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RESEARCH ON THE EFFECT OF TEMPERATURE AND DURATION OF IMMERSION ON THE LAYER THICKNESS OF ZINC COATING OBTAINED IN MICROALLOYED ZINC MELTS

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ABSTRACT

This paper aims to establish the influence of temperature and duration of immersion on the thickness of zinc layer deposited through a thermal process, in correlation with the chemical composition of melted zinc. Layers obtained in microalloyed zinc with nickel, bismuth, tin, lead, aluminium, at different times of immersion and temperature, are analyzed. In terms of layer thickness, melted zinc microalloyed with bismuth and / or lead to coating to increase the content in these elements has thicknesses of increasingly small effect given the increasing fluidity of the melt in their presence. Decreased thickness of the layer is enhanced by increasing temperature and decreasing the duration of immersion. Best results are obtained at a temperature of 460^{0}C and 5 seconds of immersion time.

KEYWORDS: duration of immersion, layer thickness, microalloyed zinc

1. Introduction

The thickness layer resulted from zinc coating of steel is an important characteristic of the galvanized product. Thick layer of hot dip galvanizing process varies with temperature and immersion time and depends on the chemical composition of melt [1]. Elements of microalloying change the fluidity and surface tension of zinc melt and consequently drainage (leakage) of zinc when support is extracted from the melt [2, 3].

Immersion temperature affects both quality and quantity of zinc deposited on the surface of bands and produce ash, slag and dross. The melting temperature of zinc is of approximately 420^{o}C and zinc layer deposited at temperatures above 420^{o}C increases to 470^{o}C (Fig. 1.)

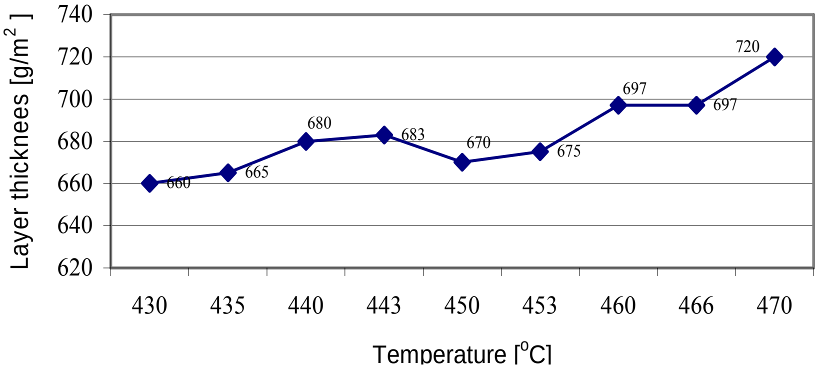

Fig.1. *Influence of temperature on the thickness of zinc coating on steel sheet by a maintenance period of 90 seconds.*

The usual working temperature in the galvanizing process is chosen between 450-460^{o}C. At lower temperatures it is a more difficult adhesion between zinc and steel and at higher temperatures (over 470^{o}C) when the layer thickness starts to decrease, Fe-Zn alloys begin to break passing interface in the melt and form a large amount of dross [4].

Time of immersion. Duration of immersion is determined by the thickness of steel sheet and desired thickness of the layer [4]. For a given temperature, a given composition to melt and the same work speed, increasing the duration of immersion leads to a corresponding increase in deposit weight.

The optimal duration is determined by technology.

The short amounts of time lead to defective adhesion and uniformity, and too long lead to a strong attack, large layer of Zn-Fe alloy and the emergence of such compounds in the melt (matt, ash), [5].

2. Experimental research

Steel sheet has been galvanized to its chemical composition according to Table 1, in zinc melts whose chemical composition is shown in Table 2.

Table 1. *The chemical composition of steel support*

C	S	Mn	P	S	Al	Ti	V	Cu	Ni	Cr	Mo	As
[%]												
0.025	0.015	0.210	0.013	0.010	0.046	0.002	0.001	0.005	0.008	0.025	0.001	0.004

Table 2. *The chemical composition of experimental zinc melts*

Alloy sample	Chemical composition, [%]						
	Ni	Bi	Sn	Cd	Pb	Al	Zn
Zn- Ni-Bi-Sn-Cd	0.16	0.71	2.95	0.26	0	0	remaining
Zn- Ni-Pb-Sn	0.16	0	2.88	0	0.72	0	remaining
Zn- Ni- Pb-Bi-Sn	0.16	0.41	3.49	0	0.43	0	remaining
Zn-Bi I	0	0.27	0	0	0	0	remaining
Zn-Bi II	0	0.36	0	0	0	0	remaining
Zn-Bi III	0	0.52	0	0	0	0	remaining
Zn-Bi-Sn-Al	0	0.44	0.86	0	0	0.33	remaining

Presences of microalloying elements influence layer thickness by altering the characteristics of zinc melt. It was applied microalloying with lead and bismuth elements that increase the fluidity [6] and favour the leakage of zinc and lead toobtaining layers with small thicknesses. Tin and nickel slow reactions between zinc and iron favour the formation of a substantial layer of zinc. Microalloying with nickel, bismuth, tin, cadmium and lead was directly made, using metallic elements, finely crushed, followed by mechanical mixing. At microalloying with nickel, it was applied a maintenance at 700^{0}C.

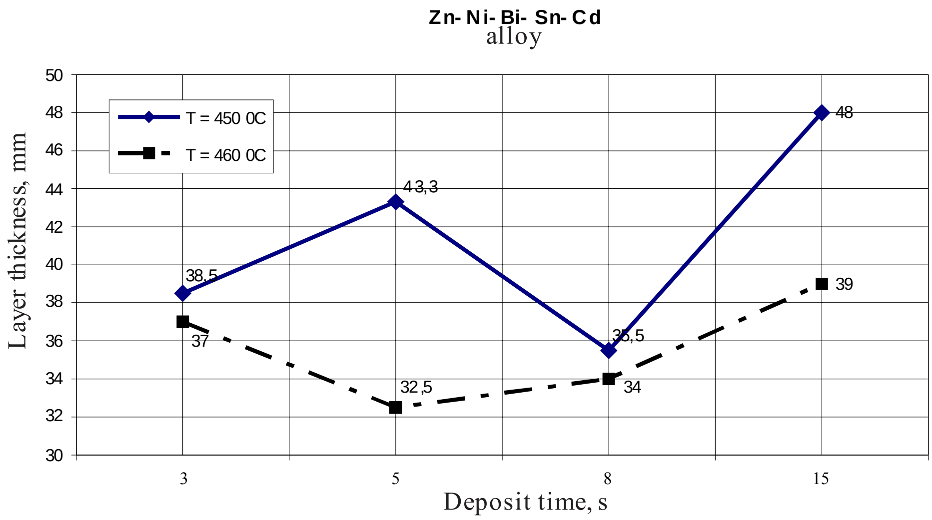

Fig.2. *Layer thickness variation depending on temperature and duration of immersion, (Microalloyed Zn with Ni-Bi-Sn-Cd).*

In the experiments, there wasn’t applied any control and uniformity process, coating thickness resulting in a free flow of zinc from the sample. Experimental immersion times were 3, 5, 8, 15 seconds. Layer thicknesses were measured with a special X-ray device.

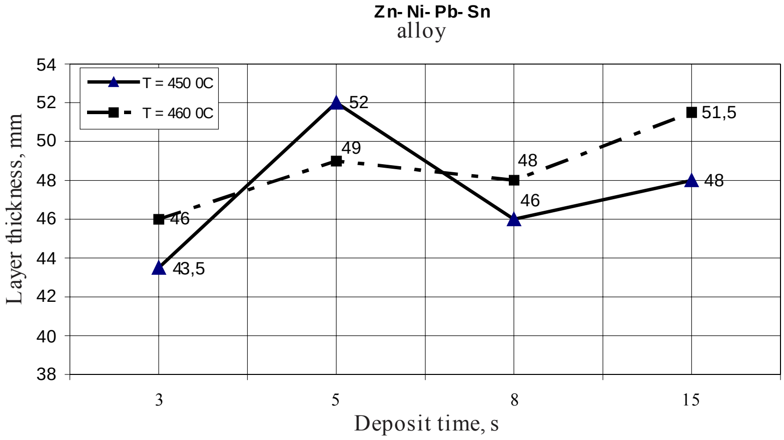

Fig. 3. *Layer thickness variation depending on temperature and duration of immersion, (Microalloyed Zn with Ni-Pb-Sn).*

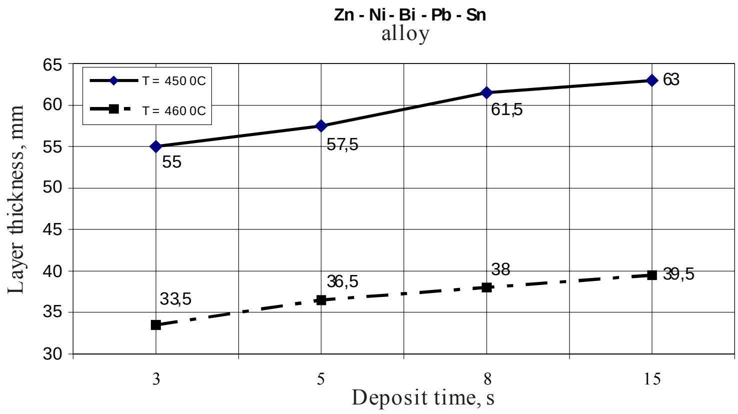

Fig.4. *Layer thickness variation depending on temperature and duration of immersion, (Microalloyed Zn with Ni-Pb-Bi-Sn).*

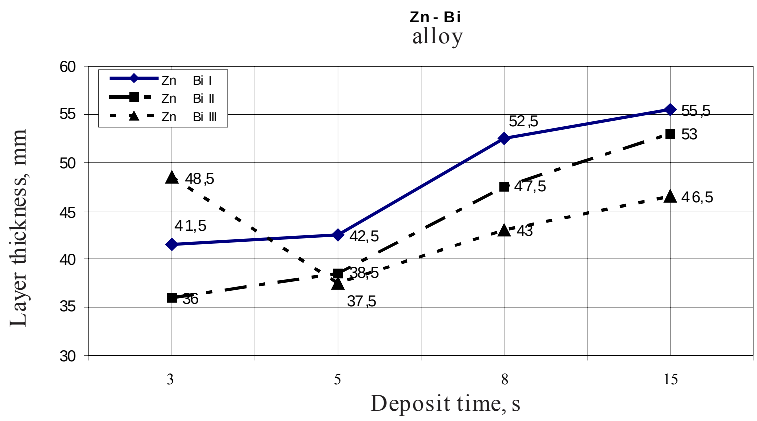

Fig.5. *Layer thickness variation on duration of immersion, (Microalloyed Zn with Bi, T= 450^oC).*

Laboratory experiments at the microalloying zinc melts were performed in the temperature range typical galvanizing processes, working at 450-460^{0}C.

By analysing the changes in layer thickness of the composite coatings obtained from microalloying with nickel (and elements for improving fluidity and structure) shown in Figures 2, 3, 4 at 450^{0}C, is observed a poor uniformity and high values of thickness, and compared to the 460^{0}C operating temperature of the melt. After the trials for these types of coatings, it is proposed a technological temperature of 460 ^{0}C and a maintenance period of 3-5 seconds. The finest layers were obtained in microalloyed zinc melt with tin, bismuth and aluminium at the temperature of 450 ^{0}C and 5-8 seconds duration of immersion (Fig. 6).

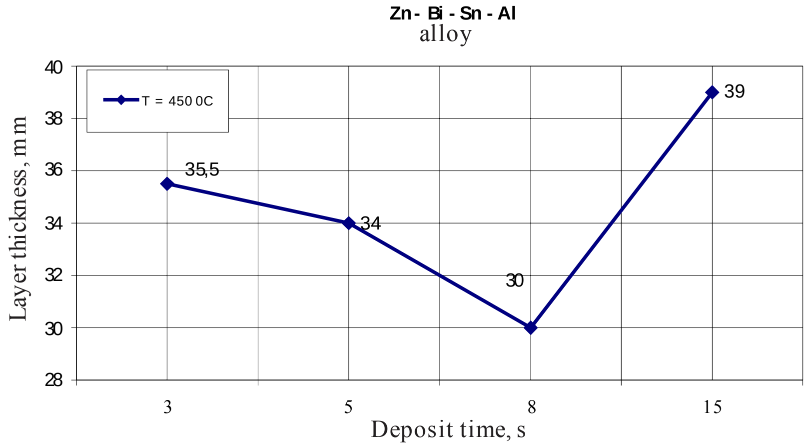

Fig. 6. *Layer thickness variation on duration of immersion, (Microalloyed Zn melt with Bi-Sn-Al, T= 450^{o}C).*

3. Conclusions

1. All types of coatings growth analyzed over eight seconds of immersion time lead to a significant increase in the thickness of the layer.

2. For coatings obtained in microalloyed Zn melts with nickel (and elements to improve the fluidity and structure: bismuth, tin, lead, cadmium) the appropriate indicate the temperature is 460^{0}C and the maintaining time is 3-5 seconds. At the temperature is 450^{0}C; it results a large and uneven layer thickness.

3. Regarding the thickness of the layer, microalloyed zinc melt with bismuth leads to decreasing layer thickness. This effect is given by the increased melt fluidity in the presence of bismuth.

For all three types of microalloyed Zn melts with bismuth appropriate the temperature is 450 ^{0}C and the duration of immersion is 5 seconds.

4. The finest layers were obtained in microalloyed zinc melt with tin, bismuth and aluminium at the temperature of 450 ^{0}C and 5-8 seconds duration of immersion.

References

[1]. Radu T. Constantinescu S. Balint L. *Materiale metalice rezistente la coroziune*, Ed. IFR. Buc. 2004

[2]. John Zervoudis, Graeme Anderson, *A Review of Bath Alloy Additives and their Impact on the Quality of the Galvanized Coating*, p. 4, Teck Cominco Metals Ltd. 120 est, Suite 1500 Toronto, Ontario, Canada

[3]. Bo Zhang, *Development of Corrosion Resistant Galvanising Alloys*, Metallurgy and Materials School of Engineering The University of Birmingham, July 2005.

[4]. Tamara Radu, Vlad Maria, Mitoseriu Olga, *Prevention and reduction of wastes in the hot dip galvanizing steel sheet*, conf int. Technology and Quality for Sustained Development TQSD 2008 Buc. P. 59 - 64, ISSN 1844 – 9159, AGIR Publisher HOUSE, Editors Univ. Polith. Bucharest.

[5]. Lucica Balint, Tamara Radu, Conferinţa Internaţională Transfrontalieră: *Integrated monitoring of environmental media(air, water, soil) in the Lower Danube Euro region*, Galati-Cahul area, Galati, 19 noiembrie 2009, Editura Fundatiei universitare „Dunarea de Jos”Galati, ISBN 978-973-627-455-8 pag. 218-222.