Dealing with Water Tank Blisters

Under what conditions should small diameter blisters (1.25 cm) in a water tank be repaired/repainted? Should the blisters be broken and the substrate examined?

Answer
Amy Forsgren
Swedish Corrosion Institute
Stockholm, Sweden:
Blistering of the paint system used in a steel water tank indicates that the steel surface was not cleaned properly or that it was contaminated with water-soluble material before the paint was applied. Alternatively, the paint itself could have contained water-soluble or hydrophilic materials. For example, application of thick layers of solvent-borne paints containing glycols can cause blistering if the solvent becomes trapped in the coating.

If the blisters are intact and the coating has good adhesion and shows no discolouration, then corrosion of the substrate is probably very limited. In this case, the blisters should be left alone, since there should not be a problem with contamination of the water by rust or serious corrosion. This is particularly true when the blistering is in isolated areas.

If the coating shows signs of disbondment or becomes discoloured with rust stains, then steps should be taken to repair the coating. This can be either spot repair or complete coating removal and repainting if the blistering is widespread. In either case, the reason for the initial blistering should be ascertained to ensure the problem does not recur.

Answer
Mike Swidzinski
Phillips Petroleum Company UK Limited
Woking, UK:
The approach depends on the coating type, tank material, type of water contained in the tank, and whether the tank has supplementary cathodic protection. My answer applies to tanks that are coated, not lined, and it is not relevant to blisters formed during tank manufacture.

In general, blistered tank coatings should be left intact unless there are obvious indications of corrosion activity. The repair of tank coatings can be costly and can result in more damage to the originally applied system than caused by blistering.

The level of tolerance to breakdown or deterioration of water tank coatings largely depends on their duty and frequency of inspection.

- If the coated tank is made from carbon steel and used to contain sea water, produced water, or brackish water, then rapid corrosion of the tank may occur if the coating is defective, especially if the water is warm or aerated. The problem may be mitigated if sacrificial anodes were part of the original design.

- If the coated tank is made of stainless steel that is coated for reasons of water purity, then the coating is unlikely to corrode. Different criteria apply to the inspection and maintenance of these coatings. These criteria are not addressed in this response.

- Tanks containing potable water will corrode less rapidly beneath a defective coating. Once again, corrosion will be significantly reduced by a cathodic protection system.

- Tanks fabricated from corrosion-tolerant materials (i.e., stainless steel) that are coated for reasons of water purity are unlikely to corrode. Different criteria apply to the inspection and maintenance of these coatings. These criteria are not addressed in this response.

A blistered coating may still be sound. If there is no evidence of local discolouration due to rusting, the coating is probably intact and providing adequate protection. A quick test is to lightly depress a blister at its extremity. If fluid weeps out, then the blister is porous to water, and the underlying substrate is at risk of corrosion.

Ultrasonic inspection can provide an indication of whether the surface under the blistered area is corroding without having to break the blisters. If this form of surveillance is possible, a routine inspection programme could be devised and implemented to monitor the tank wall condition at the worst blistered areas.

If the blister is porous and ultrasonic inspection is not possible, then removal of a blister will be necessary if the tank condition beneath the blistered area must be established. In this case, a representative sample of blisters should be broken and the coating removed until sound, uncorroded metal surface is found. The diameter of the exposed area may be 100 percent larger than the original blister.

The need for remedial action should then be gauged against remaining tank life, the corrosion/pit-
ting rate, and tank wall thickness for containment.

If no further action is required, then the exposed area beneath the blister must be recoated. The existing coating should be cleaned back to achieve a sound, feathered edge (preferably by grit blasting), and a compatible tank coating repair system should be applied.

The original coating manufacturer should be consulted about selection of the required repair system.

Answer

Jim Ellor
Corrpro Companies Inc.
Alexandria, VA, U.S.:  

In answering this question, an assumption is made that the coating is not under warranty. If the coating is under warranty, it should be repaired as stipulated. Before any non-warranty maintenance of a blistered coating is planned, one should answer several questions.

• How long has the tank been in service, and how much longer until the next maintenance?
• Is corrosion associated with ruptured blisters in the immediate vicinity of intact blisters?
• What is the consequence of significant coating failure?

Generally, it is common to find a few small blisters in water tanks after a brief service period (i.e., 6 months). Such blistering is related to soluble contaminants on the substrate or between coats. This condition is especially true in overhead areas where “pure” condensing water promotes blistering through osmotic forces. However, this blistering may not be cause for significant alarm.

If the extent of blistering is less than 0.1 percent of the total area and if it is isolated, one might be inclined to leave the blisters untouched. It is conceivable that the coating remains an effective barrier to corrosion. A pseudo-equilibrium may also exist between the coated substrate and its environment, inhibiting further blister growth. Continued monitoring is suggested at 12-month intervals until remedial action is deemed to be necessary.

If the blisters are widely scattered but the total blistered area is small, it may be acceptable to defer maintenance until a follow-up inspection, perhaps within 6 months.

In either case, if there is little blister growth between inspections, maintenance can be deferred. If there is evidence of blister growth, especially with
scattered blisters, maintenance painting at the next opportunity is warranted. More than likely, complete recoating will be necessary. The initial inspection should include detailed photographs and notes of the blistered areas. Rankings can be assigned in accordance with ASTM D714, Standard Test Method for Evaluating Degree of Blistering of Paints, for each blistered area.

If there are ruptured blisters and corrosion, immediate maintenance is suggested. The degree of maintenance should follow the blistering patterns. If the ruptured blistering/corrosion is localised, only such areas need maintenance. If the ruptured blistering/corrosion is widespread, the entire surface needs maintenance. In addition, a new specification or quality assurance process is warranted.

Each analysis must also address the consequences of failure. In a potable water storage tank, some blistering and substrate corrosion is common. The existence of some blisters is not a major reason for concern. However, if a process stream is utilising high-purity, distilled water, iron contamination from ruptured blisters may have significant consequences in other parts of the plant. In such cases, a more conservative approach is suggested.

Breaking blisters to examine the substrate is problematic. Some may suggest that blisters be broken and the blister liquid examined. If the liquid is alkaline, little steel corrosion is expected. While this may be true, there are also examples where little underfilm corrosion occurs and the substrate liquid is neutral pH. In aqueous environments, substrate corrosion is more controlled by ionic permeability than by the pH of the blister liquid. Permeability measurements would be of more value than destructive inspection of the blisters.

During destructive blister inspections, one must remain objective about the findings. It is likely that some minor, localised corrosion will be found under a blister. This corrosion will typically be a thin spot of black iron oxide surrounded by bright steel. In most cases with blistered but non-ruptured barrier coatings, such findings are not a large concern because corrosion is not propagating. Interestingly, with some high-hardness coatings, one will find similar under-coating corrosion without blistering. This shows that blistering does not indicate more substrate corrosion than the absence of blistering. Blistering is simply the response of a coating to local

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Disbonding and the influence of osmotic or internal coating stresses.

The single biggest advantage to a destructive examination is failure analysis. The presence of local contaminants (e.g., salts, solvents) within the blister may reflect on the application process. In such cases, analysis of the blister liquid may provide some insight to the likely spread of blistering throughout the rest of the coating. If the likely cause of the initial blistering is common to the rest of the coating, significant rework may be warranted.

In all cases, any destructive inspection should be repaired before placing the tank back into service.

**Answer**

**Curtis Peacock**  
**Dixon Engineering, Inc.**  
**Lake Odessa, MI, U.S.:**  

A thin-film epoxy polyamide system is generally applied as a lining in potable water storage tanks for immersion service. In my experience, there are three main causes for blistering of a lining in the wet interior of a water storage tank: oil contamination, effect of soluble salts, and improper cure.

Oil contamination that has resulted in blistering could come from machinery, oil in the air from the blasting process, or oil left on the substrate or preceding coats from workers’ hands. If the oil is not removed from surfaces to be coated, blistering or flaking of the coating applied over contaminated areas may result.

Soluble salts such as chlorides or sulphates promote blistering when present on any surface under a coating. This osmotic blistering results in pressure overloading of the coating applied over the soluble salts.

Blistering resulting from recoating an inadequately cured coating is generally a result of solvent entrapment.

ASTM D714, Standard Test Method for Evaluating Degree of Blistering of Paints, can be used to rate the
size and frequency of blisters and to measure them. The blisters should be broken, and the substrate, if exposed, should be examined for corrosion and pitting. If the prime coat is found to be intact after the blisters are broken, the film thickness of the prime coat should be measured to determine if sufficient film build remains to provide continued protection of the steel substrate. If the examined blister exposes the steel substrate, the potential for active corrosion exists. Only by breaking the blisters and examining the exposed surface can a cause and recommendation for repair be determined. Once the cause of blistering is determined, similar pitfalls can be avoided through inspection procedures if the tank is determined to require repainting.

This evaluation system and the budgetary constraints of the client can be used to determine whether total repainting is required or installation of a cathodic protection system to protect the exposed surfaces is sufficient. However, in all instances, the substrate should be examined after the blisters have been broken (only enough should be broken to determine the cause). Only by this examination can the cause and effect of blistering be determined and remedies be recommended.

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