

# Corrosion of Tinned Sheets During Transportation— A Case Study

Inder Singh and A.N. Mukherjee

National Metallurgical Laboratory,  
Jamshedpur-831007, India

## ABSTRACT

At buyer's end complaints regarding black stains/spots on the tinned sheet transported by a Tin Sheet Manufacturing Co. were received very frequently. The problem was investigated thoroughly. In general, the tinned sheets are stacked one above the other and in between Di-octyl-sebacate (DOS) is applied which acts as an inhibitor as well as the lubricant. Normally, 1000 sheets are stacked in a bundle, strapped crosswise and then transported to different parts of the country. On examination of the whole system, it was observed that the sheets were packed loosely, resulting in fretting corrosion due to uneven load on the sheets and the relative movement of the sheets. Further, the DOD was found to be acidic in nature. No fault in electro-tinning process was observed.

The potentiodynamic polarization studies on the untreated and treated sheets with DOS and DOS containing stearic acid and sodium nitrite were also conducted in 3.5 % NaCl solution. The OCP was found to be more negative in comparison to the treated sheets and the corrosion rate of the treated sheets was also on the higher side. Photographs show that there is dissolution of tine coating, associated with fret. The data are discussed in details. Recommendation for the solution of the problem are given.

## INTRODUCTION

Complaints by the buyer at a distance place regarding the black stains/spots on the tinned sheets were lodged with a Tin Sheets Manufacturing Co. very frequently. The problems which was referred to NML for its investigation was studied thoroughly. The affected areas on the tinned sheets were cut for examination, study and photographs

After tinning and normal processing the sheets are stacked one above the other and in between the sheets Di-octyl sebacate (DOS) is applied which acts as both inhibitor and lubricant. About 1000 sheets are packed, strapped crosswise as shown in Fig.1 and then it is transported to different parts of the country. It was reported that the black stains developed during transit. The same is not seen during storage at works.

## OBSERVATIONS

On examining the whole system, it was observed that packing of treated tinned sheets with DOS was not done properly and uniformly and the load distribution on the sheets was also not uniform. At some place, the sheets were strapped too lightly and at other places too loosely. This had resulted in relative movement of sheets during transit and friction amongst sheets.

## EXPERIMENTATION

Affected areas of the tinned sheets were collected for examination and study at the lab. The affected areas were examined using magnifying glass. Samples of DOS was also collected to know its alkalinity/ acidity. 24 gms of DOS which is insoluble in water was shaken with 100 ml of distilled water. The pH of the resultant solution was taken using Toshniwal pH meter. The experiment was repeated thrice. The data are set-forth in Table-2. Liquid chromatographic analysis of DOS was also carried out to confirm its molecular structure. (Fig. 2).

Potentiodynamic polarization studies on the untreated and treated tinned sheets with DOS containing stearic acid and  $\text{NaNO}_2$  as inhibitor were conducted using Potentiosat/Galvanostat of PARC-273 in 3.5 % NaCl solution at room temperature. One square centimeter area of the sample were exposed for polarization test at a scan rate of 5 mV/Sec.. A saturated calomel electrode was used as a reference electrode and platinum foil as an auxiliary electrode. The results of the polarization studies are shown in Table-1 and Figs 3-7. Photographs of the affected areas was taken (Figs. 8-11).

## RESULTS AND DISCUSSION

Liquid chromatograph curve and data indicate that the DOS which is being used is a perfect and stable compounds (Fig.2). Table-1 shows that OCP of treated tinned sheet is more negative in comparison to untreated tinned sheet, indicating high corrosion rate which is found experimentally (Figs.3-7). On neutralization of DOS with mild alkali, the potential is found to be positive and the corrosion rate comes down and equivalent to untreated tinned sheet (0.12 mpy). On treatment of the tinned sheet with DOS containing 0.2 % stearic acid, no doubt, the potential becomes positive (-469.78 mV), but the corrosion rate increases from 0.12 to 0.73 mpy. An attempt was also made to decrease the corrosion rate of tinned sheet using DOS with sodium nitrite, which is known to as a good passivator. Here, sodium nitrite does not inhibit the dissolution of tin coating due to DOS, rather it increases the dissolution rate from 0.12 to 0.29 mpy. Further, on increasing the concentration of sodium nitrite from 0.2 to 0.5 %, the corrosion rate also increases from 0.21 to 0.55 mpy and OCP become more and more positive, indicating anodic polarization. This results in higher dissolution of tin coating.

The micro-photographs at magnification of 80 indicate the dissolution of tin coating associated with fret (Figs.8-11) The affected area appeared to have a good pattern with perforation. This substantiates that there is dissolution of tin coating due to acidic nature of DOS and the pH of the DOS/distilled water mixture was found to be acidic in nature (Table -2) The acidic nature of DOS what is being used by the company contributes in the dissolution of the coating and substantiate the potentiodynamic data. The black spots observed may be due to the oxidation of tin ions released during fretting.

## CONCLUSIONS

1. The packing of sheet has loosely been stripped, resulting in abrasion/friction because of relative movement of sheets in the package
2. DOS being acidic in nature which should have been neutral aggravates further the dissolution of tin coating
3. Photographs indicating perforation substantiate the dissolution /abrasion of tin coating
4. Black spots observed on the sheets id due to the oxidation of tin during fretting/abrasion

## RECOMMENDATIONS

1. It is recommended to pack tinned sheets securely and tightly such that here should not be any relative movement during transportation
2. DOS should be neutralized with mild alkali before use.

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Fig. 1 Line diagram of a bundle showing stacking of tinned sheet.