Electrocoating

Electrophoretic deposition (also known as electrocoating or e-coating) is a process by which electrically charged particles are deposited out of an aqueous solution and onto a conductive (metal) part or assembled product. During the electrocoat process, paint is applied to a metal part at a certain film thickness, which is regulated by the amount of voltage applied. The electrocoat solids initially deposit in the areas closest to the counter electrode and, as these areas become electrically insulated, solids are forced into more recessed bare metal areas to provide a complete and even coat.

Because of its ability to coat even the most complex parts and assembled products with specific performance requirements, electrocoating is used throughout the industry to coat a variety of products including: agricultural equipment, appliances, automobiles, automotive parts, marine components, transformers, metal office furniture, lawn and garden equipment and furniture, fasteners, trim appliances, fixtures and much more.

Finishers choose electrocoating to provide their products with a durable, lasting coating. And because e-coat can be used as a primer, topcoat or both, and with other types of coatings, the versatility is endless. Electrocoating offers numerous benefits including: cost savings, increased line productivity and environmental advantages. Due to the higher transfer efficiencies, precise film-build control and low manpower requirements, electrocoating offers significant cost savings. Environmental advantages include no- or low-VOCs (volatile organic compounds) or HAPs (hazardous air pollutants), heavy metal-free products, reduced exposure of workers to hazardous materials, reduced fire hazards and minimum waste discharge.

THE ELECTROCOAT PROCESS

Electrocoat paint (or electro-paint) is a colloidal dispersion of pigment and binder in water. Deionized water is a major component of an electrocoat bath, making up 80-90% of the bath.

Electrocoat products are referred to as either anodic or cathodic, indicative of where coating deposition takes place. The electrodeposition of an e-coat system is initiated by the electrolysis of water. The result of increasing hydrogen (H^+) and hydroxide (OH^-) ions concentration changes the pH value at the electrodes. This neutralizes the colloidally dispersed water-soluble paint particles, which then coagulate and precipitate as water-insoluble particles at the electrode surface, or substrate (Figure 1). The paint layer gets tightly packed and insulates the electrode. This insulation causes the electrolysis of water to stop and no more particles are precipitated, thus stopping the coating process.

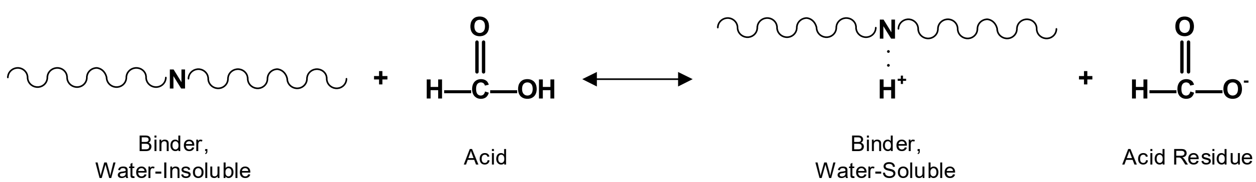

Figure 1. Cathodic neutralization.

Anodic e-coat involves the use of negatively charged paint particles that are deposited onto positively charged metal substrates. During the anodic process, small amounts of metal ions migrate into the paint film, which limit the performance properties of these systems. These ions become trapped in the depositing paint film, and, due to their ability to interact with moisture, limit the corrosion performance of these films. As most anodic systems are made of acrylic binders, they offer high UV resistance and excellent color and gloss control. The main use of anodic e-coat is for interior products or moderate exterior environments.

Cathodic e-coat, where positively charged paint particles are attracted to a negatively charged part, are high-performance coatings with excellent corrosion resistance. All automobiles, for example, have cathodic e-coat as the first paint layer. While epoxy e-coats are excellent corrosion primers, a topcoat is applied for products used in exterior environments for better weathering durability. Depending on the resin, cathodic e-coat can also be formulated for exterior durability. Epoxy/acrylic mixtures are often used on agricultural equipment for reasonable corrosion resistance with good weathering durability.

Ultrafiltration (UF) plays an important role in e-coat systems. In fact, all industrial e-coat lines have a UF system. The UF system improves the efficiency of electro-paint usage and minimizes its environmental impact as the amount of wastewater sent to drain is drastically reduced.

ULTRAFILTRATION IN ELECTROCOATING

Ultrafiltration is used in e-coat systems to separate out e-coat paint from water. Water passes through the membrane as UF permeate (also known as effluent). While the permeate is primarily made up of water, some elements of the electro-paint bath may also pass through the membrane including low-molecular-weight resin, solvents and dissolved salts.

After parts are dipped into the e-coat paint bath and electrocoated, they are rinsed to reclaim undeposited paint solids. The undeposited e-coat paint solids are sent to the ultrafiltration system where the permeate is used for rinsing and the rejected, undeposited paint solids are returned to the paint bath (Figure 2). This closed loop cycle ensures minimal wastewater is produced and may increase the efficiency of the e-coat paint process to more than 95%.

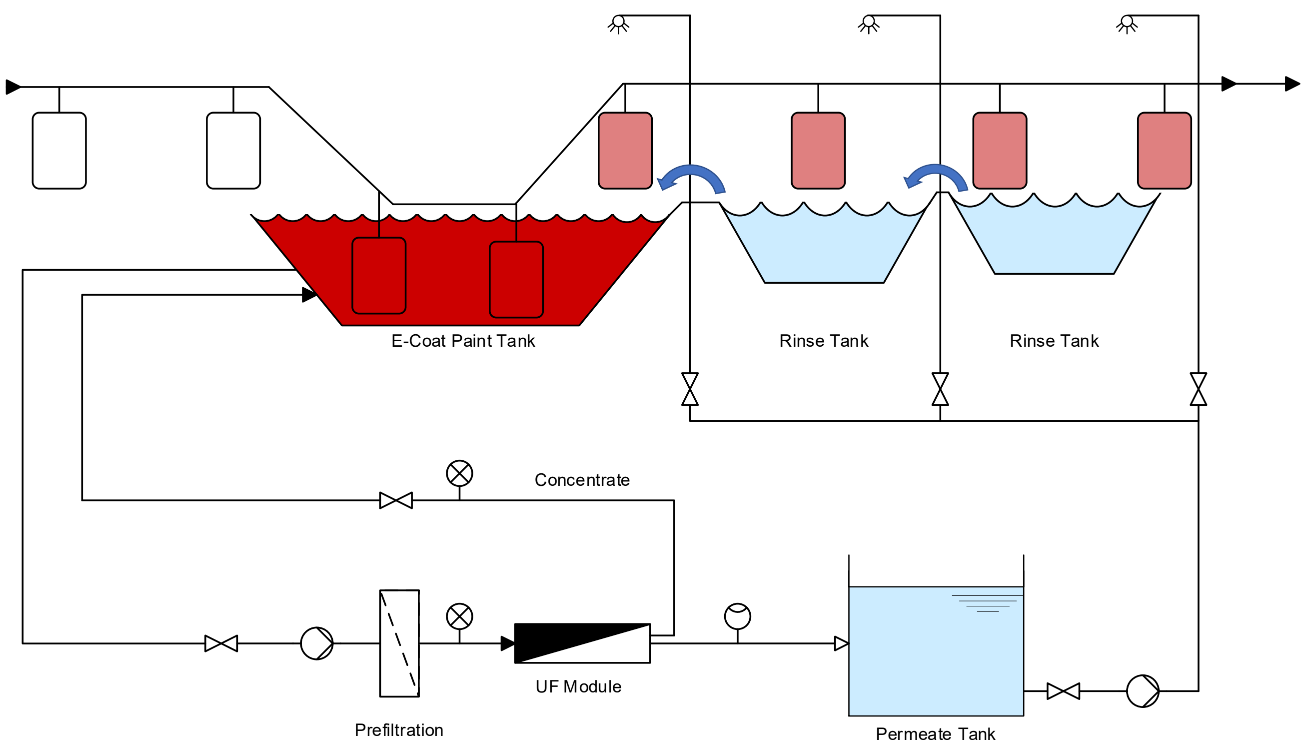

Figure 2. Diagram of a typical e-coat system.

The ultrafiltration system is also used to control the parameters of the paint bath itself. By putting some permeate to drain and replacing this volume with DI water, the amount of solvents, ions and low-molecular-weight resin may be reduced in the e-coat paint bath.

The surface area of the part being coated, and the geometry of the part determine the required volume of the rinsing fluid. The UF system should produce enough permeate flow to meet this volume demand. For optimized rinsing, a minimum 1.5-2.0 L (0.40-0.53 gal) permeate per m^2/h (10.8 ft^2/h) coated surface is recommended.

MICRODYN-NADIR offers net-wrap and fiberglass E-COAT elements specifically for electrocoating processes. NADIR® membranes have proven a high resistance towards solvents and temperature over a wide pH range, while also permanently maintaining their hydrophilic properties despite frequent cleaning during their operational lifetime.

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