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PROTECTIVE EFFECTS OF VAPOUR PHASE CORROSION INHIBITORS TESTED IN LABORATORY CONDITIONS

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This research investigates protective effects of vapour phase corrosion inhibitors (VpCI) tested in laboratory conditions. Such tests are required to control the production quality and to provide for high-quality protection of products during exploitation. There are three different tests run to obtain results on effectiveness of protective effect of VpCIs (Razor Blade Test, Water Drop Test and VIA Test). Each test differs in its defined performance procedure, as well as in evaluation of the obtained results, yet all three tests confirmed that vapour phase corrosion inhibitors provide adequate protection of the material exposed to an aggressive atmosphere. Therefore, it is justified to use vapour corrosion inhibitors as a protection mechanism when designing surface protection technology.

Key words: corrosion, surface protection, inhibitor, vapour phase corrosion inhibitors, tests

INTRODUCTION

According to the study published by the World Corrosion Organization, significant material resources are spent on damages caused by corrosion. It is estimated that between 375 and 875 billion US dollars, i.e. between 15 and 35 % of costs caused by corrosion damage could be saved annually just with application of appropriate corrosion control systems [1]. In order to achieve this, there are three principles to protect materials exposed to aggressive reactants from the environment. Along with elimination of external and internal damage factors, there is also a protection mechanism based on creation of a barrier between the protected material and the aggressive environment. Vapour phase corrosion inhibitors (VpCI) provide protective mechanism based on such principle. It is known that electrochemical corrosion develops in the electrolyte, and if corrosion inhibitors are applied even in small concentrations, corrosion can be reduced to technologically acceptable limits [2, 3]. Throughout their service life in various exploitation conditions, materials are susceptible to decay caused by corrosion mechanisms [4], so it is necessary to apply an appropriate system of protection against corrosion occurring in different conditions. Corrosion inhibitors suit the above-mentioned purpose because their efficiency has been confirmed while being applied in various heating and cooling systems, in steam boilers, in the oil and gas processing industry, in chemical industry, in protection of steel reinforcement in concrete, etc. [2, 5-7]. Results obtained by this research support such statements, as laboratory tests run in this research have confirmed protective effect of corrosion inhibitors in different conditions.

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EXPERIMENTAL PART

The experiment described in this paper has been performed by the Razor Blade Test, the Water Drop Test and the VIA Test. Those tests confirmed the effectiveness of corrosion inhibitors in practical conditions. Such tests are carried out on a daily basis to control the quality of corrosion inhibitors in production and to assure high-quality protection of products.

Razor Blade Test

The Razor Blade Test is a rapid laboratory test that shows whether test samples fulfil the requirements for corrosion protection. In order to confirm the effectiveness of protective foil treated with corrosion inhibitors, two out of three tested samples have to be without visible signs of corrosion. Testing of metal protection against corrosion is performed by putting of a sample in direct contact with deionized water and foil treated with a corrosion inhibitor. To run the test, the following laboratory utensils are required: latex gloves, cleaning cloth, sandpaper, pipette and metal pliers, as well as materials: VpCI 126 Blue film treated with an inhibitor, untreated foil, deionized water, methanol, sodium chloride and four test samples. Samples are 70 × 50 mm carbon steel plates. Prior to testing, samples are cleaned with sandpaper to remove coarse impurities from the surface, Figure 1.

Figure 1 Cleaning of test samples

Figure 2 Test samples in methanol

Testing is performed on four samples. Three samples are protected by foil and one sample is taken as a control without foil. After the test, samples are compared to assess the corrosion inhibitor action. After rough cleaning, test samples are placed in a container with methanol for five minutes, so that methanol removes the remaining impurities and grease from the samples, Figure 2.

Figure 3 Applying drops of deionized water to the test samples

Once being prepared for testing, samples are labelled and placed on foil. Two drops of deionized water are applied on the front surface of samples with a pipette, and then the front surfaces of panels are covered with foil, as shown in Figure 3.

Such prepared samples are put to rest for two hours and then visually inspected to assess the experiment results. Positive result of experiment is declared when two out of three samples covered with corrosion inhibiting foil do not exhibit traces of corrosion. The Figure 4 shows test samples after completion of the test.

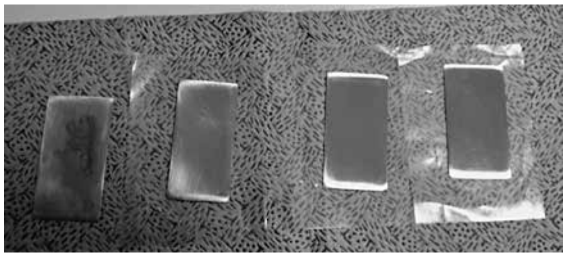

Figure 4 Samples after completion of the test

As shown above, applied corrosion inhibiting foil proved 100 % protection efficiency. All three protected samples have not exhibited any traces of corrosion, whereas the fourth sample (first sample on the left) tested without protective foil has developed corrosion on its surface.

Water Drop Test

The Water Drop Test is used to examine corrosion resistance of metals protected with corrosion inhibiting film or foil. The test lasts for 48 hours. In order to run the test, the following equipment is necessary: rubber tubes, latex gloves, cleaning cloth, sandpaper, adhesive tape, pipette and metal pliers, as well as VpCI 126 Blue film treated with a corrosion inhibitor, deionized water, methanol and four test samples. Test samples are prepared from carbon steel plates in dimension 70 × 50 mm. The experiment starts with cleaning of samples with sandpaper in order to remove coarse impurities. Samples are then placed in a container with methanol for five minutes to remove impurities and grease from their surface. Once being prepared for testing, samples are put into polyethylene bags, one of which contains the corrosion inhibiting film VpCI-126 Blue, and the other is not treated with inhibitor. Rubber tubes are put in the bags to prevent sticking of test samples to polyethylene sheets. Bags are then sealed and left for 24 h to allow the inhibitor to act. After 24 h, there is a small bag prepared out of VpCI film by sealing three sides. There is 10 ml of deionized water added in the bag and then the fourth top side is sealed as well. Deionized water is left in bags for 30 minutes to enable extraction of inhibitor from the film. After 30 minutes, polyethylene bags are cut and a drop of corrosion-inhibited deionized water is taken out of the VpCI bag to be put on each test sample. Sheets covering the samples are cut to add a drop of deionized water on each sample, as shown in Figure 5. Cuts are then sealed by adhesive tape and put to rest for the next 24 h.

After resting for 24 h, test samples are visually inspected for traces of corrosion. Traces of corrosion are presented in Figure 6.

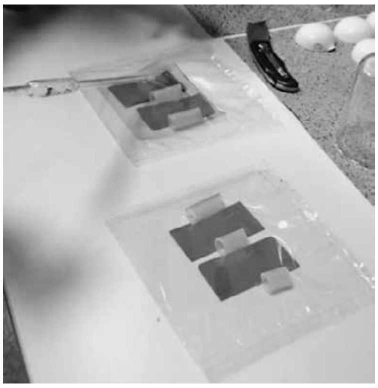

Figure 5 Adding of deionized water to test samples

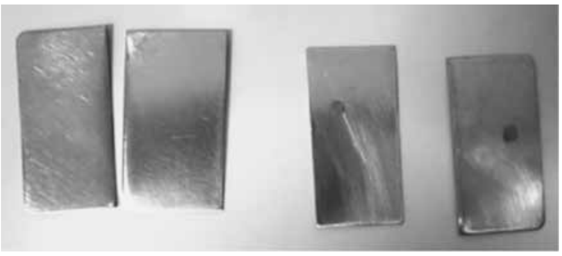

Figure 6 Surface of test samples after the experiment

Test samples with corrosion inhibitors have not developed corrosion on their surface, while samples without protection exhibited clear traces of corrosion.

VIA Test

VIA Test is performed in a glass container with inhibitor foil and metal plugs placed in rubber holders. The VIA test lasts for 24 ± 1 hours. Samples are graded with grades from 0 to 3, where the grades 3 and 2 are taken as positive with respect to protection of metal from corrosion. The grade 3 refers to good level of protection, and the grade 2 marks medium effect of protection. The test is performed with the following equipment: latex gloves, jars, seven VIA lids, masking tape, adhesive tape, sandpaper and metal pliers, as well as VpCI 126 Blue film treated with corrosion inhibitor, seven carbon steel plugs of diameter d = 15,9 mm and height h = 12,9 mm, deionized water, glycerine and methanol. The experiment starts with sanding of plugs to remove coarse impurities and proceeds with polishing to obtain a smooth and shiny surface. The polishing of plugs is shown in Figure 7.

Well-polished plugs are put in methanol for five minutes in order to remove small particles of impurities and grease, as presented in Figure 8.

After cleaning of plugs, inhibitory tapes are labelled with numbers. Plugs are placed in rubber holders with polished side down, facing the inner side of the jar, so that the polished surface is exposed to vapour inhibitor. Inhibiting foil is stuck onto the lid and put in the jar in a hanging position to allow it to release corrosion inhibitors, as shown in Figure 9. The process of corrosion inhibition lasts for 20 ± 1 hours.

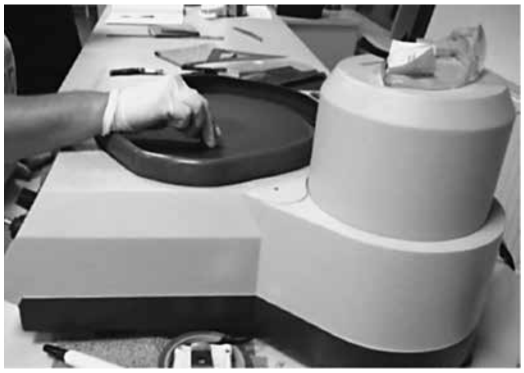

Figure 7 Machine polishing of plugs

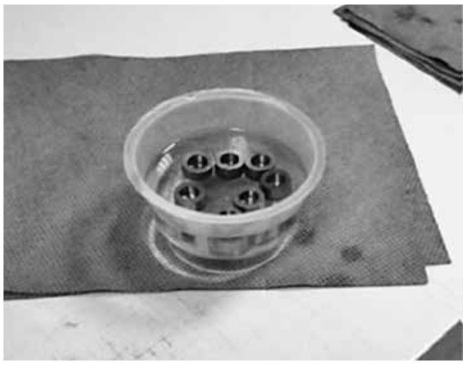

Figure 8 Plugs in methanol

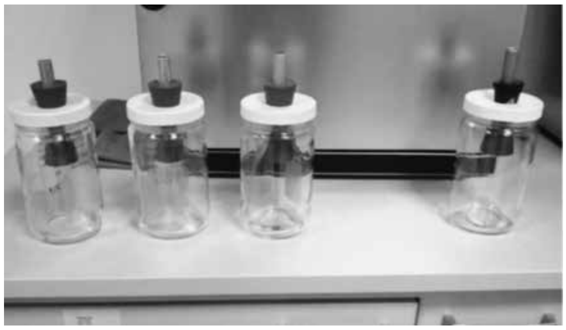

Figure 9 Plugs in glass jars with inhibitor

After the exposure, plugs are removed from glass jars and 10 ml of a 3 % glycerine solution is added to jars. Jars are closed and left to rest for another two hours. The process of extracting glycerine from jars is shown in Figure 10.

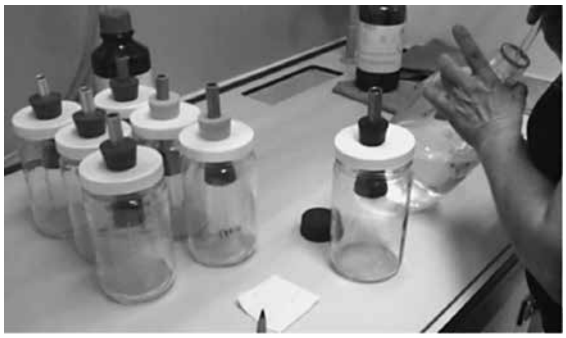

Figure 10 Extraction of glycerine solution from a jar

After two-hour resting, test samples are put into oven and kept in for another two hours at 40 °C, as presented in Figure 11.

Figure 11 Test samples in oven

Figure 12 Visual inspection after testing

After resting for two hours in the oven, glass jars are opened and plugs are wiped with a cloth and methanol to remove the condensate. Samples are then left to dry completely at room temperature. Appearance of plugs after testing is shown in Figure 12.

Dry samples are visually inspected for traces of corrosion and coloration. All samples treated with inhibitor are evaluated as of grade 3. The untreated control sample exhibited traces of corrosion.

CONCLUSION

Results of three different tests (Razor Blade Test, Water Drop Test and VIA Test) clearly prove the protective effect of the vapour phase corrosion inhibitor (VpCI). Reliable protective action of corrosion inhibitors is assured through formation of a barrier between aggressive reactants and the surface of protected material. Their wide application possibilities speaks in favour of their inclusion in surface protection technology. As confirmed by this research, even small concentrations of vapour phase corrosion inhibitors can prohibit development of corrosion mechanisms and provide an adequate protection of materials within the observed conditions.

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Note: Responsible person for English translation: Martina Šuto.