Seeking an Optimum Coating System for New Welded Steel Tanks

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The purpose of this article is to stimulate thinking about the development of a standardized system or systems for the coating of new, welded steel, water storage tanks. One possible standard will be presented, with the hope that it will generate a response from the industry for the development of a system or systems that will better serve the steel tank fabricator and user.

The development of a standardized coating system has been thwarted thus far by

- the differing shop fabrication and cleaning capabilities of the tank fabricators;
- the desire of each coating supplier to gain an advantage on the competition by introducing new alternatives in brand-name coatings instead of promoting generic types;
- the failure of the engineering education system to address the prevention of corrosion and the design of coating systems, leaving the specifying engineer at the mercy of the coating suppliers and the fabricators;
- the trend of the specifying (usually consulting) engineer to utilize the coating supplier's canned specification instead of specifying a coating system that will best fit the needs of the tank user;
- the failure of the welded steel tank designer and fabricator to recognize the need for design details that will improve the coating system life and the long-term corrosion protection of the structure; and
- the shortcomings of the American Water Works Association (AWWA) Standards for Welded Steel Tanks and the AWWA Standard for Painting Steel Water Storage Tanks. These shortcomings are primarily due to the need for consensus prior to adoption, and the long adoption period, together with the need for the standard to accommodate many operating environments and application conditions.

WHY NOW?

The steel tank industry is presently faced with increasing complaints, legislation, regulation, and litigation concerning the abrasive blast cleaning of exterior surfaces in congested (and sometimes non-congested) areas and the releasing of particulate matter into the atmosphere. The release of volatile organic compounds (VOC's) into the atmosphere has also become a concern to the environmental agencies of local, state, and federal governments. These are of concern both on new construction and on the maintenance of older structures.

In addition, the marketing efforts of competitive storage media (concrete, fiberglass, bag-lined metals, shop-coated bolted tanks) have brought the welded steel tank marketers to an awareness of the need to address corrosion in the design, fabrication, and construction of the welded steel tank.

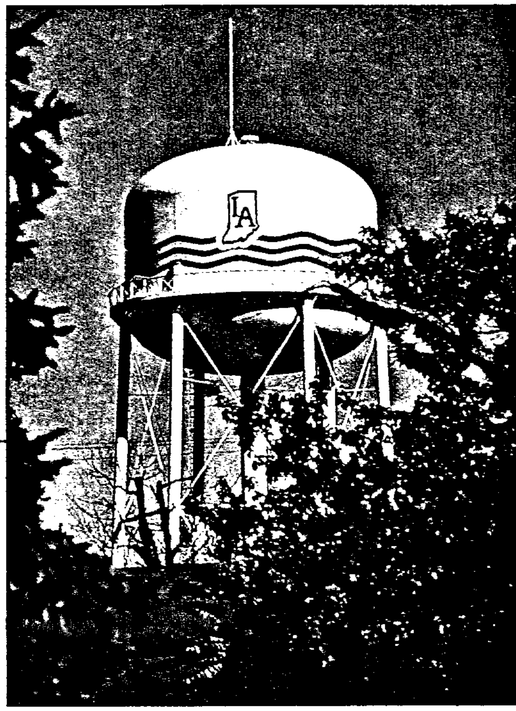
Other factors should also help to establish the standard coating systems. The entrance of the National Sanitation Foundation (NSF) into the scene in their role as a testing and approving agency for direct and indirect water additives may make the standardization of interior coatings a more viable option, and perhaps an economic necessity.

Also, the industry now has enough experience with "high tech" coatings to develop standards for their use without the jeopardy of recommending unproven materials and procedures.

The AWWA D102 painting standard has been difficult to develop and revise. The last revision took 14 years (from 1964 to 1978). It is now 1987 and we do not have a new one. It is not the fault of the task force chairmen — they are given the tremendous responsibility of coping with the pressures of coating manufacturers, tank constructors, and the consensus requirements, to produce a standard that will be technically and economically feasible for an extended period of time.

WHAT SHOULD "THE SYSTEM" ACCOMPLISH?

When in search of a panacea, one usually receives a response that what is a "cure" for one



Manager Keith Bossung received a community involvement award for the innovative repainting of the Investor Utility-owned elevated tank in Seymour, IN.

person's (or firm's) illness may well be poison to his neighbor (or competitor). Therefore, one should start with a set of objectives that will be compatible with the needs of the tank fabricators and constructors, engineers and designers, and the ultimate end-users of the tanks.

For the sake of this article, a "system" shall refer to a concept of coating the interior and exterior of a tank. The general objectives of such a system are listed below.

- Reduce initial cost.
- Provide a coating life of 20 years minimum, hopefully meeting or exceeding the life of the "factory-applied coatings" on modular construction tanks and directly confronting the claims of high maintenance for steel tanks and "no maintenance" for tanks constructed of the non-homogeneous structural materials such as concrete and fiberglass.
- Eliminate or minimize the need for on-site exterior abrasive blast cleaning.
- Minimize release of VOC's or other harmful materials into the atmosphere.
- Provide a coating system that will be easily maintained by touch-up and maintenance topcoating, thus eliminating the need for abrasive blasting to bare steel until several topcoatings have occurred.
- Eliminate unsealed or uncoated interfaces of steel surfaces.
- Meet the anticipated NSF standards and the Environmental Protection Agency regulations.
- Describe the system in generic or performance terms so as not to preclude qualified manufacturers of coatings, yet uphold the standards of quality and performance that are necessary in such a recommendation or standard.
- Provide enough flexibility to adequately protect the tank exposed to a severe environment, yet not economically penalize the purchaser of a tank subject to milder exposures.
- Utilize only a few generic types of coatings, thus simplifying the purchasing and application of coating materials (minimizing material inventories and the training of the applicators).

In order to complicate things as little as possible, let's consider a coating system for a rafter-supported low pitch cone roof ground storage tank. This system will also be applicable for standpipes and single pedestal elevated tanks. Tower-supported tanks may be a more difficult task.

EXTERIOR COATINGS

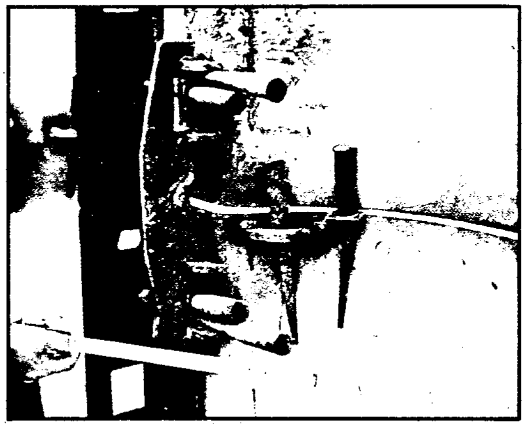
One of the primary needs of the exterior coating system is that abrasive blast cleaning in the field be minimized or eliminated. The obvious way for this to occur is for the cleaning and prime coating of the exterior surfaces to be performed prior to the arrival of the steel to the job site.

The second requirement is that the primer should have resistance to abrasion, and be self-healing when subjected to small abrasions and scratching.

The third requirement is a recoat window varying from a few days to as many as 400 days. This will also require a coating resistant to ultraviolet light, moisture, oil, soil, and salts.

The fourth requirement is compatibility with more than one spot touch-up primer and topcoat. In this way, the touch-up primer may be tailored to the environment (during application and in-use exposure), and the finish coat may likewise be varied by initial design or may be changed during construction without removing the primer.

The fifth requirement is a high resistance to corrosion under a variety of conditions. It would be desirable for the standard primer to perform successfully in the most severe environ-



Left: Erection fit-up equipment must be removed from the steel. Right: Removal causes burrs and gouges which must be repaired.

mental exposure, yet not be prohibitively expensive. Initially, one may presume this to be impossible; but when one considers that the relatively expensive, highly corrosion-resistant primer should suffer less extensive damage during the delivery, handling, and erection operations, the savings in field cleaning and priming of abraded areas will offset a large portion of the more expensive priming cost.

Zinc-Rich Coatings Are Possible Candidates

A possible solution is a zinc coating, perhaps an inorganic zinc or a three-component zinc-epoxy, applied in a quality manner in environmentally controlled conditions. Proper curing before stacking, loading, shipping, and unloading techniques, and care during the erection process will be required. Proper welding contours and surface quality will be required to be incorporated into the AWWA standard or the project specifications. All this needs to be accompanied by the concept of total product responsibility to ensure that all workmen (design, fabrication, shipping, loading and unloading, erection and welding) are aware of the need for the care they will have to exercise.

Field Surface Preparation and Priming

The key to an economically and environmentally acceptable exterior coating system will be eliminating or minimizing all exterior abrasive blast cleaning, even the spot abrasive blast cleaning of welded seams and abraded areas.

A possible solution is that after the erection crew has removed the weld slag, examined the welds, and ground rough welds and burrs, they would then clean the area around the welds, fitting scars, and scaffold bracket clip attachments using a profile producing nonwoven abrasive disk. This can be done only if the welds are of proper contour, with no undercut or overlap. When the coating crew arrives, they would clean all exterior surfaces with a moderate pressure (approximately 3000 psi) water blast with an inhibitor. This would remove rust, dirt, mud, salts, oil, grease, and weld flux from all primed or unprimed surfaces; inhibit corrosion until the primer could be applied; and not leave a residue that would harm the spot painting or topcoating of the steel.

Spot Priming

Before the areas requiring primer corrode or are recontaminated, they should be primed. It is likely that the areas will not be free of slight rusting; therefore, the application of a highly preparation-sensitive spot coating such as the original zinc primer may not be feasible. In that case, if the tank is not located in a severe environment, possible candidates include an epoxy-mastic or an organic zinc-rich primer compatible with the shop-applied primer. Severe environments might require the abrasive blast cleaning of the abraded and welded areas and the application of the same preparation-sensitive primer (such as inorganic zinc) as applied to the steel in the shop. In non-severe environments, exposed steel might be topcoated without priming, for some topcoats are now touted as having that capability.

Topcoating

The next coat (which may be an intermediate or a finish coat) should be applied before the contamination of the previously pressure washed and inhibited surfaces. The primer selected should be one that can be topcoated with a variety of materials. An alternate finish coat(s) might become necessary if the scheduling of the construction and subsequent painting is revised, resulting in different application conditions than originally planned.

Polyurethanes are among the highest performing finish materials available today, with the aliphatic polyester varieties apparently having the best combination of life, color and gloss retention, and graffiti- and abrasion-resistance. The variations in polyurethanes offer a wide range of possibilities. The most important characteristic of the exterior intermediate and/or finish coat would be the ability to be applied by a variety of methods under a wide range of temperatures (atmospheric, steel, and coating material) and humidities. Presently, this may preclude the use of the most popular aliphatic polyester two-component materials.

Higher structures in congested areas may necessitate the use of sprayable materials with dry-fall characteristics, such as vinyls, to minimize damage to surrounding property.

INTERIOR COATINGS

Interior systems should have the same characteristics as those for the exterior — long life, abrasion resistance, a wide recoat window, and resistance to ultraviolet light (in the case of an open tank), oil, dirt, and other contaminants. Ideally, the internal primer should be the same as the exterior primer. This would allow the fabricator to order or stock only one item of primer material. If the NSF determines that zinc primers are acceptable, then they become an option, greatly simplifying the selection of primers.

A difference in requirements between interior and exterior primers appears to be the need for abrasive blast cleaning in the field. Present coating technology appears to preclude any other alternative to field cleaning of steel for potable water immersion service. This poses less of a problem than on the exterior, as the blasting residue is more easily contained. In fact, abrasive blast cleaning in the field of the submerged areas may still be the best alternative on new construction, although it is more costly than properly performed shop cleaning and priming.

The surfaces that frequently present the greatest corrosion problems are those on the underside of the roof and its supports. These areas are usually complicated by the presence of unwelded lapped seams and unpainted rafter-to-roof plate interfaces. So-called self-supporting roofs frequently have intermittently welded angle stiffeners. Because of the impossibility of coating the unwelded areas, these intersections may suffer rust staining, and in some cases have shown significant steel loss at this interface. The more serious problem, however, in the columnless self-supporting roofs and the column- and rafter-supported roofs has consistently been the structurally detrimental corrosion of the channel or I-beam rafters or of the angle stiffeners or supports. The tops of the horizontal legs or flanges are very difficult to clean and coat in the field.

The most viable alternative to date has been to clean and coat the rafters and undersides of the roof plates with the complete interior paint system or with all but the finish coat prior to erection of the roof. If zinc primers are allowed in the container zones, then that primer alone should suffice. Welded and abraded areas are then spot-cleaned and coated. If angle stiffeners are welded to roof plates or self-supporting roofs, they should be welded continuously. The lower leg of the angle should be sufficiently far from the steel plate to allow the proper cleaning and coating of the angle and the plate. Many times the angle will not be required if slightly thicker plates are used or if the plates on a dome roof are dished prior to erection.

If zinc-rich primers are not allowed on the interior, the abrasion resistance required for good shipping and construction durability would probably dictate the use of a high build polyamide epoxy system. This system also seems most likely to comply with the proposed VOC regulations. However, high build epoxy is not the ideal answer, for it has a narrow recoat window. Some AWWA epoxy systems have a *very* short manufacturer's recommended recoat window. The concept of complete coating of the roof prior to erection and the complete field blasting and coating of the submerged areas does, however, minimize this problem.

RESPONSE SOUGHT

This writer hopes that readers will find what has been presented in this paper *controversial* enough or *acceptable* enough to generate a response that can achieve a meeting of the minds. Readers are encouraged to write to the Editor or to the author directly at P. O. Box 24359, Speedway, IN 46224. ■

Problem Solving Forum

THIS MONTH'S QUESTION

How does one recoat the interior of a potable water tank which has an existing grease coating?

—submitted by Tom Lambert
Tom Lambert Painting Company

From E. Crone Knoy of
Tank Industry Consultants, Inc.,
Speedway, IN:

From the first day I was employed in the tank business on August 22, 1960, I have heard of "wax-grease" coatings for the interior of potable water storage tanks. I'll have to admit, the thought of drinking water that had been contained in a tank coated with grease was a bit repulsive, but wax-grease was easy to apply, required minimal surface preparation, and had been in use since at least 1918.

In 1960, the alternatives were red lead paints, zinc-dust/zinc-oxides, coal tar derivative coatings, and asphaltic type (petroleum-based) coatings. Although short-lived in the market place, the World War II-born phenolic or "bakelite" coatings were of some prominence. Just coming over the horizon were the vinyl and epoxy coatings as we know them today. The vinyl and epoxy coatings were considered to be exotic as their life was unproven, and it actually took abrasive blast cleaning (then called sandblasting) to properly clean the steel before the tanks were coated. The epoxy coatings even came in two buckets, and they wouldn't work until you mixed them together a certain way. And, boy, if you took too long a lunch hour, you might come back to find not only a bucket of rubber, but all your paint hoses and guns would be filled with solid epoxy.

Deep groove pitting in a six-year-old tank coated with wax-grease.

That didn't happen with good old wax-grease. "Just open up the bucket and dab it on." It stuck to anything, especially your shoes, work clothes, and skin. It required no exotic application equipment and no training of the workers.

There are several *myths* concerning the wax-grease type coatings which were developed prior to 1918.

- Wax type coatings are included in the current American Water Works Association (AWWA) D102-78 Standards. (They are reprinted in the "Foreword" as a means of reference only.)
- Wax type coatings form a protective barrier between the water and the steel.
- Wax coatings are economical.
- Wax coatings cannot be successfully removed to properly apply other coatings.

The biggest myth about the wax-grease coatings is that they cannot be effectively removed and new type coatings applied over the steel. Granted, there have been failures of the new coatings when applied over previously "greased" steel; but, there have been failures of coatings applied over all kinds of surfaces. When the proper cleaning and application methods are specified and enforced, and the proper coating specified and used, there have not been failures. One of the failures I have seen occurred when the owner specified an inorganic zinc coating to be applied over a tank interior that had not been degreased. To add insult to injury, only an SSPC-SP 6, commercial blast cleaning, had been specified.

The older, successful applications of epoxy were performed by scraping off the old grease coatings, solvent cleaning if needed, and then abrasive blast cleaning to SSPC-SP 10, near-white blast cleaning. A visual check and white cloth test would then be run and additional cleaning and blasting performed if necessary. The application of high build epoxy coatings followed. No other method of verifying grease removal was used, and successful applications were obtained on hundreds of tanks.

These previous recoating projects were also accomplished without the aid of the presently available biodegradable degreasing solution. A presently used method consists of applying a degreasing agent containing a peptizer. A peptizer changes a gel into a solution, holding it into colloidal suspension until it is washed off the surface. Agitation by a stiff brush helps, but usually the remaining solution is readily washed off by a moderate pressure (300 psi) washing. Proprietary food grade FDA-approved solutions are available.

Any grease or oil remaining on the surface can be found by observing the steel under black light. Although not visible under normal lighting, under black light oil or grease shows up a greenish yellow. After the abrasive cleaning of the surface is accomplished, the epoxy material is applied. Do not try to apply a vinyl coating or an inorganic zinc, as you will be headed for failure.

Crone Knoy's response was one of five that appeared in the December 1986 Problem Solving Forum.

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