A MODIFIED CELL DESIGN FOR THE QUANTITATIVE EVALUATION OF VAPOUR PHASE CORROSION INHIBITORS

A SUBRAMANIAN, M NATESAN*, A GOPALAN, K BALAKRISHNAN AND T VASUDEVAN

Department of Industrial Chemistry, Alagappa University, Karaikudi 630 003. INDIA

* Central Electrochemical Research Institute, Karaikudi 630 006. INDIA

A modified cell design was fabricated to evaluate the vapour phase corrosion inhibitors (VPI) in the powdery as well as liquid/oily forms by continuous condensation test method. Using this experimental set-up, problems associated with the condensation of water vapour on the inhibitor, which reduces the volatility can be eliminated and more reliable quantitative weight loss results can be obtained. The modified method was used in the evaluation of a series of compounds as VPI and it was found that the results were quite reproducible and comparable with visual observation.

Keywords: Vapour phase inhibitor, cell design.

INTRODUCTION

Corrosion inhibitors are substances which when added to corrosive environments in relatively small dosages will drastically bring down the corrosion rates. In the case of submerged exposures the inhibitors are referred to as contact inhibitors. In the case of vapour phase exposures the inhibitors are known as vapour phase inhibitors. They are used to protect metal equipment and components during transport and storage. Several chemicals qualify as VPI [1,2] for example dicyclohexylammonium nitrite and cyclohexylamine carbonate for ferrous metals and benzotriazole for copper and silver. Commercial products are either pure or mixtures of chemicals and are available in different forms like powders, tablets, emitters, sachets and liquids.

The main requirement for VPI are that they should be effective, in giving lasting protection and should be non-toxic. The vapour phase inhibitors function by the vapourization and the transport of its vapour to the metal surface when it condenses or dissolves in condensing moisture to form very thin protective film. The VPI are mostly used to bring down uniform corrosion without promoting other forms of corrosion, such as pitting etc. The success of a VPI application is a function of its protective ability and its durability. Several techniques have been developed to evaluate their effectiveness. Stroud and Vernon [3] made use of heated test tubes containing aqueous inhibitor solutions and suspended metal specimens in the upper parts of the tubes. Then the inhibitor effectiveness was tested by mass loss determinations Wachter et al [4] used a train of flasks in which a steam of air was saturated with water, brought in contact with VPI, then projected onto a metal specimen and the inhibitor effectiveness was evaluated by qualitative visual inspection and comparison with control. William Skinner [5] has reported a new cell design to evaluate VPIs quantitatively. The cell assembly is claimed for example dicyclohexylammonium nitrite and to enable a fairly accurate simulation of operation conditions. It is also claimed to have overcome the problems associated with contamination of the equipment. However, the problem associated with moisture condensation on the VPI sample persists in this design also. The reproducibilities of results obtained with existing methods were not fully satisfactory due to the effect of often condensation of water vapour on the further volatility of the VPI. In view of this, it was decided to develop a new modified cell design to evaluate all forms of VPI by continuous test method. Using this modified cell design, problems associated with condensation of water vapour on the VPI sample can be eliminated. Hence more reliable visual observation and quantitative weight loss results can be obtained that brings out the actual performance of the VPI.
**TABLE 1: Creation of different relative humidities using glycerol and water mixture**

<table>
<thead>
<tr>
<th>Relative humidity (%)</th>
<th>Vol of glycerol taken (ml)</th>
<th>Vol of water taken (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>90</td>
<td>91.4</td>
<td>88.6</td>
</tr>
<tr>
<td>80</td>
<td>81.7</td>
<td>8.3</td>
</tr>
<tr>
<td>70</td>
<td>64.2</td>
<td>35.8</td>
</tr>
<tr>
<td>60</td>
<td>73.2</td>
<td>26.8</td>
</tr>
</tbody>
</table>

\[ M = \text{MCO}_2 > \text{MBO}_3 = \text{MPO}_4 \]

The same trend is observed in visual observation also.

Amine based VPIs, such as SVN-1, SVN-2 and SVN-3 have been developed for ferrous and non-ferrous metals and the influence of concentrations on their performances was also evaluated under the above mentioned experimental conditions by continuous condensation test method. The experimental results reveal that in the case of SVN-1 and SVN-2, 100 mg/l of vapour space is the optimum concentration, giving best performance of nearly 100%. Above this concentration, a decrease in the efficiency of the compounds is observed. But in the case of SVN-3, 250 mg/l of vapour space gives better performance than other concentrations.

**CONCLUSION**

The use of vapour phase corrosion inhibitors for the protection of metals is becoming more popular. Several new products have recently been developed for both ferrous and non-ferrous metals. This modified cell design is simple and more reliable to screen different VPI and also it enables to choose the best concentration of the inhibitor. Hence, it can be recommended for the evaluation of the effectiveness of samples of VPI.

**Acknowledgement:** Authors are thankful to the Director, CECRI, Karaikudi and Dr. N.S. Rengaswamy, Head, Corrosion Science and Engineering Division of their constant encouragement and support. Authors also acknowledge the CSIR, New Delhi for providing financial assistance for this investigation.

**REFERENCES**

4. A Wachter, T Skei and N Stillman, Corrosion (NACE), 7 (1951) 284