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Anti-Corrosion Coatings For Bolts and DTI's

Bolts and DTI's are used in bridges, refineries, roller coasters, towers, and such structures; in the polluted big city areas of the eastern US and in seacoast situations. In these locations good quality anti-corrosion coatings are mandatory. Inorganic and organic zinc based paints with specific types of sophisticated topcoats are used to protect the steel substrate, and you can't put plain old uncoated bare steel bolts in the connections that hold these structures together.

Because we're bolting specialists, even though not corrosion experts, Applied Bolting Technology gets questions about what coatings to use on bolts and DTI's. Here's how we answered some of them, with advice from others. We though readers of Link might appreciate a synopsis.

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Subject - Expected Relative Corrosion Resistance of Hot Dipped vs. Mechanically Galvanized Bolting Hardware

Question: You only offer mechanically galvanized DTI's, and we have installed your DTI's on bolts which have been mechanically galvanized (MG) to ASTM B695 C1 *50* on a water treatment plant. The specifications, however, called for hot dipped galvanized (HDG) bolts and DTI's to ASTM Al53 Class C."

"Will the corrosion life of the bolts be adversely affected by the substitution of mechanically galvanized bolts and DTI's for hot dipped galvanized hardware?"

Answer: No. When coated, the MG hardware might even be superior. Given that the coating thickness of the MG and HDG zinc substrate is equivalent in these specifications, both systems should demonstrate a similar corrosion resistance. The corrosion tests comparing the two types of zinc coatings on bolt show that, in a specific type of accelerated corrosion test[1], **MG OUTPERFORMED HDG ZINC** by a wide margin to **first red rust.**

Background: Until very recently we have only made mechanically galvanized DTI's. It's been some time since hot dipped zinc has been attempted on DTI's, and is currently not offered. Mechanical zinc is superior to hot dipped zinc at least when topcoated, so it is not worthwhile to hot dip them. If a customer insisted that we supply hot dipped DTI's, we would oblige and try it, and of course only sell them if the load/gap properties were still predictable after hot dipping. Mechanically galvanized DTI's, however, will function correctly with hot dipped bolts provided the combination is proven on a Skidmore prior to installation. On the other hand, you must not mix HDG nuts, for example, with MG bolts, because of the possibility of encountering an uninstallable assembly

According to Thomas Cook, who is a chemist and professor at Black Hills University, MG zinc tends to be looser in nature than HDG zinc, and as a substrate for paint this may be advantageous. He further states that MG bolts tend to have more zinc on their shanks than do HDG bolts (that's good). Then he goes on to point out that HDG nuts are tapped after galvanizing so they can be assembled, and their uncoated ID can allow a corrosion cell to develop just ahead of the nut (that's bad). MG nuts are, on the other hand, tapped oversized before coating, and so will have some zinc on the ID.

According to Simon Boocock of the Steel Structures Painting Council, if the zinc thickness deposited is similar, then there should be reasonable agreement on corrosion life when topcoated.

Allan Stoneman of ILZRO (International lead-Zinc Research Organization) cautions that the “Rome Paper” published in 1988 compared HDG with equivalent thickness plated zinc (not MG zinc) and found plated zinc definitely inferior when exposed to severe industrial atmospheres.

Gordon Allison of McDermid, Inc., states categorically that an MG substrate cannot be inferior to HDG, and in most sulfur dioxide corrosion tests MG performs much better than HDG.

Subject - The DTI “Gap” As A Corrosion Crevice

Question: “This is 1996, and DTI’s have been used in coastal environments and in corrosion-prone refineries for more than 25 years. Is there any evidence that leaving a DTI gap of, for example, .005” maximum, poses any corrosion threat to the bolt when the structure has been painted?”

Answer: No, there is no evidence of this at all. In fact, there is considerable evidence to the contrary. The residual DTI gap, which was in evidence immediately after the bolt installation, is really “not there” after a short while. It gets filled up, or “bridged,” by the paint system, and facility owners report no difference in corrosion potential or maintenance requirements between a bolted connection with and without DTI’s.

Background: Intellectually, it is possible to conceive of a bolt corrosion problem that stems from the hypothetical situation where the DTI residual gap allows the products of corrosion to somehow pass through to the bolt shank. But think of all the structures constructed around tidal estuaries in England starting in the 1960s. Think of the thousands of bridges constructed in the coastal areas of the US like Oregon, California, South Carolina, Alaska, and around New York City (the George Washington Bridge, Goethals Bridge, etc.). *There has been no documented occurrence of any special corrosion situation that has been linked to the* presence *of the hundred million or so DTI’s installed in those structures.* Even uncoated weathering Type 3 bolts that are installed in combination with epoxy coated DTI’s have not shown any signs of distress due to corrosion from the apparent residual DTI gap.

Parenthetically, this author has had personal experience in the reconstruction of a 75-year-old, completely uncoated, riveted railroad bridge in suburban Toronto. The areas around the rivets, the rivets themselves, and the plies within the clamp of the rivet, all were seen to be sound, even though the steel angles through which the rivets passed were, after 75 years, substantially corroded away. By “substantially corroded away,” I mean that they practically weren’t there, except around the rivets. Clearly, the rivets provided some low level of clamping force all those years, and kept the products of corrosion from entering between the plies, just like a correctly tensioned bolt will do. And it’s DTI’s that best assure the correct clamping force which will keep the connection plies together.

Subject - Better Corrosion Protection Than Zinc

Question: “If corrosion is a serious problem, what coating(s) are commercially and economically available for bolts and DTI’s that provide superior performance to that of zinc, and that will not complicate the nut/bolt thread fit and the torque resistance of the assembly during tightening? And, as a corollary, is there a coating that is suitable for A490 bolts and DTI’s since zinc is not allowed?”

Answer: There is at least one, but they all go under the general name of bi-metallic coatings. There are a number of them around, but the most visible is Dacromet, which is a combination zinc and aluminum coating of thickness about a half mil or less. Dacromet can be applied to both A325 and A490 bolts and DTI’s, will provide from two to five times the corrosion resistance of MG, costs about the same, and can be topcoated by any means or by Dacromet’s special line of coatings for even better corrosion resistance. In our opinion, if you can coat your bolts, nuts, washers, and DTI’s with something that gets about five times the corrosion resistance of zinc, at the same costs, it’s a no-brainer. Go for it.

Coating A490 bolts with Dacromet is a real advantage to engineers faced, for example, with renovating bridge connections for increased capacity, such as to the new seismic codes. These engineers want to use A490 bolts as a substitution for the same diameter A325 bolts. Their alternative is to put larger diameter A325 bolts into the connection, which necessitates drilling out the holes, refitting new plates if that results in bolt spacing problems, etc., all of which is very costly. Galvanized A490 bolts and their nuts are currently prohibited, so a Dacromet coated A490 is a natural. O

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1 Pittsburgh Testing Laboratory, Tests for 3M Company, Salt Spray, 1978 (Holford)
Twin City Testing, Tests for 3M Company, Salt Spray, 1982 (Holford)