CORROSION BEHAVIOR OF TINNED BRASS

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Abstract: *The research conducted in the laboratory has focused on two aspects: obtaining the tinned brass; the assessing of the corrosion resistance of tined brass obtained. To thermal tinning the effect of temperature and the immersion time on the characteristics of coatings resulted were studied. The variation of the layer thickness depending on the temperature and the immersion time were established. Some samples were subjected to a heating at 350 °C for 10 minutes. After treatment, the appearance of the samples became grey-matt showing the increasing of alloying degree of the tin into brass by diffusion process.*

The samples obtained who had the best appearance of the coating (adhesion, continuity, porosity) tinned under the same conditions were tested for corrosion resistance. It consisted in immersing the samples in saline solution at room temperature for 30 days with the determining of the weighing changing at every 10 days.

Keywords: *brass, heat tinning, corrosion, gravimetric indices.*

1. Introduction

Brass alloys are characterized by special physico-chemical and mechanical properties, which determines their use in various fields such as chemical industry, shipbuilding, electronics, weapons, machinery, manufacture of coins, art, etc.. Use properties of brass are determined by their chemical composition, structure and processing (forming or casting). Most mentioned areas of use have as important requirement good corrosion behaviour. Brass, generally, are corrosion resistant alloys, but there are conditions that can have a significant corrosion. Factors favouring brass corrosion damage are internal tensions and some corrosive environments such as: moisture, oxygen, sulphur dioxide, ammonia, mercury salts, etc.. Rich in zinc brass have lower corrosion resistance than those with zinc less, [1].

Among especially dangerous types of corrosion encountered in brass mentions [1] corrosion or season-cracking, and pitting corrosion.

One possibility to increase the corrosion resistance is allying with one or more elements of binary brass (Cu-Zn), resulting in special brass. A great influence in this regard is alloying with Al, Ni, Sn.

In seas and oceans are used as installations and pipelines, brass aluminium, brass Admiralty, naval brass and Gun metal alloy [2, 3, 4, 5,]. Brass corrosion resistance in seawater is conditioned by inhibition of dezincification (intercrystalline corrosion caused by β'- CuZn phase separation on the grain limit of α phase).

Another possibility to increase the corrosion resistance of brass is applying a corrosion protection consisting in coating with paints and varnishes, epoxy resins associated with polyamides, polyvinyl vinyl, polyesters, and polyurethanes [6, 7, 8]

Good results were obtained for metal deposits of tin or lead, hot applied on brass pipes used in making pipes for shipbuilding or marine work.

This paper studies the effect of the tin protection to the corrosion resistance of a brass with high zinc content. He considered that, besides strong character corrosion of tin coating, tin leads to the formation of non-toxic reaction products, thus avoiding environmental pollution, aim which it becomes increasingly important in the present context.

2. Experimental

The research conducted in the laboratory has focused on two aspects: obtaining the tinned brass and the assessing of the corrosion resistance of tined brass obtained.

For experiments was used the brass that had the following composition: 40% Zn, 1.3% Pb, balance Cu.

Flow of tinning process is shown in Figure 1.

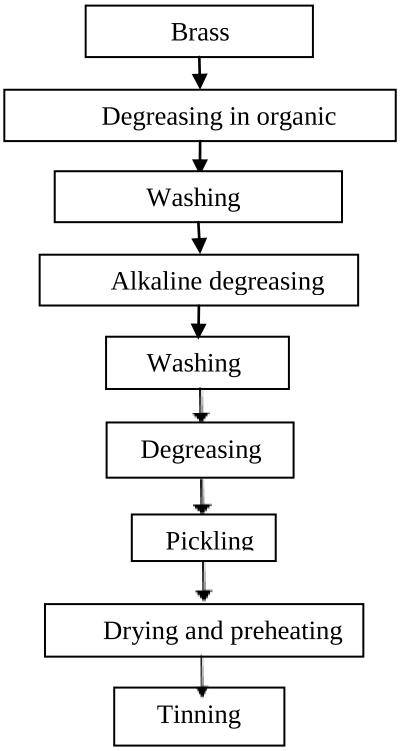

Figure 1: *Flow of tinning process*

The first step of degreasing was performed with acetone at ambient temperature by brushing. Chemical degreasing was performed for 10 minutes with a solution containing: 60 g/L NaOH, 70 g/L Na_2C0_3, 40 g/L NaCl [9], at ambient temperature. Pickling was carried out by immersing the samples for 60 seconds at room temperature in a solution of 60 cm^3/L H_2S0_4, 15 cm^3/L $HN0_3$ and 4 cm^3/L HCl [10]. Washing after each treatment was performed thoroughly with water for complete removal of reagents. Drying was done by pressing samples on filter paper and the samples preheating were done by keeping them above the tinning tank before immersion.

To thermal tinning, the effect of temperature and the immersion time on the characteristics of coatings resulted were studied.

Table 1 and Figure 2 presents effect of temperature on the thickness of the tin coatings, resulted after immersion for a period of 25 seconds.

Layer thickness was measured by weighing samples, in g/m^2, before tinning and after tinning, by relating the difference in mass on the surface of the sample.

The increasing of the layer thickness with temperature was observed. This is the result of both the favouring of the processes that lead to formation of alloys between support and layer and the stimulation of the diffusion processes.

Regarding the influence of maintaining time of the brass sample in the tin melted at temperature of 280 °C, is observed a variation with a minimum that corresponded to 15 seconds(fig.3).

Table 1: Layer thickness variation with temperature (immersion time 25 s)

Temperature, [°C]	240	250	260	270	280
Layer thickness, [g/m^2]	37,56	95,38	165,20	256,81	491,15

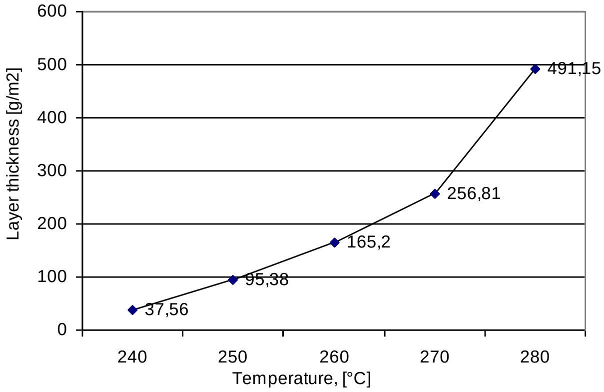

Figure 2: *Layer thickness variation with temperature for a period of 25 seconds immersion.*

At less maintenance times, the layer thickness is larger due to mechanical entrainment of melt onto the support. At bigger times are facilitated the formation of thick layers of alloy between brass and tin.

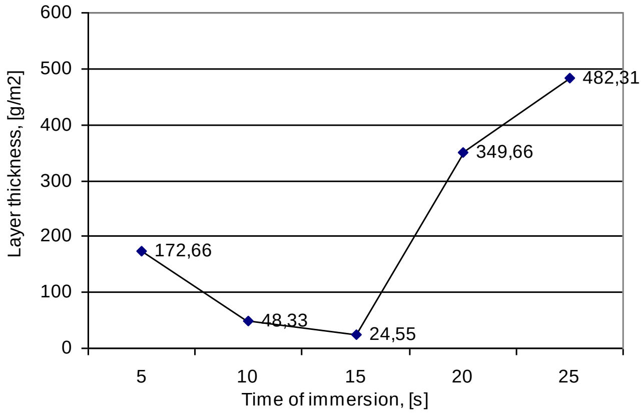

Figure 3: *Layer thickness variation with immersion time, at 280 ° C*

Some samples were subjected to a heating at 350 °C for 10 minutes. After treatment, the appearance of the samples became grey-matt showing the increasing of alloying degree of the tin into brass by diffusion process.

The samples obtained who had the best appearance of the coating (adhesion, continuity, porosity) tinned under the same conditions (i.e. temperature of 280 °C and maintenance time of 15 seconds) were tested for corrosion resistance. It consisted in immersing the samples in saline solution:27 g/L NaCl, 6 g/L $MgCl_2$, 1 g/L $CaCl_2$, 1 g/L KCL_2, pH = 6.8, at room temperature, for 30 days with the determining of the weight changing at every 10 days.

Figure 4 show the change in mass of the samples subjected to corrosion depending on the time, respectively loss or increase in mass reported on the sample surface after 10 days, after 20 days and after 30 days.

The results show an increase in mass for brass and so deposit corrosion products on the surface, produced with a good grip since the evidence before weighing washing and brushing was applied.

It shows a better behaviour for brass corrosion compared to heat treated tin and brass blank. Tinned brass samples showed a very good behaviour corrosion mass loss recorded being of grams per unit area.

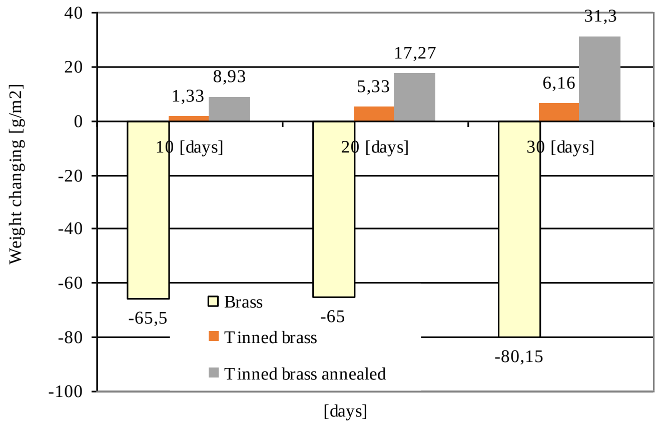

Figure 4: *Weight changing depending on the duration of corrosion*

In order to determine the corrosion speed, the gravimetric method was used. The corrosion speed was determined using the relation:

$$v_{cor} = \frac{m_{cor}}{S \cdot t} \quad (1)$$

where:

v_{cor} - gravimetric index [g/m^2·h];

m_{cor} - mass loss (increase) through corrosion [g];
S - surface area, [m^2];
t - corrosion duration [h].

Figure 6 show the behavior to corrosion of the analyzed samples, according to the duration exposure to the corrosive environment. Values of corrosion speed shows a minimum corrosion rate for tinned brass and maximum corrosion rate to brass.

The figure 7 show the mass variation of analysed sample for studied periods of time respectively: 0-10 day (Δt_1), 10-20 days (Δt_2), 20 - 30 days (Δt_3)

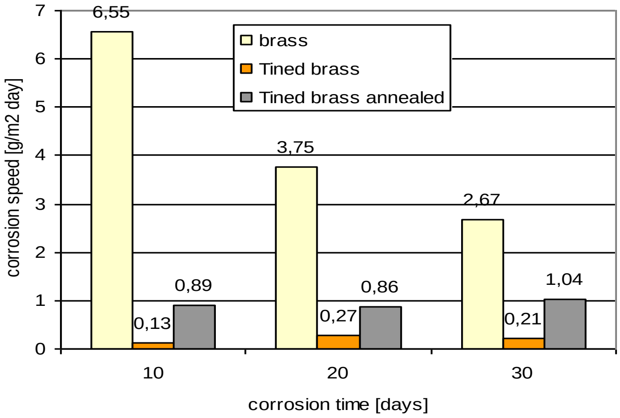

Figure 6*: Corrosion behaviour of the analysed samples, according to the duration exposure to the corrosive environment*

It was observed that brass supports a strong corrosive attack within 10 days and in the following time, products of corrosion formed on its surface limit the progress of corrosion process. Tinned brass is corroded very little in the first period but it supports a major attack (three times higher) in the following interval. The corrosive attack in the last interval was absent (weight variation occurs at the fourth decimal). The tinned brass that was heat treated is corroded in the first ten days but over the next ten days the corrosive attack is maintained.

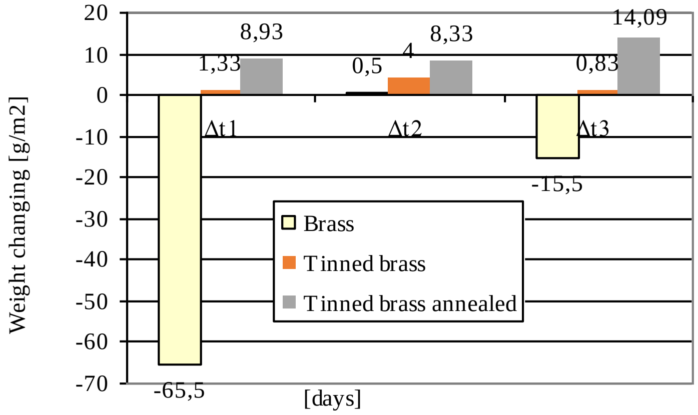

Figure 7: *Variation of mass of samples subjected to corrosion depending on intervals of time: Δt_1 (0-10 days), Δt_2 (10-20 days), Δt_3 (20 to 30 days).*

The corrosive attack shall resume after twenty days. Different corrosion behaviour at different time intervals is therefore strictly dependent on the products of corrosion that affects both surface samples and the corrosive environment. The study of these products will be subject to investigation regarding only the corrosion of tinned brass plates.

The figure 8 show the corrosion speed of analysed samples on the time intervals respectively: 0-10 day (Δt_1), 10-20 days (Δt_2), 20-30 days (Δt_3).

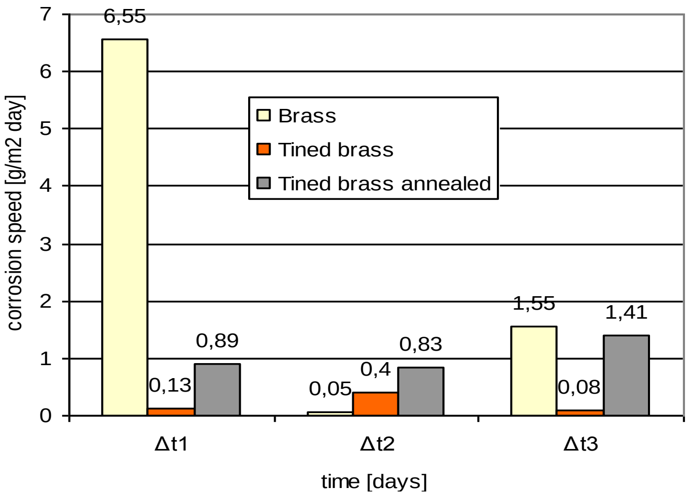

Figure 8: *Corrosion speed of analysed samples on the time intervals respectively: 0-10 day (Δt_1), 10-20 days (Δt_2), 20-30 days (Δt_3)*

3. Conclusions

- at tinning brass, resulting layer thickness increases with temperature by favouring alloys formation between layer and support, and stimulation of diffusion processes;
- if immersion time is small, thicknesses of resulted layers are higher due to mechanical adhesion of the melt onto a much lower temperature support;
- if the time of immersion is high, it facilitates the formation of thick alloys layers between brass and tin;
- results obtained from corrosion in saline solution for brass shows an increase in mass as deposit of corrosion products on the surface;
- tinned brass samples showed a very good behaviour in corrosion, loss of mass recorded being of grams per unit mass;
- values of corrosion speed shows a minimum corrosion rate for tinned brass and maximum corrosion rate to brass;
- it was observed that brass supports a strong corrosive attack within 10 days and in the following time, products of corrosion formed on its surface limit the progress of corrosion process;
- different corrosion behaviour at different time intervals is therefore strictly dependent on the products of corrosion that affects both surface samples and the corrosive environment.

References

[1] Geru N., Chirică D., Marin M., Marin EL, Coşmeleaţă G., ş.a. *Materiale metalice*. Ed, Tehnică, Bucureşti, 1985.

[2] Mihăilescu D., Mitoşeriu O., *Tehnologii subacvatice*, Ed. Tehnică Bucureşti, vol. 1, 2000.

[3] Oprea F., Radu T., lonescu F., *Mecanisme şi procese privind coroziunea materialelor metalice*, Ed. Şt. F.M.R., 2000.

[4] Alexandru I, ş.a. *Alegerea şi utilizarea materialelor metalice*, Ed. Didactică şi Pedagogică R.A., Bucureşti, 1997.

[5] Oniciu L. *Coroziunea metalelor, Aspecte fundamentale şi protecţie anticorozivă,* Ed. Şt. şi Enciclopedică, Bucureşti, 1986.

[6] *Testing performed by Chemical & Material Engineering* TechLabs, Rockwell Automation , April 2006

[7] "ASM Handbook Volume 5, *Surface Finishing*", ASM International 1994, p. 407

[8] Ferreira, S. and Salvado, Miranda and Zheludkevich, I., "*Sol-Gel Coatings for Corrosion Protection of Metals*", Journal of MaterialsChemistry, 2005, p. 48

[9] Marinescu A., Adonianţ GH., Bay E., *Tehnologii electrochimice şi chimice de protecţia materialelor metalice,* Ed. Tehnică, Bucureşti, 1984.

[10] Radu T., Constantinescu S., Balint L., *Materiale metalice rezistente la coroziune*, Ed. Şt. F.M.R. 2004.