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ELECTRODEPOSITION OF MODIFIED CNSL RESIN ON MILD STEEL

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ABSTRACT

A method has been described for the preparation of water soluble CNSL resin using formaldehyde for use in electrodeposition. The bath composition and operating conditions to get good deposit on mild steel was standardised. The coated panels were subjected to physical tests, accelerated tests and electrochemical tests for assessing the protective property of the coatings.

Key words: Electrodeposition, CNSL resin, protective coating

INTRODUCTION

Cashew Nut Shell Liquid (CNSL) has been identified as a suitable phenolic resin base for electrodeposition as a protective coating because of its low cost and resistance towards rungus growth 1 . The long chain ot its low cost and resistance towards rungus growth 1 . The long chain hydrocarbon substituent in CNSL serves to provide internal platicisation of the cured product, resulting in excellent flexjbility which is also highly resistant towards acids and alkalies, unlike other phenolic resins 2 . Preparation of water soluble resin and electrodepositable resin based on CNSL was not reported earlier. The phenolic group present in the CNSL can be modified with formaldehyde and the side chain can be modified by triethanolamine. The resin thus obtained can be emulsified and electrodeposited.

In this paper, a method has been described for the preparation of water soluble CNSL resin using formaldehyde, for use in electrodeposition. The bath composition and operating conditions to get uniform deposit on mild steel substrate was standardised. The coated panels were subjected to physical tests, accelerated tests and electrochemical tests for assessing the protective property of the coatings.

EXPERIMENTAL

Preparation of water soluble resin

CNSL was mixed with formaldehyde using alkali as catalysts, in different ratios. From this 10:4 resin, i.e. 10 parts of CNSL mixed with 4 parts of formaldehyde was found suitable for electrodeposition.

10 ml of this resin was mixed with 7.5 ml of triethanolamine and cooled; 2.5 ml ethylene glycol monoethyl ether was then added to give clean solution. This was followed by slow addition of 30 ml of distilled water with stirring. Thus water soluble resin was prepared.

Pretreatment of mild steel panels and electrodeposition of CNSL resin

The mild steel plate (5.0 cm x 7.5 cm) was cleaned by pickling using dilute hydrochloric acid, dried and sand blasted to near white surface. It was made the anode and immersed in the resin bath with the current 'on' with two aluminium plates acting as cathodes. The applied voltage was controlled between 25 and 40 volts and the coating time was 2 minutes. The coated panel was taken out, kept as such for one minute and baked at 125°C for about 30 minutes. The bath composition and the operating conditions were standardised and number of plates were coated for further studies.

Standardisation of various parameters to get uniform coatings

Various concentrations of the resin solution were prepared and anodically electrodeposited on mild steel plates by using constant voltage and fixed time.

The resin bath was kept at different temperatures and number of panels were coated. After drying, the thickness of the coating was measured.

Solutions of different pH values were prepared, and electrodeposited panels were prepared in them and thickness assessed.

The efficiency of deposition at various voltages were studied. The relation between (i) current density and time at constant voltage and (ii) voltage and time at constant current density were determined. The voltage at which the maximum deposition occurred also was ascertained.

Physical properties of the coated panels

The thickness of the coatings was measured using Elcometer. The pencil hardness and scratch hardness were determined as per specification. The adhesion was tested by using 10 x 15 cm. coated thin panels. Flexibility of the coated panel was determined by using conical mandrel bend tester. The gloss of the coating on polished mild steel surface was also determined.

The water absorption of the coated specimen was determined by immersing stainless steel coated panel in distilled water for a period of one month. The covering power of the bath was checked by electrodeposition on mild steel surface.

Accelerated tests

Salt spray tests

The coated panels in triplicate were kept in salt spray chamber for a period of 15 days. The electrolyte used for spray was 3% sodium chloride and the thickness of the coating was 30 microns.

Immersion tests

The specimens of 30μ coating thickness in duplicate were immersed in the following solutions for a period of 15 days: distilled water, 5% sodium hydroxide solution, 3% sodium chloride solution, 2% sulphuric acid solutions. The plates were taken out and washed in running water, dried and the performance of the coated panels were examined.

Electrochemical tests

The variation of potential with time of coated panel was determined by using printing voltmeter in 3% sodium chloride solution.

The capacitance-resistance of the coated panel was measured in 3% sodium chloride solution by using Wayne Kerr Universal Bridge Instrument.

RESULTS AND DISCUSSION

Results are presented in figures 1 to 6. It is seen from Fig.1 that the coating thickness increased as the resin concentration increased upto 7.5% and decreases thereafter.

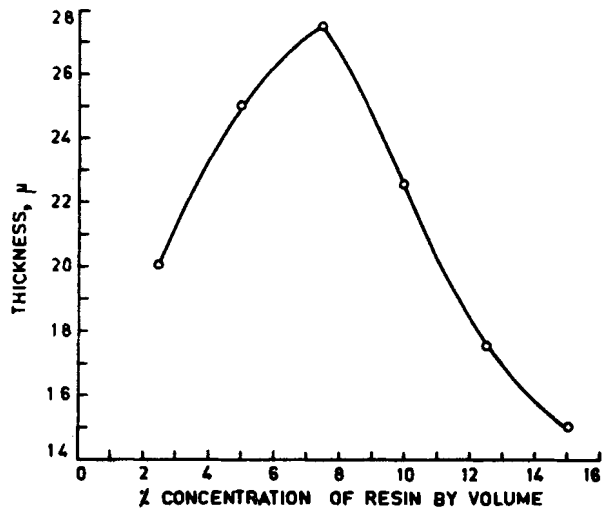

Fig. 1. Variation of Thickness with Concentration of Resin

Fig.2 shows that the coating thickness increased with increasing temperature linearly up to 35°C.

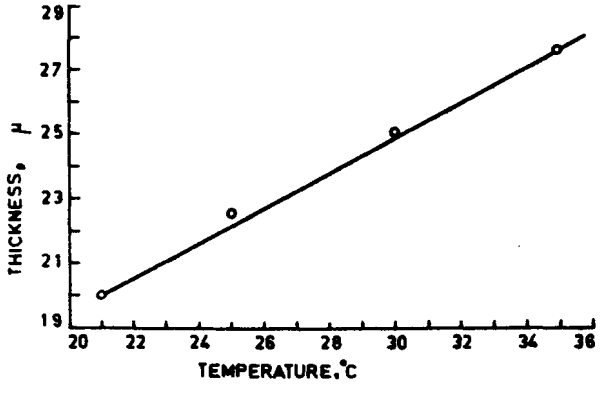

Fig. 2. Variation of Thickness with Temperature

It was further found that the optimum working pH range was 8 to 9. Coulombic efficiency study showed that at 30-35 V the deposition has reached a maximum level and then afterwards no further deposition took place. This behaviour may be seen in Fig.3.

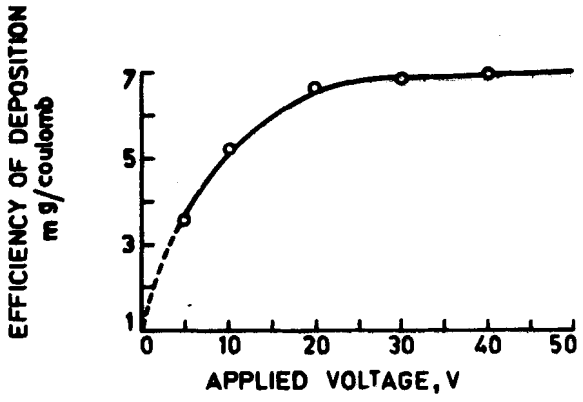

Fig. 3. Efficiency of Deposition with various Voltages

And also the coulombic efficiency increased as the pH of the solution decreased. The relation between the current density and different period (Fig.4) showed that the current density decreased with time.

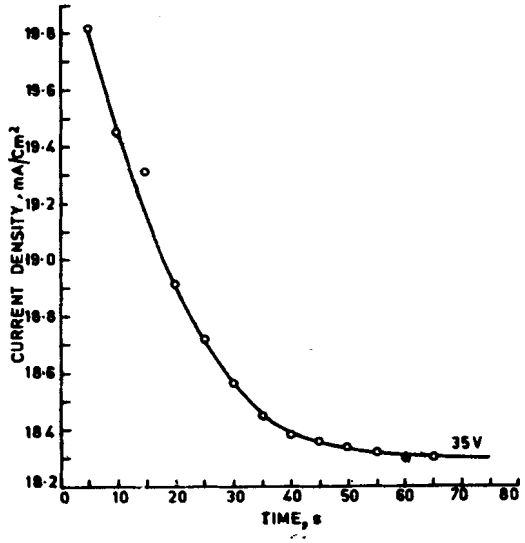

Fig. 4. Variation of Current Density VS Time at constant Voltage

But at a particular current density, the thickness of the coating reached a maximum level and thereafter there was no possibility of further deposition with time. The relation between voltage and thickness of coating with time at constant current density showed that the voltage increased with

time (Fig.5).

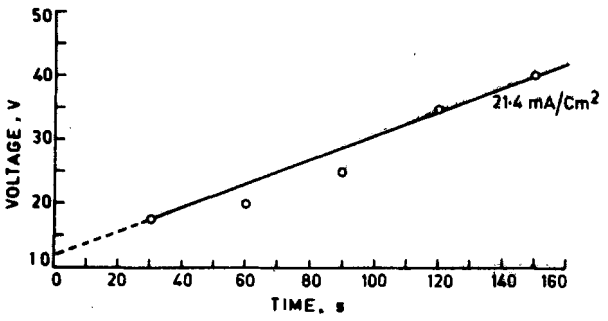

Fig. 5. Voltage VS Time at Constant Current Density

The optimum voltage at which the maximum deposition occurred was indicated in Fig.6

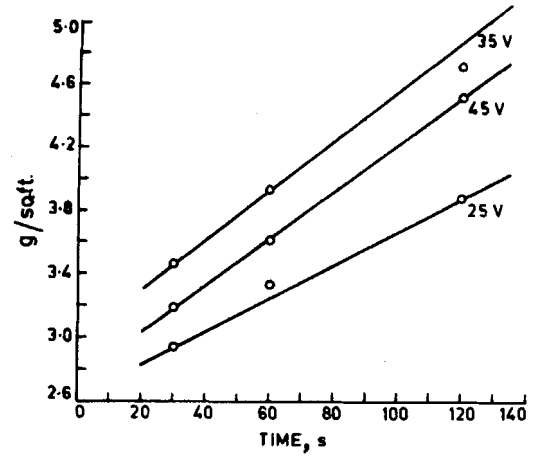

Fig. 6. Weight of Deposit VS Time at Different Voltages

The optimum voltage was 35. Above 40 volts, gassing occured and deposit thickness decreased.

The thickness of the coating measured by Elcometer for 2 minute deposition was found to be 22-27 μ. The observation of pencil hardness shows that when the thickness of the coating increased, the pencil hardness decreased and also when the thickness of the coating was less, the pencil hardness was good. The adhesion was also satisfactory. The coating passed flexibility tests. The water absorption of the coated resin was 3% after immersion in distilled water for one month. It was calculated that the covering power of 100 ml resin was 12 square feet.

The CNSL electrodeposited plate was not affected by salt spray tests up to 15 days and by immersing the plate in 3% sodium chloride solution, 2% sulphuric acid solution, distilled water for 15 days. But the coating immersed in 5% sodium hydroxide was affected within 7 days. This shows that the electrocoated CNSL does not withstand in alkali medium.

The potential-time study in 3% sodium chloride solution showed an initial potential of -0.308V and after 96 hrs the potential was -0.542V. The capacitance-resistance showed an initial capacitance of 0.080 nF and a final capacitance of 0.085 nF after one month. The initial resistance was 9.909 x 10^6 ohms and the final resistance after one month was 4.5455 x 10^6 ohms. So the capacitance was not changed with time in 3% sodium chloride solution but the resistance decreased with time. This result showed that the water uptake of the film was less and also there was no swelling taking place on the surface of the coating. Hence the performance of the coating was good.

CONCLUSION

It was possible to prepare a water soluble resin based on CNSL resin and the condition for electrodeposition on mild steel substrate of the resin was standardised. The operating condition for obtaining satisfactory deposit was determined and the physical and corrosion resistance properties of the coated panel were evaluated by immersion tests, accelerated tests and electrochemical tests. It was observed that the performance of the coating was satisfactory.

REFERENCES

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