MANGANESE COATINGS: TEMPERATURE INFLUENCE ON ELETROCHEMICAL DEPOSITION

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Manganese as an element is widely used in a wide range of industries. Its application in steel production has led to attempts to recycle it from batteries or other electronic devices. Electrochemical deposition is a low-energy process, but the electronegativity of manganese limits this process. Supplementing the electrolyte with other materials can improve the efficiency of electrochemical deposition, for example selenium, sulfur and tellurium compounds [1].

Selenium and sulfur compounds are the most widely studied electrolyte additives, and they have a positive effect on the electrodeposition of manganese coatings. Although the use of SeO_2 and H_2SO_3 have proved effective the drawbacks, selenium compound toxicity and sulfurs corrosive properties, leave more to be desired. Research on insertion of tellurium additives in manganese coatings is scarce and by that this research seeks to expand it [2].

The carbon steel (ASTM A283, grade A) plates were used as a substrate for electrodeposition of Mn coatings. NaOH and HCl solutions were used for degreasing and etching the surface of carbon steel plates before electrodeposition process, respectively. After each of these procedures, the rinsing with distilled water was applied. Electrochemical deposition was carried out in aqueous electrolyte containing the mixture of $MnSO_4$ and $(NH_4)_2SO_4$ ($\cdot 5H_2O$). The ammonium complexes in solution inhibit the formation of manganese hydroxides, resulting in denser and thicker manganese coatings [3]. Sodium tellurate ($Na_2TeO_4 \cdot 2H_2O$) was used as electrolyte additive; pH of electrolyte was maintained about 2.32. During electrochemical deposition two lead anodes, coated with lead(IV) oxide (Pb/PbO_2), and polyvinylchloride (PVC) woven membrane, separating the anode and cathode compartments, were used. Deposition lasted for 7 minutes with a cathodic current density of 15 A/dm^2, at four different temperatures: 20, 40, 60, 80 °C. The results of deposition under these conditions are displayed in Table 1.

Table 1. Current yield and thickness of manganese coating in regard to deposition temperature

Deposition temperature, °C	**20°C**	**40°C**	**60°C**	**80°C**
Current yield, %	42.7 ± 3.5	51.6 ± 1.1	69.7 ± 6.9	80.9 ± 4.6
Mn coating thickness, μm	10.3 ± 0.8	12.4 ± 0.3	12 ± 1.2	13.9 ± 0.8

Further coatings would undergo phosphating process that would further increase anti corrosion properties [4].

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