

ELECTRODEPOSITION OF ZINC FROM ACETATE BASED ELECTROLYTES

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Zinc electrodeposits are widely used to protect iron and steel from corrosion which are relatively inexpensive. Zinc coatings are normally obtained from chloride and non-cyanide alkaline baths. The environmental corrosion along with the electrolytes sensitivity towards metallic impurities limit the use of chloride electrolyte. The use of additive, less cathode efficiency and the effluent treatment do not permit the use of non-cyanide zinc plating baths to a greater extent. Hence, the need for the search for a better zinc plating electrolyte is necessary. In this paper the authors present the details of zinc plating from an acetate based electrolyte and the results of Hull Cell studies are presented in this paper.

Keywords : Zinc electrodeposition, Hull Cell studies.

INTRODUCTION

It is well known that zinc electrodeposits find a large number of applications in resisting corrosion. It is used as a protective on ferrous metals to protect them against corrosion. Since zinc is anodic to steel it protects the bases metal even though the deposits contains discontinuities. Now-a-days zinc is electrodeposited from noncyanide alkaline electrolytes [1] and acid chloride type of electrolytes [2,3], as an alternative to those based on cyanide, which are highly toxic. Various attempts have been made by different workers to study acid electrolytes [4,5]. A review of the literature shows that the electrodeposition of zinc from an acetate electrolyte had not been investigated, although acetate as a minor ingredient had been experimented upon by various investigators. Hence, it was decided to study the electrodeposition of zinc from an acetate electrolytes. In this paper the authors present the results of the Hull-cell studies obtained for different zinc plating electrolytes and the effect of brighteners was also studied through the Hull Cell experiments.

EXPERIMENTAL

Cold-rolled steel specimens were used as the cathodes. A regulated power supply system with less than 1% ripple in the DC output was used as the current source throughout the studies. Temperature was maintained at 273 K. High-purity (99.95%) zinc was used as the anode material. The cathode

surfaces were subjected to the usual precleaning procedures like degreasing, alkaline electrocleaning, and acid dipping.

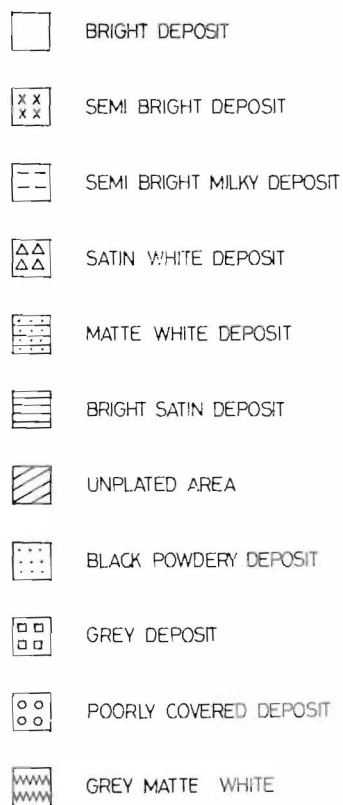


Fig. 1: Hull cell patterns

Hull Cell studies

Polished steel cathodes of 100 x 75 x 0.25 mm size after precleaning were plated in a 267 ml Hull Cell with a current of 1.0 A each for a duration of 10 minutes to find out the effect of bath constituents and compositions in the nature of the deposit.

RESULTS AND DISCUSSION

The results of the studies carried out are presented in the Figs. 1 to 7.

Effect of zinc acetate

The effect of addition of varying concentrations of zinc acetate in zinc plating electrolyte and when operated at cell current of 1 A and at 303 K is presented in Figs. 2 and 3. From the figure it may be seen that with increase in zinc acetate concentration the nature of the deposit also improves. When the zinc acetate concentration reaches 50 g/l matte white deposit was obtained at the high current density area along with semibright deposit at the low current density area. The further increase in concentration of zinc acetate to 175 g/l matte white deposit was obtained over the entire area of the Hull Cell plate. It may also be seen from the figure that a further increase in concentration of zinc acetate gradually decreases the current density range for acceptable

deposits. From these studies it may be concluded that a 200 g/l zinc acetate concentration is optimum to obtain smooth uniform matte white deposit over a wide current density range.

Effect of sodium acetate

The effect of addition of varying concentrations of sodium acetate in zinc plating electrolyte containing 200 g/l zinc acetate and when operated at cell current of 1 A and at 303 K is given in Fig. 4. From the figure it may be seen that with increase in concentration of sodium acetate the nature of the deposit also improves upto a concentration of sodium acetate leads to poor coverage. From these studies it may be concluded that a concentration of 100 g/l of sodium acetate is highly beneficial to produce satin white deposit.

Effect of aluminium sulphate

The effect of addition of varying concentration of aluminium sulphate in a zinc plating electrolyte containing zinc acetate 200 g/l, sodium acetate 100 g/l and when operated at 1 A cell current for a duration of 10 mts at 303 K is given in Fig. 5. From the figure it may be seen that with the introduction of aluminium sulphate the nature of the deposit will improve to a considerable extent to produce uniform white deposit over the entire area of the Hull Cell plate, with increase in concentration of aluminium sulphate the nature

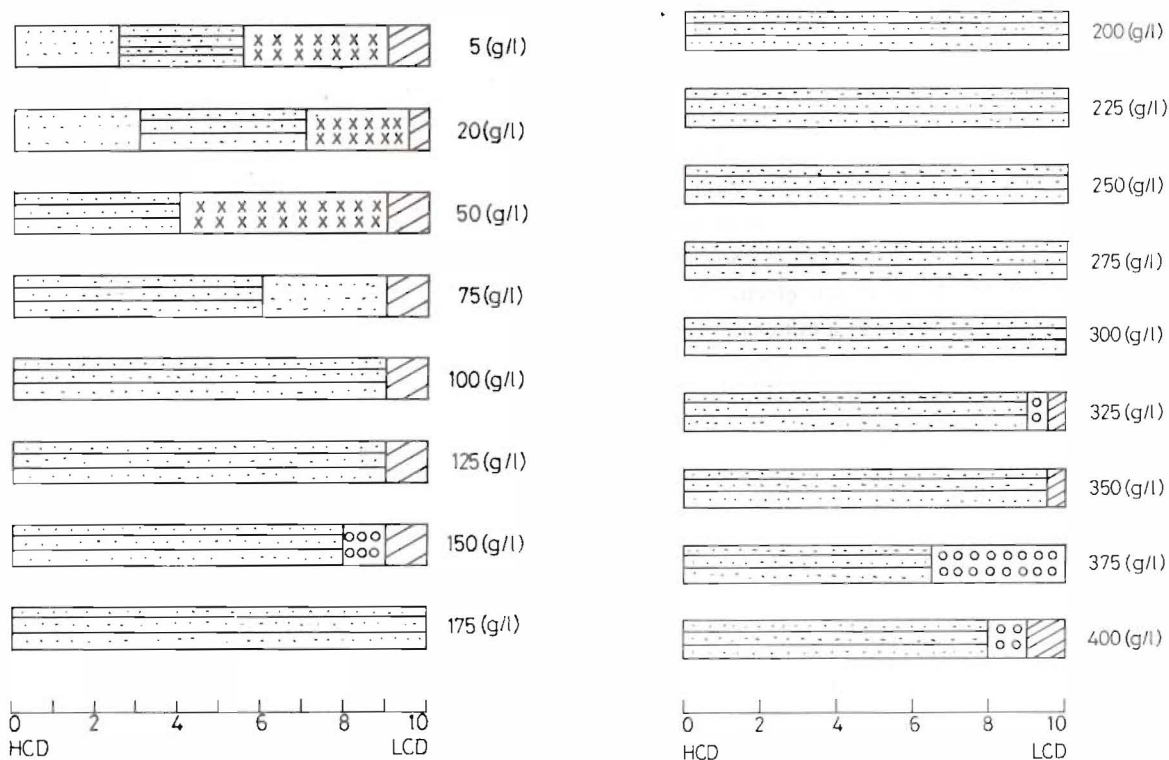


Fig. 2 and 3: Effect of varying concentration of zinc acetate in acid zinc plating electrolyte at 1 A cell current and at 303 K

of the deposit also improves. When the concentration of aluminium sulphate was maintained at 60 g/l one obtains uniform matte white zinc deposit over a wide current density range. Therefore it may be concluded from these studies that a 60 g/l concentration of aluminium sulphate is beneficial along with zinc acetate 200 g/l, sodium acetate 100 g/l. It is known that aluminium sulphate is normally added as a grain refining agent in zinc plating systems.

Effect of boric acid

The effect of increase in concentration of boric acid in a zinc plating electrolyte containing zinc acetate 200 g/l and sodium acetate 100 g/l is given in Fig. 6. From the figure it may be seen that the nature of the deposit changes appreciably until the boric acid concentration is increased 60 g/l a further increase in concentration of boric acid produces only poorly

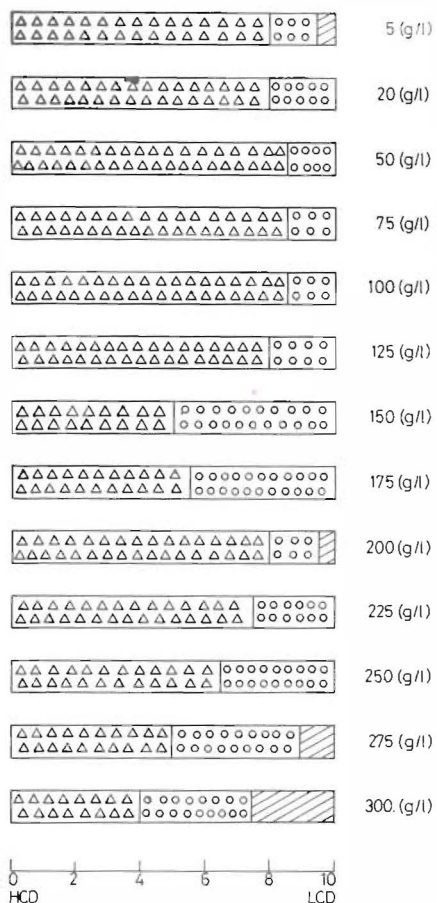


Fig. 4: Effect of varying concentration of sodium acetate in acid zinc plating electrolyte containing zinc acetate 200 g/l at 1 A cell and at 303 K

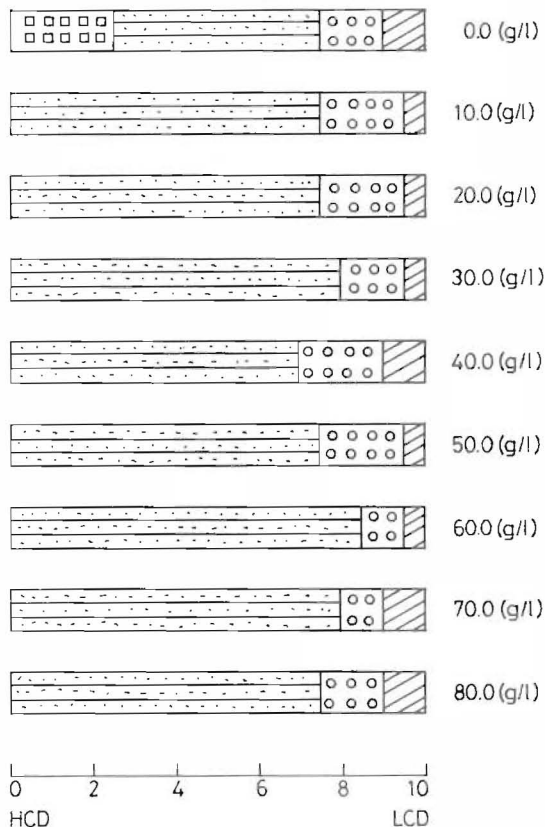


Fig. 5: Effect of varying concentration of aluminium sulphate in acid zinc plating electrolyte containing zinc acetate 200 g/l and sodium acetate 100 g/l at 1 A cell and at 303 K

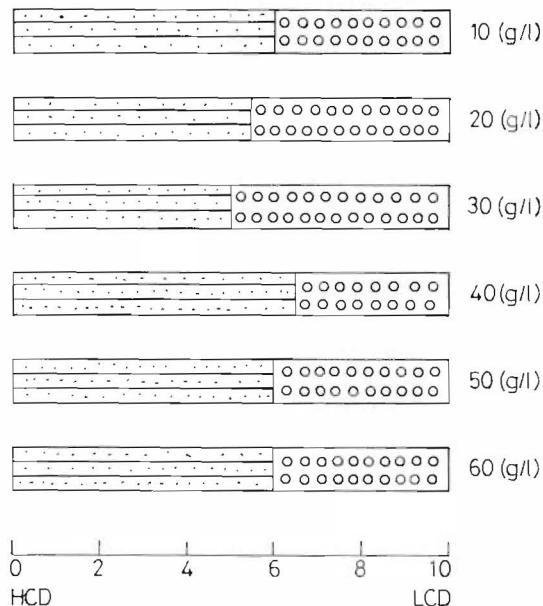


Fig. 6: Effect of varying concentration of boric acid in acid zinc plating electrolyte containing zinc acetate 200 g/l, sodium acetate 100 g/l and aluminium sulphate 60 g/l at 1 A cell and at 303 K

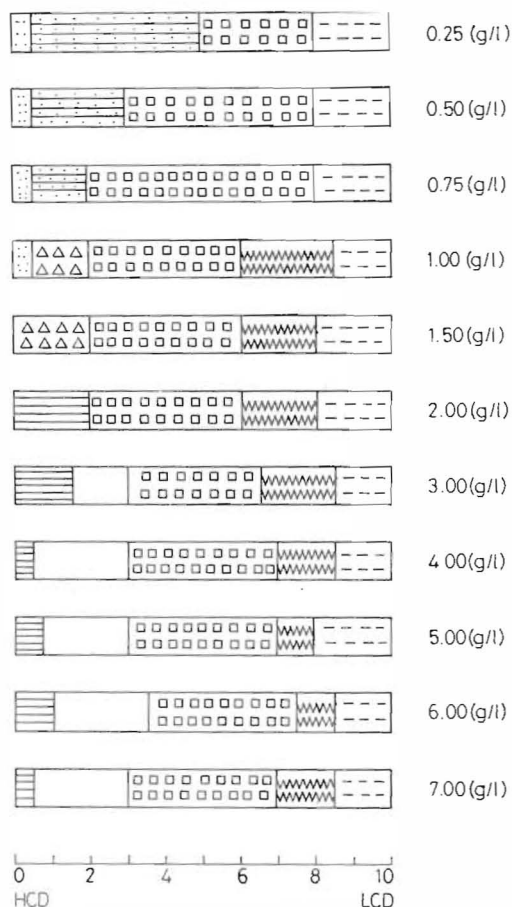


Fig. 7: Effect of varying concentration of gelatin in acid zinc plating electrolyte containing zinc acetate 200 g/l, sodium acetate 100 g/l, aluminium sulphate 60 g/l and boric acid 40 g/l at 1 A cell and at 303 K

covered zinc deposit. From these studies it may be concluded that the boric acid concentration can be fixed as 60 g/l the addition of boric acid to zinc plating electrolyte will help to maintain the pH of the zinc plating electrolytes because of the buffering action.

Effect of gelatin

The effect of varying concentration of gelatin in zinc plating electrolyte containing zinc acetate 200 g/l, sodium acetate

100 g/l, aluminium sulphate 60 g/l and boric acid 40 g/l and when operated at 1 A cell current for a duration of 10 mts at 303 K is given in Fig. 7. From the figure it may be seen that either the introduction or the increasing in concentration of gelatin upto 2 g/l does not produce any appreciable change in the nature of the deposit obtained but when the concentration of gelatin reaches 3 g/l bright deposit was noticed at the high current density area. A further increase in concentration of gelatin 4 g/l the current density range to obtain bright deposit also increases. A further increase in concentration does not bring about any appreciable improvement in the nature of the deposit. Hence from the studies carried out it may be concluded that with addition of gelatin at concentration of 4 g/l in a zinc plating electrolyte containing zinc acetate 200 g/l, sodium acetate 100 g/l, aluminium sulphate 60 g/l and boric acid 40 g/l it is possible to obtain bright deposit at a current range from -1 A/dm² to 3 A/dm².

CONCLUSION

From the studies carried out it may be noted that an acceptable uniform matte white zinc deposits can be obtained from a zinc acetate bath. It may also be further noted that bright zinc deposit can also be obtained from the zinc acetate electrolyte with the addition of gelatin. The following bath compositions and operating conditions are recommended to carry out zinc plating

Zinc acetate: 200 g/l; Sodium acetate: 100 g/l; Aluminium sulphate: 60 g/l; Boric acid: 40 g/l; Gelatin: 4 g/l; Temperature: 303 K; Duration: 10 mts; Current density: 1-3 A/dm².

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