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Test report

Salt fog testing of tubing clamps

ASTM B-117 or ISO 9227

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Tubing clamps with tubing

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ABSTRACT
Salt spray testing in 5 % NaCl and 35 °C of different tubing clamps TC-01 and tubes has been performed for BVS AS. The salt spray testing (ASTM) of pipe and pipe clamps of 254 SMO and AISI 316L fitted to a 316L BVS Cable Tray that were vibrated during the test, revealed some fretting corrosion in the contact points between pipe and clamp.
The test was run for 13 days (312 hours) with continuous vibration. The applied vibration is significantly more intense and constant compared to the vibrations on an offshore platform. To transfer the result to life-time prediction of the parts on a platform is almost impossible.
The material loss at the contact points between clamps and pipe of both 254 SMO and 316L is visible but quite small (<0.04 mm). This did not have any impact on the clamp force and functionality.
Taking into account previous results for the same materials and conditions tested for 1000 hours it is shown that the penetration rate decreases significantly with time. This indicates that penetration of the pipe will not occur within reasonable time (50 years).

The test results relate only to the items tested

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APPENDICES

"[List appendices here]"

1 Introduction

For BVS AS SINTEF has performed salt spray testing of tubing and clamps of different types and material combinations. The test is performed according to ASTM B-117 / ISO 9227 that is testing in salt fog containing 5% NaCl and at a temperature of 35 °C.

2 Testing

The test was made in a salt fog chamber according to ASTM B-117 / ISO 9227. The testing time was 312 hours (13 days). This corresponds to about 5 years of vibration on a platform. During one year a platform experiences around 7 mill vibrations. The 254SMO clamps and pipe and AISI316L clamps and pipe were attached to a BVS Cable Tray of AISI 316 and exposed to vibrations during the whole testing period. The setup is shown in Figure 1. The vibration was excited by a ball vibrator that had a frequency of about 30 Hz.

Figure 1 Picture of the test specimens inside the salt spray chamber.

3 Results and discussion

After the test, fretting corrosion was found at the contact point between pipe and clamps on both SMO and 316L. The fretting on the SMO clamp and pipe was less than on the 316L components.

Normally 254 SMO is very resistant in salt spray. The very high vibration intensity applied to the test object is making the difference and enhance corrosivity especially regarding fretting corrosion.
The vibration is much more intensive than in actual exposure on platforms, but in this case, it is used to provoke corrosion and reduce testing time. However, it is impossible to know how much the corrosion is accelerated. That is normal for all salt fog testing as this type of testing is mostly used to compere different products or for qualification purposes. Direct scaling the salt fog test results to corrosion in actual condition is very difficult and is normally not done. The salt spray test is fine to use for evaluating product changes as the result can be obtained within a fairly short time (couple of weeks).

Corrosion was only seen in the contact between the clamps and the pipes. When the corrosion products were removed by cleaning in HNO_3 it was quite difficult to differentiate between corrosion and mechanical marks at the contact point. The depth of the marks on the pipes was anticipated by focusing a microscope on the edge of the marks and on the bottom and calculates the focus height difference. The average depth values of marks are presented in Table 1. In this case (312 hour test) the average depth was less than 0,040mm (40 µm)

Testing has also been made on the same materials in the same way before/1/. That test was run for 1000 hours. The test results for the current test and the earlier test is comparable regarding test conditions. For both cases the depth of the corrosion and deformation marks of the tubes has been measured by focusing a microscope on the edge of the mark and inside the mark. On the clamps no deformation was observed. The result is seen in Table 1.

Table 1 Depth in pipe as a function of time

Time (hours)	316L depth (µm)	SMo depth (µm)
312[1)]	38	35
1000[2)]	54	44

1) This test
2) Earlier tests/1/

It can be noticed that the depth of the marks is not very different on the pipe tested for 312 hours and 1000 hours. This means that after an initial deformation/corrosion the depth increase rate is significantly reduced. This is visualized in Figure 1where logarithmic curves are fitted to the result. The fitted curves **indicate** that the deformation/corrosion will never penetrate the pipe i.e. never reach the wall thickness (WT=800 µm) of the pipe.

The fretting of the contact point had not any significant influence on clamp force. There was no extra vibration sound indicating loose parts during testing and when opening the clamps the initial tension was still intact as far as it could be considered by opening manually with the special design clamp tool.

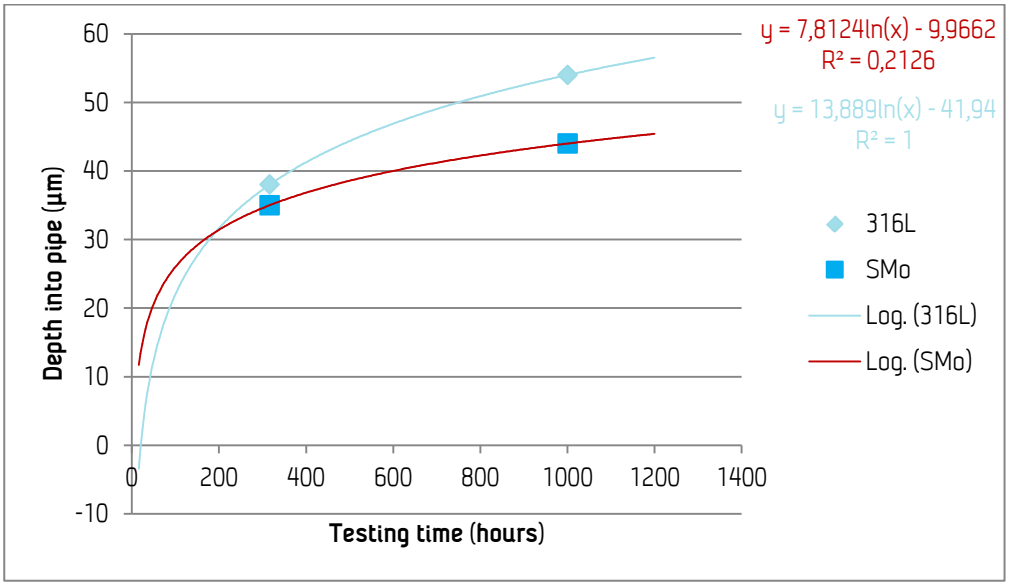

Figure 2 Penetration of pipe as a function of time. (Normal wall thickness of the tubes used is ca 800 µm)

4 Conclusion

The salt spray testing (ASTM) of pipe and pipe clamps of 254 SMO and AISI 316L fitted to a 316L BVS Cable Tray that was vibrated during the test, revealed some fretting corrosion in the contact points between pipe and clamp. When the corrosion products were removed by HNO_3 it was difficult to see the corrosion attack. This indicates little corrosion.

The test was run for 13 days (312 hours) with continuous vibration. The number of vibration cycles corresponds to about 5 years on an offshore platform. The applied vibration is significantly more intense and constant compared to the vibrations on a platform that vary quit much. To transfer the result to life time on a platform is almost impossible.

The material loss at the contact points between clamps and pipe of both 254 SMO and 316L is visible but quite small (<0.04 mm) and did not have any impact on the clamp force and functionality.

By taking into account previous results for the same materials and conditions tested for 1000 hours it is shown that the penetration rate decrease significantly with time indicating that penetration of the pipe will not occur within reasonable time (50 years).

5 Reference

/1/Tor G. Eggen, Nils-Inge Nilsen: "Salt fog testing of tubing clamps" Pr.: 2011-12-13

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