A SHIFT IN CORROSION PREVENTION POTENTIAL

Julie Holmquist, Cortec® Corp., and Shane Baker, Cortec Global Services (CGS), discuss the benefits of vapour corrosion inhibitor (VCI) technology for tank bottom and cased pipeline corrosion mitigation.

The last two and a half decades have seen a shift in the oil and gas industry's approach to corrosion protection on aboveground storage tank (AST) bottoms and inside cased pipeline crossings. The use of vapour corrosion inhibitors (VCIs) has emerged as a supplement to the primary strategy of cathodic protection (CP). While VCIs became popular in the mid-1900s for preservation of wartime assets, it was not until the late 1990s[1] and early 2000s[2] that they started to be seriously used and tested as a method of AST bottom protection from soil-side corrosion. As data accumulated over time, it became evident that VCIs were a viable alternative and complement to CP. Their practical acceptance by industry users is reflected by the adoption of VCIs in standards such as API Technical Report 655[3] in 2021 and AMPP SP21474-2023[4] in 2023. While testing and data collection continue, another important step in VCI standardisation is achieving broader

awareness of the benefits of VCI technology among those who manage oil and gas storage facilities. By understanding how VCI works and where it has been used, decision makers can better evaluate the advantages of adopting VCI and whether it warrants a shift in their corrosion prevention strategy.

Figure 1. Single bottom tank at US East Coast tank farm received VCI injection through ports drilled in the concrete ring wall (image courtesy of Shane Baker).

Figure 2. ER probe placed after VCI injection to continue monitoring corrosion potential readings under the tank (image courtesy of Shane Baker).

The affinity of VCIs for metal void space protection

VCIs come in many forms, including salts of amine carboxylates. These salts, whether applied as a powder or mixed with water, have varying degrees of volatility that allow them to diffuse as vapours through the air. When trapped within a void space, their affinity to metal allows VCI molecules to adsorb onto metal surfaces, creating an invisible protective layer that blocks the interaction of metal molecules with oxygen and moisture, slowing down or completely avoiding the formation of a corrosion cell. As long as the VCI molecules remain inside the void space, they continue protecting the metal surfaces.

This vapour-phase protective action makes VCIs very adaptable to enclosed spaces of many shapes and sizes. Beneath AST bottoms, VCIs are able to diffuse through sand and form a protective molecular layer on metal surfaces where the uneven tank bottom is not in direct contact with the cathodically protected sand pad. Inside casings designed to provide extra protection from physical impact on piping passing under roads or berms, VCIs offer supplementary corrosion inhibition by diffusing through difficult-to-reach areas where no protection has been applied, where CP has shorted, or where coatings or wax fillers may have failed.

CP/VCI installation and maintenance comparisons

Representative challenges for CP installation include oversized tanks and double bottoms. Some tanks cover 1 acre (0.4 ha.) of land, making it easy to lose the drill head signal under the tank by the time it gets halfway across. It may not be possible to regain reception until the drill head nearly reaches the other side, making directional drilling for CP installation highly impractical on extra-large tanks. Double bottom tanks also create more complications for CP. A second bottom is often installed when corrosion in the original tank floor becomes severe enough to threaten tank integrity. Before adding the second bottom, several inches of clean sand may be placed over the first bottom, along with a CP system. In some instances, it is necessary to install a lattice-work of metal strips across the tank bottom and spot weld every corner before a new bottom is installed. The final step is to then hook it to a rectifier. In contrast, adding VCI to a double bottom tank involves drilling holes through the tank wall into the space between the two floors, injecting VCI slurry, and installing electrical resistance (ER) probes. Furthermore, while CP grid systems can only be installed at the same time as the new tank floor, VCI can be added to double bottom tanks even after they have been put into service.

While VCI and CP systems both require workers to take monthly corrosion readings, CP can become more complicated if the voltage is out of bounds and/or corrosion is detected. This may require adjustment of the rectifier or replacement of the anodes. In contrast, VCI is relatively maintenance-free.

The relative ease of VCI application and maintenance does not mean that CP is out of the picture. In some cases, VCI is combined with CP to boost overall protection. In other cases, only one method is used. Sometimes, VCI is not added until the CP system needs a retrofit since VCI application is less invasive.

Case studies

US East Coast tank farm

A tank farm on the US East Coast stores a variety of petroleum products not far from the Atlantic Ocean. In this highly corrosive environment, tank operators pay close attention to rectifier readings and take steps for remediation when corrosion potential readings on CP systems fail to meet standards. For several consecutive years, the client identified four to 12 priority tanks where they wanted their contractor to carry out CP or VCI remediation work. Many were single bottom tanks where VCI protection was needed as a supplement to deficient CP activity. The crew would drill holes in the ring wall and inject VCI at a dozen different points on average (depending on tank size). When finished, they would insert ER probes at VCI injection points for easy monthly monitoring of corrosion potential by technicians.

VCI at southern US oil terminals

A crude oil transport company asked for similar VCI application work underneath several massive tanks (277 ft [84 m] dia.) in Texas, US. The tanks were already under construction, so the team had a narrow timeframe – from 16.30 pm on Friday night to 07.00 am Monday morning – to complete VCI application before welders returned for a new week of work. Fortunately, this situation allowed the team to apply VCI via injection through the empty tank floor. The tank floor was mapped out and the team identified where to drill holes to evenly inject and distribute VCI beneath the floor. Workers circled each drill site in red for easy visibility in the dark tank environment, then plugged each hole and painted a red 'X' on the panel when VCI injection was complete. With the tank covering 1 acre (0.4 ha.) of land, it took two days to drill holes and inject VCI (much time was devoted to mixing VCI powder with water, which is no longer necessary with the availability of a ready-to-use slurry form). When the weekly shift started, tank builders welded a small patch over each injection point to finish the job. The same client used VCI to protect tanks at the Cushing tank terminal in Oklahoma, US. Data collected at this tank terminal from 2014 to 2019 offered helpful insights on VCI/CP benefits and interaction, indicating that the use of VCIs in conjunction with CP for five years had significantly decreased corrosion rates compared with the previous three years of CP-only protection.[5] Repeated application requests by the same company in two locations underscores their high rate of satisfaction with VCIs.

VCI for cased piping systems

Another US East Coast storage facility requested VCI protection of onsite terminal pipelines feeding in and out of ASTs. Similar to larger transport pipelines, these piping systems were enclosed in larger casings for physical protection under tank farm berms or roads. Corrosion protection was needed within the casing voids, so the team injected what they calculated to be enough VCI for 40 ft (12 m), sealing and wrapping the ends of the casings to keep VCI inside and corrosive elements out. The client expressed initial satisfaction with the quick and clean application process and more positive feedback was received after the inspector reported good corrosion potential readings in the following months.

Figure 3. Drilling VCI injection ports for double-bottom tank. Two parallel horizontal lines show the locations of the original floor (lower line) and the newest floor (top line) (image courtesy of Shane Baker).

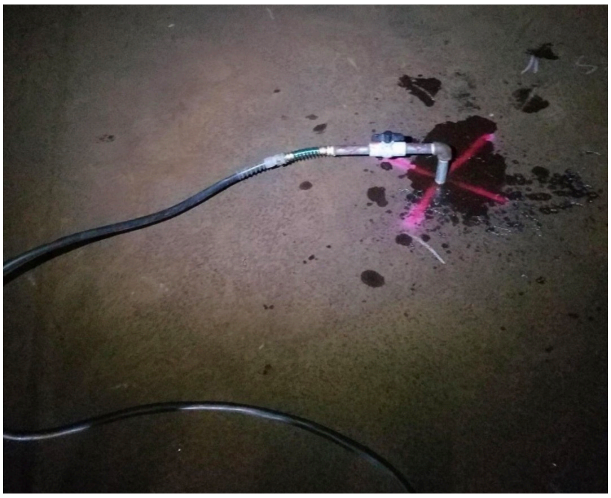

Figure 4. Injection through the tank floor is one of the easiest ways to apply VCI; although other options exist for application on new, existing, and in-service tanks (image courtesy of Shane Baker).

Time for a shift in corrosion potential?

Industry standards are often a good reflection of what has already been accepted as a standard industry practice. However, it is also helpful to hear specific examples of where CP/VCI application has been observed on tanks across the US. As evidenced in this article, oil and gas industry players can shift their corrosion prevention potential by adopting VCIs as a complement to traditional CP. T&T

Figure 5. VCI was also injected into casings where tank farm pipelines were buried under ground (image courtesy of Shane Baker).

References

1. SHUKLA, P. K., 'Vapor Corrosion Inhibitors for Corrosion Control of Aboveground Storage Tank Bottoms', SRNL-MS-2021-00110. Pipeline Research Council International, PHMSA R&D Forum, (1 December 2021), accessed 11 March 2026, https://primis-meetings.phmsa.dot.gov/meetings/f4a3f78b-a3eb-4c51-bbda-4407d9db68e8/files/5ac36e47-f1e2-4135-903a-8e3d21f3b33e/PRCI-Pavan_Shukla.pdf.
2. WHITED, T., 'Corrosion Slowed on Tank Bottoms', Pipeline & Gas Journal, accessed 11 March 2026, https://www.cortecvci.com/Publications/Papers/Petro_Chem/VpCI-608.pdf.
3. 'Volatile Corrosion Inhibitors for Storage Tanks', American Petroleum Institute, API TR 655, (28 April 2021), accessed 11 March 2026, https://www.apiwebstore.org/standards/655.
4. 'External Corrosion Control of On-Grade Carbon Steel Storage Tank Bottoms', Association for Materials Protection and Performance (AMPP), AMPP SP21474-2023, (31 May 2023), accessed 11 March 2026, https://store.ampp.org/ampp-sp21474-2023-external-corrosion-control-of-on-grade-carbon-steel-storage-tank-bottoms.
5. WHITED, T., OLUIC, A. J., and HOLMQUIST, J., 'Reducing Soil-Side Corrosion in Aboveground Storage Tanks', *Chemical Engineering*, (1 January 2023), accessed 11 March 2026, https://www.chemengonline.com/reducing-soil-side-corrosion-in-abovegound-storage-tanks/?printmode=1.

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