INTERCORR 2010
ABRACO 2010
Centro de Convenções do Hotel Praia Centro
Fortaleza/CE · 24 a 28 de Maio

INTERCORR2010_094

Corrosion Protection Of Flanges, Valves And Welded Joints Application Experience In Petrobras Facilities

M. Schultz[1], R. Singh[2], E. Lyublinski[3], Y. Vaks[4], M. Posner[5], T. Natale[6]

Abstract

During the last 5 years a very simple method was developed among NTIC, PETROBRAS and ZERUST to protect flanges, valves, welded joints and control instruments from atmospheric and crevice corrosion. This paper describes the application experiences at different PETROBRAS facilities of this new system using volatile corrosion inhibitors to fight against atmospheric and crevice corrosion. This system increases the efficiency and service life of corrosion protection for standard and non-standard types of flanges, valves, welded joints and control instruments in outdoor and indoor environments. The data presented here are the bases for defining the abilities of this solution, for selecting the type of cover for a particular application, and for recommending this solution for applications in all PETROBRAS facilities, as on-shore and off-shore. The solution is very simple and easy to install and uninstall, taking only a few minutes without need for special tools.

Keywords: flanges, valves, welded joints**,** corrosion, protection, inhibitor, efficiency, offshore, inland, refinery

Introduction

Corrosion of flanges, valves and welded joints is a major world-wide problem in many industries, including Oil and Gas Exploration and Production, Petroleum Refining, Mining, Chemical Process, Petrochemical, etc. Various forms of corrosion, including general, pitting and crevice come into play, which can lead to leaks and increased maintenance, repair and replacement costs. Attacks occur on surfaces between the flange faces, on welded joints, as well as on flange bolts and nuts, the severity of which depends on the external environment and operating conditions (see Figure 1).

[1] M.Sc., Corrosion Engineer – PETROBRAS – E&P
[2] Director – ZERUST Brasil
[3] D.Sc., Electrochemical Engineer – Northern Technologies International Corporation
[4] Mechanical Engineer – Northern Technologies International Corporation
[5] D.Sc., Chemical Engineer – Northern Technologies International Corporation
[6] Mechanical Engineer – Northern Technologies International Corporation

There exist numerous solutions, including various forms of coatings, covers, tapes, wraps, housing guards, etc. These vary in complexity of installation and cost, and work primarily by forming a barrier between the flange to be protected and the corrosive environmental elements. Unfortunately, these simple barrier products often are not effective in combating the atmospheric conditions encountered at many industrial sites.

FIGURE 1 – Examples of Flange Corrosion

Volatile corrosion inhibitors (VCI) have been used in packaging to protect metal parts during storage, handling and transportation for many years, dating back to the original Shell patents and the Northern Technologies International Corporation (NTIC) patent for VCI film. This VCI technology has been combined with barrier films to develop a flange and valve protection system (FPS)[1], which provides an effective protection solution against aggressive industrial environments. The FPS was designed to be an economical solution with operational and handling requirements aimed at:

- ease of installation and replacement
- ability to customize, in the field, for installation on typical as well as unconventional and complex flange and valve configurations

On a functional level, basic operational requirements for the FPS included:

- low water vapor transmission rate
- minimum one-year stability in full-sun exposure, outdoor environments
- protection against a wide range of aggressive corrosive conditions

[1] NTIC trade name Zerust® Flange Saver™

Principally, two styles of FPS were developed (see Figure 2):

- One-layer system, with VCI incorporated into the barrier film
- Two-layer system, consisting of a barrier film (low permeability polymeric, without VCI) as the outer layer and a separate inner VCI film layer; then desiccant is placed between the layers

This paper summarizes field tests in highly corrosive environments.

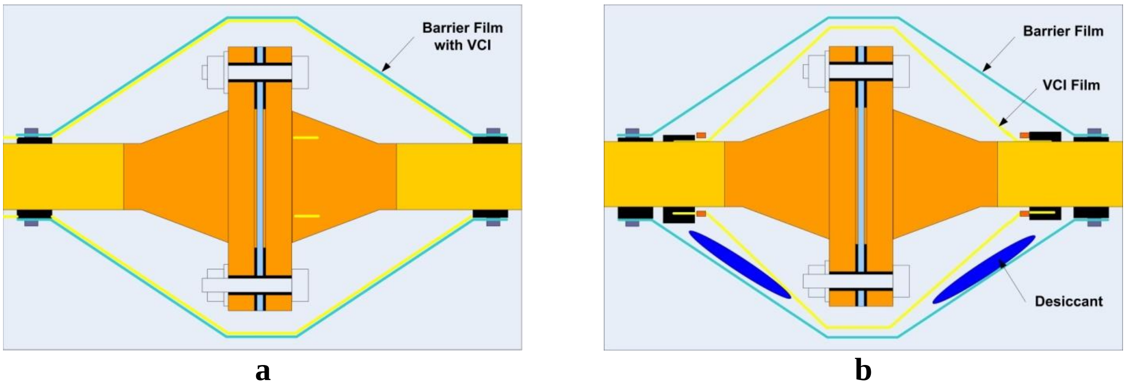


FIGURE 2 – Styles of FPS:
a) One-layer system
b) Two-layer system

Experimental Procedures

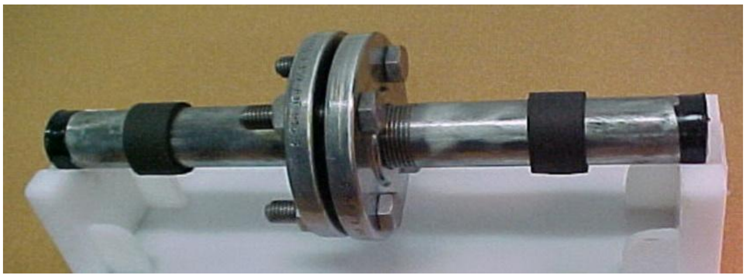
Evaluation of field testing results was performed by either quantitiative of qualitative means, as follows:

- Sample Quantitative Evaluation: Steel specimens were installed inside (test) and outside (control) an FPS cover at the start of testing. At the end of the trial period, the FPS cover was removed and the specimens were inspected. Corrosion rates exhibited inside and outside the FPS cover were determined per ASTM G1-901.

- Sample Qualitative Evaluation: An FPS cover was installed onto the test sample, while the control sample was left unprotected. Results were evaluated qualitatively at the end of the trial period by comparing the amount of corrosion on the FPS test sample vs. the amount of corrosion on the unprotected control samples.

Results and Discussion

Field testing was performed after successful laboratory tests of flange assemblies in Salt Spray/SO_2 Gas Cycle chambers (Figure 3).



a

b

c

FIGURE 3 – SaltSpray/SO_2 Gas Testing Results:
a) Flange assembly before exposure,
b) Flange Assembly Parts – Control – No FPS Protection,
c) Flange Assembly Parts – Test – Two-Layer FPS Protection

Field trials were performed at several locations in Brazil, focusing on warm, humid climates that were more prone to accelerated corrosion problems. Table 1 lists each of the test site locations with a brief description of the local environmental conditions.

TABLE 1
FIELD TESTING SITE ENVIRONMENTS

Test Location	Location Type	Exposure Time (months)	Facility Type	Corrosion Environment Severity	Conditions
1	Offshore	11	Platform	Aggressive	Warm, Humid, Salt spray from ocean
2	Seaside	11	Refinery	Moderate	Warm, Humid
3	Inland	5			
4	Inland	11			
5	Inland	11			

Quantitative results were obtained using metal. Results are presented in Figure 4. In all cases, significant reductions in corrosion rates are observed, ranging from 10- to 26-fold.

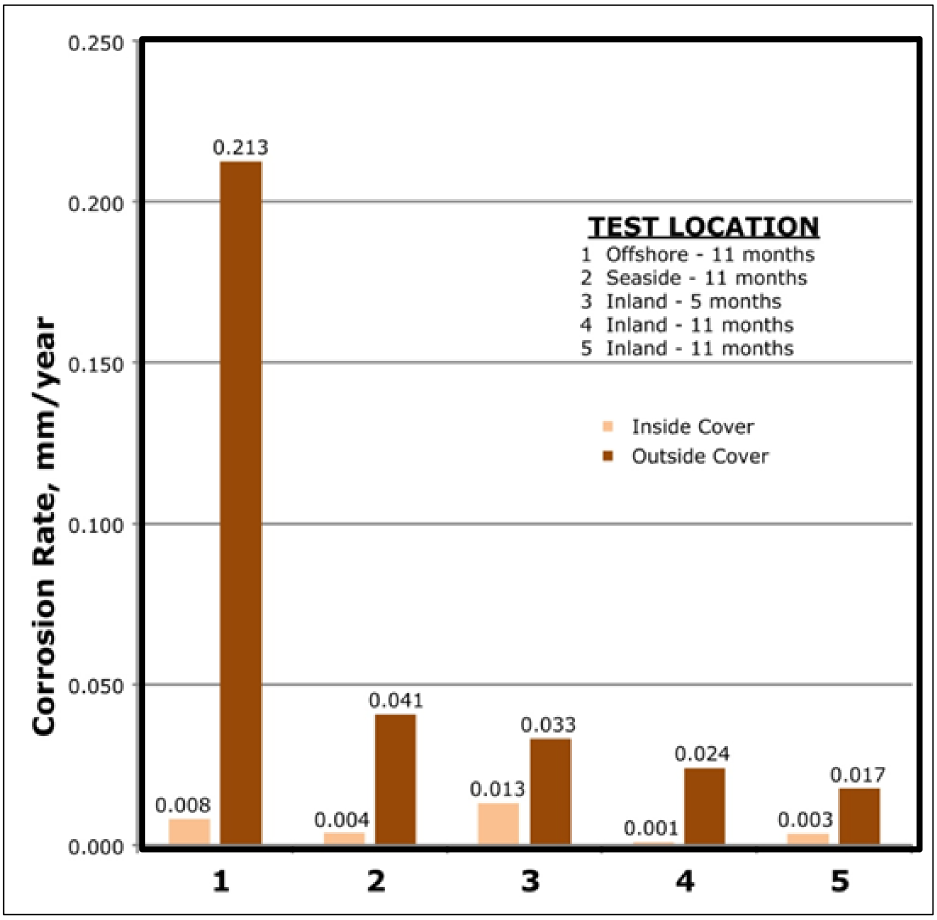
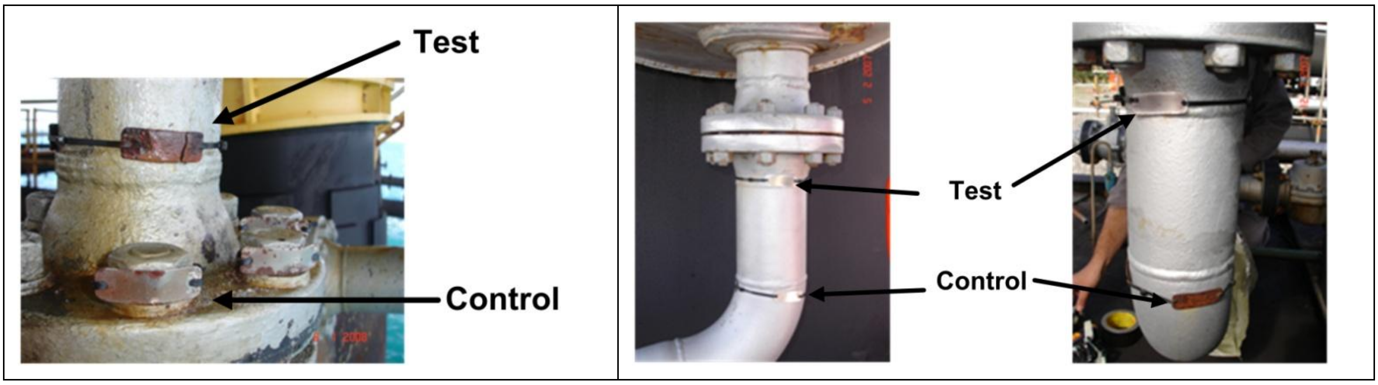


FIGURE 4 – Corrosion Rates of Metal Specimens

Qualitative evaluation of field testing results also produced visually discernable differences in corrosion levels. FPS covers were installed on flanges and valves of various configurations (see Figure 5). Typical results, comparing specimens, demonstrated clear differences in amount of corrosion inside vs. outside the FPS covers (see Figures 6).

FIGURE 5 – Various Configurations of FPS Cover Installations



a b

FIGURE 6 – Field Trial Specimens:
a) Offshore - 11 months;
b) Seaside - Start of trial (left), 11 months (right)

Conclusions

1. Both the one-layer and two-layer FPS provided significant corrosion protection of flanges, valves and welded joints in a wide variety of laboratory and industrial environments. The industrial test sites included offshore, refinery, seaside and inland locales.

2. The field tests of FPS demonstrated high effectiveness and stability in industrial environments containing Cl^-, H_2S, SO_2 and CO_2, with relative humidities up to 100%, temperatures up to +35°C, and exposure to intense ultraviolet radiation for periods up to one year.

3. The FPS is easy to install and can be customized, in the field, for application with typical as well as unconventional and complex flange and valve configurations.

Bibliography References

1. ASTM Standard G1, 1990, "Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens, cleaning, corrosion product removal, evaluation, mass loss, metals, preparation, specimens," ASTM International, West Coshocton, PA, USA.

2. IEC 68-2-30, 1980, "Basic Environmental Testing Procedures, Part 2: Tests," International Electrochemical Commission, Geneva, Switzerland.

3. ASTM Standard G85, 1998, "Standard Practice for Modified Salt Spray (Fog) Testing," ASTM International, West Coshocton, PA, USA.