By Tony Ippoliti

Waterborne Coatings

for Water and Wastewater Treatment Plants: Part 1

Most Americans view clean water as an investment in public health and the economic well being of our nation. As a result of this concern for water quality and the passage of the Clean Water Act, America's water and wastewater treatment plants are among the best in the world. Still, deteriorating infrastructure is a major national concern, and with the continued growth of suburban areas, plant expansion is continuing and new plants are needed.

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Much of the funding to update these facilities must come from local governments that are finding themselves in the difficult position of having to do more with less. As a result, many water and wastewater treatment facilities are focusing on operation efficiency. The title of a recent WEF conference was "Plant Operations: Maximizing the Performance of Small and Medium-Sized Wastewater Treatment Plants," and the keynote address focused on the importance of plant operations and maintenance. The service conditions in water and wastewater treatment plants cause facilities and equipment to be susceptible to degradation. The role of paints and coatings is to protect metal substrates from corrosion and concrete from chemical attack and deterioration. This is especially important given the current focus on operation and maintenance efficiency.

During the past 20 years, the processes performed in water and wastewater facilities have remained basically the same. They include collection/grit removal, flocculation/coagulation, clarification, purification, transmission and distribution. Today, plants are using these processes even more efficiently, meaning that far more gallons per day can be treated using these same processes.

Similarly, the protective coatings used in water and wastewater treatment facilities during the past 20 years remain basically the same. Epoxies and urethanes remain the workhorses and most common types used. However, VOC regulations have been the catalyst for changing the formulation of these coatings to reduce VOC emissions by moving from low volume solids to high volume solids. These regulations also have spurred advances in the formulation and usage of waterborne coatings. In recent years, there has been a tendency to over-specify solvent based epoxies and urethanes where other generic coatings will provide acceptable performance at reduced cost.

Coatings are being improved in ways that allow them to better accommodate construction schedules and to better meet maintenance painting needs. During the past 20 years, materials of construction also have changed in water and wastewater treatment facilities. There is greater use of concrete, non-ferrous metals and PVC/FRP. These materials have their own surface preparation needs and require coatings that will adhere to and protect these surfaces.

Benefits of Waterborne Coatings

New polymers allow today's waterborne epoxy and urethane coatings to be abrasion, chemical and moisture resistant at prices competitive to conventional coatings. Complementing these resins are additives that help the coatings overcome flash rusting, so they can be applied directly to bare steel. In addition, most waterborne coatings are tolerant of damp concrete surfaces. Due to their good adhesion, some waterborne coatings can be applied directly to hard-to-coat surfaces that previously required special primers. Two examples are acrylic coatings applied directly to galvanized surfaces and acrylics or waterborne epoxy coatings applied directly to PVC/FRP surfaces.

During the last several years, high performance cementitious waterborne block fillers have been developed. These block fillers provide a one-step application that will smooth the surface of concrete that has voids and "bugholes" and provide better sealing and impermeability to water while providing a suitable surface for subsequent coatings.

Much of the appeal of waterborne coatings is related to the application benefits they offer. These include low odor, enabling application without affecting other trades and allowing accelerated construction schedules. Waterborne coatings also have high flash points that can reduce fire hazards and can be cleaned up with soap and water, eliminating the high cost of disposal of organic solvents that are considered hazardous wastes. Unlike some difficult-to-apply solvent-borne coatings, waterborne industrial maintenance coatings can be applied easily by brush, roller or spray. Since they do not contain quantities of organic solvents that may lift, wrinkle or soften existing coatings, waterborne coatings may be applied directly to existing coatings without the fear of lifting or wrinkling the existing system.

New Technology

Waterborne resins based on new technologies continue to be introduced into the marketplace, permitting new coating choices with improved performance. One type allows cross-linking to take place within a single-component coating as it cures. Therefore, film integrity is improved, leading to increased chemical and corrosion resistance. Another type introduces an innovative hardener for a waterborne epoxy primer, allowing for colder temperature application, faster dry times for shop application, faster cure and increased chemical and corrosion resistance.

These advantages can result in significant benefits for the owners and operators of water and wastewater treatment facilities. With the exception of immersion (where waterborne coatings usually are not recommended), these coatings, once considered less effective than solvent-borne systems, are becoming desirable alternatives.

However, there are a few limitations to the usage of waterborne coatings. For example, waterborne coatings should not be applied to wet or sweating surfaces. In addition, temperature and relative humidity can affect waterborne coatings more than their solvent-borne equivalents. Unless specially formulated, they generally should not be applied below 50° F, above 90 percent relative humidity and not less than 5° above the dewpoint.

Dry times for waterborne coatings are more dependent on relative humidity than dry times for solvent-borne coating systems. In times of high humidity, curing and film formation of these coatings may be slowed because of the nature of water. There is no such thing as faster evaporating water or slower evaporating water. In moisture saturated atmospheric service (wherever surfaces are exposed to continuous high humidity and condensation during application), waterborne coatings are generally not recommended, even if the condensed moisture is removed from the surface prior to painting.

Very low temperature application of waterborne coatings also is not possible because of the freezing point of water. Ice or frost may form on surfaces to be coated and this may prevent film formation and adhesion. While some waterborne products may be applied at temperatures as low as 35° F, at this time waterborne coatings cannot be formulated for application at temperatures below 32° F.

Considerations in Specifying Coatings for Water and Wastewater Treatment Plants

While The Clean Water Act spawned a surge in the building and updating of water treatment plants, The Clean Air Act of 1970 was the impetus for enormous change in the paint and coatings industry. Due to amendments passed in 1990, a new proposed maximum VOC content level for architectural and industrial maintenance paints and coatings took effect in 1999. Waterborne coatings for industrial maintenance use comply with these federal rules for VOC compliance.

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In addition to applicable regulations, another consideration when specifying coatings for water and wastewater treatment facilities is the substrate to be coated and the exposure conditions.

Substrates:

Steel typically is used for pumps and piping, storage tanks and clarifier catwalks. Waterborne primers for steel should contain corrosion inhibitors that passivate the steel when applied to make them resistant to corrosion.

Concrete substrates in water and wastewater treatment plants typically are floors, walls and ceilings. Protective coatings for concrete must be resistant to its alkalinity. In addition, the first coating applied to concrete surfaces must be able to fill voids in concrete masonry units (CMU) and seal cast-in-place concrete to create an acceptable surface for topcoats. Cementitious waterborne acrylic or epoxy block fillers are

coatings to use on concrete surfaces. They offer impermeability and may be topcoated with a multitude of solvent-borne or waterborne protective coatings.

The use of non-ferrous metals such as aluminum is increasing. Handrails around clarifiers and basins commonly are made of this metal. Although not usually painted, coatings for aluminum must have good adhesion qualities. Waterborne wash primers are available that do not contain the acids found in traditional wash primers yet offer excellent adhesion properties.

Galvanized surfaces have been difficult to coat successfully. Solvent-borne alkyds required special primers so that saponification (which leads to peeling) would not occur while other types of topcoats over galvanized surfaces required wash primers for adhesion. Waterborne coatings can be applied directly to galvanized surfaces without the use of special primers.

Items made of PVC and FRP (fiberglass reinforced plastic) also are found in water and wastewater plants. PVC is primarily used for piping. FRP is commonly used to fabricate small storage tanks. When outside, these construction materials need protection from the sun's ultraviolet light to prevent deterioration and weakening. Waterborne coatings with good adhesion and UV resistance such as acrylics make a good choice for these substrates.

Exposures:

In a water or wastewater treatment plant exposure conditions vary. Interior ceilings may be clean and dry and never need recoating after initial painting. Walls in laboratories may be subjected only to an occasional splash. Exterior structures may be subjected to sunlight and rain. Floors may be subjected to abrasion, washdown, lubricants and oils in maintenance areas or treatment chemicals. Equipment such as dewatering devices may be wet in one area yet dry in another. Piping may be dry during one time of year while sweating profusely during another. Therefore, coating selection may be a challenge and should include the help of a knowledgeable coating representative with experience in the specification and application of waterborne coatings.

To assist a specifier or owner in choosing the protective coating system to use in a particular area of the plant, the Society of Protective Coating's (SSPC) Environmental Zones Painting Systems is another tool that may be used. Within the 12 Environmental Zones listed, from 0 (interior exposure) to 3E (severe chemical exposure), the reader will find a description and a coating system suitable for use in each area.

For example, one type of structure requiring protective coatings is the digester cover in a wastewater treatment plant. The SSPC lists this area as Environmental Zone 1B (Exteriors, normally dry) and suggests urethane coatings and acrylic coatings. Both of these types of industrial maintenance coatings are available with water as their solvent. As stated earlier, these coatings can be applied easily, and pose no solvent hazard. Waterborne primers are available for these topcoats, and they offer the durability and service life expected of these coating types. Digesters may have concrete bases and steel tops. A waterborne coating system may be used for both of these substrates.

Table 1: Waterborne Protective Coating System for Cl_2 and H_2S

Substrate	Primer	Intermediate	Finish
Concrete	WB Filler/Sealer	WB Epoxy	WB Epoxy
Steel	WB Rust Inhibitive or WB Zinc-Rich Primer	WB Epoxy	WB Epoxy
Drywall/FRP	Suitable Primer	WB Epoxy	WB Epoxy

Digester Coating System Example:

- **Exterior Steel Cover—**WB Rust Inhibitive or WB Zinc Rich Primer / WB Acrylic or WB Urethane Topcoat
- **Exterior Concrete Walls—**WB Cementitious Filler/WB Acrylic Topcoat

In concrete secondary containment or chemical storage areas, cementitious waterborne coatings can be used as block fillers or surfacers. Topcoats for these structures include waterborne epoxies or waterborne urethanes. Be sure that the system is resistant to the specific chemicals and the concentrations at which they are stored.

Waterborne coatings also provide the necessary protection against attack from chlorine gas and hydrogen sulfide (Table 1).

For water storage tank exteriors, one coating system offers the highest level of corrosion protection and durability available. It consists of a zinc-rich primer, an epoxy intermediate coat and a urethane topcoat. It is estimated that this protective coating system can offer more than 20 years of durability. (See NACE International Corrosion 98 Paper No. 509.) This same system is available using waterborne protective coatings and may be considered for use on these structures (Table 2).

Table 2: Waterborne Protective Coating System for Steel Water Storage Tanks

	Coating Type*	Surface Prep	AWWA Dft. Required	Accepted Dft. Range
Primer	WB Zinc-Rich Primer	SSPC-SP 6	2.0	3.0–4.0
Intermediate	WB Epoxy		2.0	3.0–6.0
Finish	WB Urethane		2.0	2.0–4.0

*Note: Complies with Outside Coating System Number 6 (OCS - 6) ANSI/AWWA D102-97 Standard for coating steel water storage tanks.

Part 2 of this article will appear in the February issue and will focus on new types of coatings as well as other advances in coating technology.

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