Protection of Offshore Platform Caisson Legs with a Vapor Corrosion Inhibitor—A Case Study

Talal A. Rahman Al-Sayed, Ahmed Fathi Eid, and Mahdi Mohamed Al-Marzooqi,
Abu Dhabi Marine Operating Co. (ADMA-OPCO), Abu Dhabi, United Arab Emirates
Usama Jacir,
Cortec Middle East, Dubai, United Arab Emirates

In November 2000, gas buildup inside the confined compartment around an offshore platform caisson leg led to an explosion. The gas was found to be hydrogen generated by the depleted anodes inside the caisson leg. An investigation of the fatal explosion made several recommendations, including removal of the anodes, biocide-treated water, and blasting grit that had accumulated inside the caisson legs over two decades. A pilot study was conducted to evaluate the use of a vapor corrosion inhibitor (VCI) for structure integrity protection after removing the blasting grit and biocide-treated water from one of the legs. Treatment commenced with spraying the internal diameter of the leg with a water-based solution containing a VCI with a biocidal treatment. This was followed by fogging the internals with an amine carboxylate VCI. Finally, a string of pouches containing VCI powder was suspended on hangers to assure continuous saturation of inhibitor in the space. Corrosion coupons were installed 6 m below the manhole before closing it. Results after one year and beyond were positive and the system was adopted for rectification of the problem.

ADMA-OPCO is a major producer of oil and gas from the offshore areas of Abu Dhabi in the United Arab Emirates. It is a partnership between ADNOC (60%), BP, Total S.A., and JODCO. It operates two major fields—Umm Shaif and Zakum—where oil and gas are produced and transferred to Das Island for processing, storing, and exporting. Multiple barge-type offshore platforms are constructed and operated on caisson legs.

Internals of the platform caisson legs are uncoated and filled with biocide-treated water and protected using suspended sacrificial anodes. They also contain debris including blasting grit. After two decades of operation, the anodes had been depleted and gas generation led to a fatal accident in 2000 when an explosion occurred inside the confined compartment around a caisson leg of a platform.

A board of inquiry recommended several actions including the removal of the blasting grit and biocide-treated water. A multidisciplinary team was assigned to investigate a methodology to maintain the integrity of the caisson legs and mitigate internal corrosion. Several options were considered and assessed for their effectiveness, ease of application, and environmental impact. These included a new grouting and sealing procedure, installation of a glass-reinforced plastic (GRP) pipe and filling the annular space with inhibited cement, and others. The final recommendation was corrosion management utilizing a vapor corrosion inhibitor (VCI). To assess the effectiveness of this approach, a pilot project was launched in 2009 whereby one caisson leg was emptied and preserved with VCI. Carbon steel (CS) weight loss corrosion coupons were used to assess the effectiveness of this approach.

FIGURE 5 Caisson leg sealed cover.

FIGURE 6 Weight loss corrosion coupons.

TABLE 1. CORROSION RATES IN PILOT AND CONTROL CAISSON LEGS

Caisson Leg		Monitoring Location	Corrosion Rate, MPY				
USEAP			Oct. 11	Jan. 12	Sept. 12	Mar. 13	Sept. 13
4494-0034	PC-USEAP-4494 0034	Above water			12.63	18.56	11.88
4494-0034	PC-USEAP-4494 0034	Below water			0.88	0.29	0.36
4494-0036	SB-USEAP-4494 0036	Above water			13.23	14.44	10.98
4494-0036	SB-USEAP-4494 0036	Below water			1.05	2.05	0.40
USAAP							
4494-0052	SB-USAAAP-4494 0052	VCI, pilot leg	0.29	0.11	0.45	3.18	0.09

The results showed clear improvement in the VCI-treated caisson leg where corrosion was maintained at low rates that were deemed acceptable. The methodology was adopted for the treatment of all other caisson legs at the complex.

In August 2013, another pilot was launched to qualify a new methodology for treated water disposal. After adopting this methodology, all caisson legs will be emptied and preserved.

Acknowledgments

The authors would like to thank ADMA-OPCO management for their support to this pilot project, and the team at Kanoo Group for their field support.

References

1. S.Z. Levin, "Volatile Inhibitors of Metal Corrosion," Second European Symposium on Corrosion Inhibitors (Ferrari, Italy: 1966), p. 765.
2. V.S. Sartri, *Corrosion Inhibitors. Principles and Application*, 1st Ed. (Hoboken, NJ: Wiley & Sons, Ltd., 1998), pp. 787-789.
3. E. McCafferty, *Introduction to Corrosion Science*, 1st Ed. (Berlin, Germany: Springer, 2010), p. 130.
4. B. Bavarian, J. Zhang, L. Reiner, "Electrochemical and SCC Inhibition of Multi-alloy Systems using Vapor Corrosion Inhibitors," CORROSION 2013, paper no. 2130 (Houston, TX: NACE International, 2013).
5. NACE TM0208, "Laboratory Test to Evaluate the Vapor-Inhibiting Ability of Volatile Corrosion Inhibitor Materials for Temporary Protection of Ferrous Metal Surfaces" (Houston, TX: NACE, 2008).
6. OECD Test No. 306, "Biodegradability in Seawater" (Paris, France: The Organization for Economic Co-operation and Development).
7. ASTM G4-01 (latest version), "Standard Guide for Conducting Corrosion Tests in Field Applications" (West Conshocken, PA: ASTM International).

This article is based on CORROSION 2014 paper no. 4200, presented in San Antonio, Texas.

TALAL A. RAHMAN AL-SAYED is vice president of integrity at ADMA-OPCO, PO Box 303, Abu Dhabi, U.A.E.

AHMED FATHI EID is the Corrosion and Flow Assurance Section leader at ADMA-OPCO. He is a corrosion engineer with 19 years of experience in the oil and gas production industries. He specializes in corrosion control, cathodic protection, and asset integrity. He has a B.S. degree in chemistry and an M.S. degree in synthesis of corrosion inhibitors. He is a registered Professional Corrosion Engineer in the British Institute of Corrosion, and a NACE-certified Senior Corrosion Technologist. He is a six-year member of NACE International.

MAHDI MOHAMED AL-MARZOOQUI is with ADMA-OPCO.

USAMA JACIR is general manager of Cortec Middle East, PO Box 115133, Dubai, U.A.E., e-mail: ujacir@cortec-me.com. He has 20 years of experience in corrosion mitigation using protective coatings and corrosion inhibitors. He is a five-year member of NACE International. MP