CORROSION

Man's endeavours to exploit the oceans have gained considerable momentum in recent years. Offshore drilling, ocean mining, desalination, offshore metallurgy, alternate food and energy resources are some of the areas of ocean engineering which registered rapid progress. The increased activities coincided with demand for a host of materials, equipment and facilities which can withstand the hostile and demanding marine environment. It is a known fact that since the inception of shipping activity, various methods have been attempted to minimise the adverse effects of biofouling like protecting by copper sheathing, use of protective paints and off late electrolytic coatings or electroplating etc. (Laidlaw, 1959). Several factors merit consideration before a material is recommended for ocean service and like, the structural strength, predicted life expectancy, knowledge of uncertainty and a thorough fundamental understanding of marine corrosion and marine fouling behaviour of that metal. According to Gerchakov and Sallman (1977) the last mentioned two factors
are interrelated which in turn depend upon the interaction of metal, biota and the natural aquatic environment. Although the electroplating method is not suited to large ships due to obvious practical reasons, yet for protecting small metallic objects such as parts of oceanographic and other marine instruments, it could still prove as one of the practical methods.

In the present investigation an effort is made to assess the behaviour of a corrosion prone, stainless steel, mild steel and mild steel electroplated with non-corrosive and antifoulant metal (Nickel and Cadmium) and plastic coated panels. A comparative account on the damage to these metal surfaces in terms of area corroded is given in Table 1. The panels measuring 10 x 7.5 x .3 Cm were exposed during late postmonsoon to premonsoon months i.e. from December 1987 to May 1988, which also happens to be the breeding season of various fouling organisms along the west coast of India (Durve, 1960; Wagh, 1965 and Karande, 1968).

Throughout the programme of work endeavour was made to study and evaluate as many types of corrosion damages as are considered significant and thus the total
<table>
<thead>
<tr>
<th>MONTHS</th>
<th>Stainless steel</th>
<th>Mild steel (ms)</th>
<th>Nickel coated (ms)</th>
<th>Cadmium coated (ms)</th>
<th>Plastic coated (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>December '87</td>
<td>2%</td>
<td>70%</td>
<td>12%</td>
<td>28%</td>
<td>3%</td>
</tr>
<tr>
<td>January '88</td>
<td>2%</td>
<td>65%</td>
<td>10%</td>
<td>22%</td>
<td>4%</td>
</tr>
<tr>
<td>February '88</td>
<td>3%</td>
<td>65%</td>
<td>10%</td>
<td>26%</td>
<td>3%</td>
</tr>
<tr>
<td>March '88</td>
<td>3%</td>
<td>68%</td>
<td>15%</td>
<td>20%</td>
<td>4%</td>
</tr>
<tr>
<td>April '88</td>
<td>5%</td>
<td>70%</td>
<td>15%</td>
<td>30%</td>
<td>5%</td>
</tr>
<tr>
<td>May '88</td>
<td>5%</td>
<td>70%</td>
<td>10%</td>
<td>25%</td>
<td>5%</td>
</tr>
<tr>
<td>December '87 to May '88</td>
<td>8%</td>
<td>50%</td>
<td>25%</td>
<td>30%</td>
<td>25%</td>
</tr>
</tbody>
</table>
area of metal corroded is noted down. The assessment of pitting characteristics has been difficult owing to lack of a suitable variable which can be measured quantitatively and treated mathematically.

The panels are exposed for monthly and six monthly durations and for better understanding each one is described separately.

**Stainless steel panels:**

The density of settlement of various foulers on stainless steel panel was slightly higher compared to mild steel. The major group of animals among the foulers that settle on monthly stainless steel panels are, barnacles and hydroids along with significant settlement of polychaetes, bryozoans and few bivalves. Their variations in different months is already described in Chapter V. Careful study of panels exposed reveals that for the monthly duration the damage to the metal in terms of area corroded is very insignificant (Plate 1). However in April 1988 and May 1988 pitting and tunneling near the hole of attachment was observed. However on half yearly panel a groove was observed which was about 2.2 mm long, 0.2 cm wide and about 0.25 cm deep (Plate 2).
Stainless steel panel exposed for monthly duration.

Stainless steel panel exposed for half yearly duration.
This phenomenon of tunneling and perforations of metal was observed only in stainless steel panels.

**Mild steel panels:**

The intensity of settlement by various foulers on mild steel panel was slightly lower compared with stainless steel monthly panels. However, on half yearly panel, the density of settlement was higher compared with stainless steel, but the biomass build up was lower. Encrusting type of bryozoans, hydroids and polychaetes are the major foulers on mild steel panels. Mild steel is a freely corroding metal, corrodes evenly and much faster. Table 1 clearly shows that the area corroded on monthly panels was in the range of 60 to 70%. However, on half yearly panel it was about 50% (Table 1). This decrease would be due to accumulation of a layer of corrosion products and increased assimilation of foulers, mainly encrusting type of bryozoans which might result into a cut in oxygen supply to the corrosion site thus retarding the process of corrosion. No tunneling of metal was observed on mild steel (Plate 3). Only a little pitting and sloughing off of metal was observed on half yearly panel (Plate 4).
Mild steel panel exposed for monthly duration.

Mild steel panel exposed for half yearly duration.
Mild steel panels coated with nickel:

The density of settlement on nickel coated mild steel panel is generally lower compared with mild steel and the biomass is also lower on monthly panels. On six monthly panels also the density of settlement was lower. Encrusting type of bryozoans and ascidians constitute the main fouling complex on six monthly panel (Chapter V). The damage to this type of panel is observed to be less compared with mild steel on monthly and six monthly panels. On monthly panels it ranges between 10 to 15% (Table 1). The corrosion observed on this type of panel is localised where crevices on the coated surfaces are formed (Plate 5). The area corroded on half yearly panels was about 25% (Table 1). Margins of the panels as well as the hole made to hang the panels to the raft were highly corroded (Plate 6). The area corroded on this type of panel is observed to be more compared with stainless steel.

Mild steel panels coated with cadmium:

The density of settlement on cadmium coated mild steel panels is generally lower compared with nickel coated mild steel panels. Bryozoans and
Mild steel panel coated with nickel exposed for monthly duration.

Mild steel panel coated with nickel exposed for half yearly duration.
hydroids were the major components on the monthly panels where as sponges, polychaetes and barnacles are also recorded. On half yearly panel polychaetes, bryozoans and ascidians were major components and the density on half yearly panel was less than that recorded on nickel coated mild steel panel. This could be due to the poisonous nature of cadmium. The area corroded on monthly panels (Plate 7) was between 20% to 30% and about 30% or more on half yearly panel (Table 1). Sloughing off of metal at the corroded site is significant in cadmium coated panel (Plate 8). it was almost similar to that observed on mild steel panels exposed for same duration i.e. six months.

Mild steel panels coated with plastic:

The density of fouling on plastic coated mild steel panels is generally more compared with any other surface in the present investigation. This could be due to availability of nontoxic smooth surface for the foulers to settle. On monthly panels, bryozoans, polychaetes and hydroids were the major contributors to the fouling complex. On half yearly panel also the density of foulers was more but less than that observed
Mild steel panel coated with cadmium exposed for monthly duration.

Mild steel panel coated with cadmium exposed for half yearly duration.
Plate 9

Mild steel panel coated with plastic exposed for monthly duration.

Plate 10

Mild steel panel coated with plastic exposed for half yearly duration.
on stainless steel panel. Ascidians and bryozoans and polychaetes were major contributors. The area corroded on the plastic coated mild steel panels was very less (Plate 9) i.e. about 5% (Table 1). Margins of the panels were the only sites corroded. On six monthly panel the area corroded was about 25% (Table 1). where in little sloughing off of surface metal is observed. Pitting was also observed but it was insignificant (Plate 10).