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

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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 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.

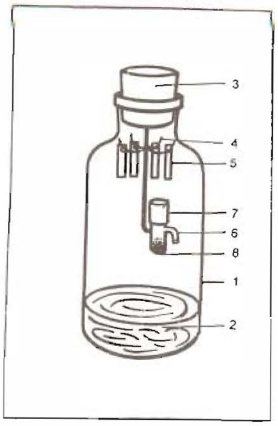

Fig. 1: Modified cell design
(1) 1 litre bottle (2) Humidity mixture (3) Rubber cork (4) Glass rods with hooks (5) Metal specimens (6) Cup with bend type outlet provision (7) Lid and (8) VPI sample

EXPERIMENTAL

Detail of modified cell design

A modified cell design is shown in Fig. 1. It consists of a 1 litre bottle (10" long x 4" wide) with tight fitting rubber cork carrying a glass rod with hooks having provisions to suspend the coupons. Just below the coupons a cup was made to place VPI sample. At the top of the cup there is a lid provision to prevent the condensation of moisture into the cup. At the middle part of the cup, there is a bend type outlet provision for the vapour to escape and fill the space in jar. Then this cell set up was kept at 313 ± 1 K in a thermostatic water bath for a suitable duration to allow for copious and continuous condensation of vapour on the metal specimens. This test was conducted at various relative humidities obtained by taking a mixture of 100 ml of glycerol and water in various proportions, as shown in Table I. After a suitable duration, the coupons were removed and both visual observation and weight loss measurements were made.

RESULTS AND DISCUSSION

A series of VPI namely morpholine and its derivatives, such as carbonate, borate and phosphate have been evaluated for mild steel at 313 ± 1 K in 100% RH using modified cell design and also other methods. The screening time was taken as 14 days. Reproducibility of results obtained by this modified cell design method is found to be better than that for other methods. The weight loss results reveal that morpholine carbonate equals the performance of morpholine, but morpholine borate and phosphate give poor performance. The grading of the compounds on the basis of their performance is as follows

TABLE 1: Creation of different relative humidities using glycerol and water mixture

Relative humidity (%)	Vol of glycerol taken (ml)	Vol of water taken (ml)
100	-----	100.0
90	31.4	68.6
80	51.7	48.3
70	64.2	35.8
60	73.2	26.8

$$M = MCO_3 > MBO_3 = MPO_4$$

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 thier 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.

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