable materials in the composition of anti-friction alloys. Thus, the technologies for the elimination of Cd and As by vacuum evaporation and by elimination by oxidative melting will be presented. This paper is a starting point for the following studies, presenting technical and ecological principles of reuse of materials that serve the machine building industry.he composite material is an assembly consisting of two or more bodies, with different structure and properties which, by combining the individual qualities of the components, form a heterogeneous material with improved overall performance.

Keywords: ecological alloys, antifriction alloys, vacuum evaporation, oxidative melting.

INTRODUCTION

The machine building industry is developing exponentially in terms of quantity and quality. In order to solve one of the main problems they face, namely the procurement of raw materials, chip recovery technologies must be developed.

Recent research shows that many workers who have worked or are working in the development of Sn-St-based alloys alloyed with Cd and As suffer from serious diseases caused by these elements. These two are stored in human tissues, especially in vital organs, and gradually lead to the appearance of the most serious diseases. It is assumed that the most harmful effect of the two elements on living organisms is the production of cancers mainly in the stomach, lungs, prostate and more.

The research took place on animals with exactly the same particularly serious consequences, namely the appearance of malignant tumors. Next, it was proposed to make ecological alloys, ie from reused materials and at the same time with the elimination of the two dangerous chemical elements. [1]

Technologies for removing arsenic and cadmium

The two most important chip recovery and Cd and As removal technologies are oxidative melting and vacuum vaporization operations.

Oxidative melting involves several steps, including crushing the alloy, adding an oxidizing mixture over the alloy such as $Na2CO3: KNO3 = 3: 1$, heating the crucible in which the mixture is, introducing technical oxygen. [2]

Melting under vacuum in an induction-heated crucible is a tried and tested process in the production of liquid metal. [3]

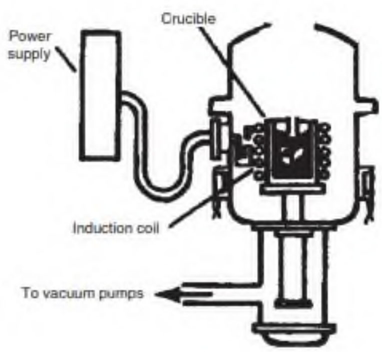

Figure 1. Basic elements of a vacuum induction melting furnance

1. Experimental procedure

They were two types of alloys used for the experiments:

• LgSnR, with the following chemical composition: Sb - 7.9%; Cu - 2.9%; Cd - 1.02 %; Ni- 0,6 %; Sn - 88% ; Pb - 0.1% and with the following characteristics: HB 250/10/30 - 29 + 33; Rm = 90 N/mm2;P0,2 = 75N/mm ; A = 7%.

• RL 38-93, with the following chemical composition: Sn - 81.10 %; Sb - 12.13 %; As - 0.35 %; Cd – 0.9 %; Ni - 0,14%; Pb - 1.4 %; Bi < 0.02%; Cu - 4.79 % and with the following characteristics: HB 250/10/60 - 26; R., = 87 N/m2; R.02 = 67N/mm2; A= 4 % .

1.1. Removing Cd and As through oxidative melting – experimental trials

1 kg of alloy was melted separately from each alloy in a stainless steel crucible. When the alloy reached a temperature of 620°C, technical oxygen was introduced. The oxidation time was 3, 5, 10, 15 minutes for each batch, the alloy being kept at a temperature of 620°C. After the oxidation time expires, the slag is removed and deoxidation will begin.

Deoxidation is obtained by the following technology: a mixture of NaoH (0.1% of the amount of melt) and charcoal powder is sprayed on the surface of the alloy. Gently shake the bath for 10 minutes at 470°C, then remove the slag. Sprinkle sulfur powder and lime flour, stir a little in the bath, then remove the slag and bubble with argon (Ar) for 5 minutes. Lower the temperature to 410°C and pour into the sample shells.

Table 1. Oxidative melting results [5]

Oxidation time (minutes)	Alloy	% amount of elements left after oxidation		% initially amount of elements	
		Cd	As	Cd	As
3	RL38-93	0,753	0,026	0,9	0,35
	LgSnR	0,980	-	1,02	-
5	RL38-93	0,645	0,009	0,9	0,35
	LgSnR	0,799	-	1,02	-
10	RL38-93	0,482	traces	0,9	0,35
	LgSnR	0,582	-	1,02	-
15	RL38-93	0,389	traces	0,9	0,35
	LgSnR	0,436	-	1,02	-

1.2. Removing Cd and As through vacuum vaporization – experimental trials

Experiments were carried out on an amount of 0.5 kg of each alloy. The experiments carried out on these alloys were based on the fact that the boiling temperature of Cd is 765°C, respectively the sublimation temperature of As is 613°C. [4]These temperatures are much lower than the boiling temperatures of the other elements that enter the composition of alloys. This research method aimed to verify the theory that by vacuum melting boiling and sublimation temperatures decrease. The results obtained are shown in the table below:

Table 2. Vacuum vaporization results [5]

T°C/t'	% Cd initial	% Cd left	% As initial	% As left
450/15	1,02	1,02	0,35	0,35
/30	1,02	1,02	0,35	0,35
/60	1,02	0,99	0,35	0,30
500/15	1,02	1,00	0,35	0,32
/30	1,02	0,97	0,35	0,30
/60	1,02	0,95	0,35	0,24
550/15	1,02	0,98	0,35	0,28
/30	1,02	0,95	0,35	0,19
/60	1,02	0,92	0,35	0,10
600/15	1,02	0,98	0,35	0,17
/30	1,02	0,93	0,35	0,091
/60	1,02	0,89	0,35	traces
650/15	1,02	0,94	0,35	0,11
/30	1,02	0,89	0,35	0,07
/60	1,02	0,84	0,35	traces
700/15	1,02	0,94	0,35	-
/30	1,02	0,88	0,35	-
/60	1,02	0,81	0,35	-
750/15	1,02	0,68	0,35	-
/30	1,02	0,41	0,35	-
/60	1,02	0,21	0,35	-
800/30	1,02	0,59	0,35	-
/30	1,02	0,34	0,35	-
/30	1,02	0,09	0,35	-

CONCLUSIONS

The recovery of chemical elements from the chip remains a challenge for industry and for humanity. In this paper we have shown how to recover two chemical elements from antifriction alloys through two unconventional technologies: oxidative melting and vacuum vaporization. Unfortunately, during the processing of alloys by the two technologies, a certain amount of tin or antimony is lost. However, these amounts that are lost are small.As can be seen in the two cases mentioned above, Arsenic is the chemical element that is easily removed from the material. Cadmium can be completely removed from the alloy only by repeating these procedures. Oxidizing melting has proven to be a more productive method of removing As and Cd components from the alloy, but it is a more expensive method.

The main advantage of these two technologies is that they protect the life and health of production workers who will no longer ingest these two elements, as well as the protection of the environment.It is imperative that such technologies be developed so that the industry ensures its continuity, is eco-friendly, and people's lives are no longer endangered.

REFERENCES

[1] C. Deac, Study of materials, Sibiu: Lucian Blaga University of Sibiu Publishing House, 2004.

[2] D. Dobrotă, Basics of designing cutting processes, Craiova: Sitech Publishing House, 2007.

[3] A. International, „asminternational.org," 2008. [Interactiv]. Available: https://www.asminternational.org/documents/10192/22533690/05115G_Sample_BuyNow.pdf/1e9c159d-93ba-48fd-9164-7d8b8479cf6e. [Accesat 14 08 2020].

[4] G. Huțiu, Ecological anti-friction alloys, Timișoara: Politehnica Timișoara Publishing House, 2005.

[5] G. Huțiu, „Experiments concerning the elimination of Cd and As through vacuum evaporation from antifriction Sn – based alloys," Academia Română, pp. 1-6, 2007. project: A study on a recycling system for end-of-life tires. *J. Clean. Prod.*, 2019;