Gearmotor Paint Coatings

A Focus on Electrodeposition Coating (E-Coat) in the Gearmotor Industry

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Introduction

The following white paper will explain the commonly used paint components and methods within the gearmotor industry, with a focus on Electrodeposition Coating (E-Coat). These processes will be described in general, with a closer examination of the E-Coat applications steps. Some pros and cons of each method will be presented along with comparative test results showing the benefits of E-Coat.

Explanation & Components of Paints

In the gearmotor industry, there are different paint options available from a myriad of manufacturers. Generally, most paints are made from three primary components: resins, solvents, and pigments. Their descriptions can be found in Table 1.

Table 1: Description of Paint Components

Component	Properties / Use	Examples
Resin	• Main component in clear coatings • Provides a translucent top-layer • Protects the paint and surface underneath	Synthetic resin, fats and oils
Solvent	• Component in sprayed paints ○ Excludes powder coating • Allow the pigments to disperse and adhere to the work piece	Esters, ketones, water, etc.
Pigment	• Gives the paint its color • Can give the paint special properties ○ i.e. chemical resistance, anti-corrosion, etc.	Color pigments, anticorrosive pigments, etc.

Common Application Methods of Paint in the Gearmotor Industry

There are multiple ways to apply these paints to the gearmotor. The three application methods discussed in this paper are: spraying, powder coating, and Electrodeposition Coating (E-Coat).

Spray painting is a method that is used across many industries. This application method involves a paint composed of solvents and pigments that is sprayed through a paint gun. This atomizes the paint into small particles and the spray is directed at the work piece. Once the paint is applied, the work pieces are left out to dry through natural convection (air drying). The thickness of the coating is not consistent and varies during each application, but a common thickness for spray paints would be around 20+ µm. It is best used when a company has a lot of work pieces that are all similar or the same in low quantities.

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Spray painting uses solvents which are usually VOCs (Volatile Organic Compounds) and dangerous to both the environment and human health. A way to rectify the problem of paint toxicity is to use a method of painting called electric painting. Both powder coating and E-Coat utilize the concept of electric painting to avoid using toxic solvents and ensure better paint adhesion to the work piece. An electric potential difference is applied between the paint and the work piece to attract the paint onto the substrate.

Powder coating is a method in which powdered paint is charged by a powered gun and applied to a grounded object using static electricity. After painting, the work piece is baked in a drying oven to form a hard-exterior coating. The thickness of the coating is not consistent and varies during each application, but a common thickness for powder coat paints would be around 50-90 μm. It is best used when a company has a moderate amount of work pieces, in moderate variety. This method does not involve any solvents, due to its use of an electric charge to adhere the paint, so it has minimal negative environmental and human impact.

E-Coat is a method in which a vat of paint is given a positive charge (cationic) and the work piece is given a negative charge (anionic). The work piece is then submerged in the paint, and the difference in charge causes the paint to attract to the piece. This ensures complete and even coverage with paint. This is one of the reasons why it is used extensively in the automotive industry. After painting, the work piece is baked in a drying oven for the paint to form a hard, electrically-insulated exterior. The thickness of the coating is the most consistent out of the three methods mentioned. A common thickness for E-Coat would be around 20-30 μm, uniformly distributed across the work surface. It is best used when a company has only a few different pieces to be painted, in large quantities. This method uses water as a solvent and since there are no VOC’s it has minimal negative environmental and human impact.

See Table 2 on the following page for a summary of the differences between the paint application methods mentioned above.

Table 2

Coating Method	Solvent	Drying Method	Coating Film Thickness (µm)	Use	Environmental Impact
Spray	Yes (VOC)	Convection, Baking	20+	High variety, low quantity	High
Powder	None	Baking	50~90	Intermediate variety and quantity	Minimal
E-Coat	Water	Baking	20~30 (Uniform)	Low variety, high quantity	Minimal

With this outlined, it is safe to say any of the three painting methods can be a viable option depending on the variety and quantity of gearmotors to be painted. Due to inconsistent coating thicknesses, certain coatings are more susceptible to problems such as paint coverage, uniform distribution, peeling, bubbling, cracking, etc. In the long run this may lead to issues with corrosion of the gearmotor case, contamination (in food processing applications), and a poor appearance. E-Coat is a simple process that can minimize the chances of these issues occurring because it ensures a uniform paint distribution across the surfaces it is applied to. These results can be achieved without E-coat by using powder coating, but it requires more effort, skill, and overall care to ensure a high-quality finish.

E-Coat Application Stages

There are not many steps in the E-Coat application process, making it simple to perform and replicate. A simplified diagram of the process can be found in Figure 1.

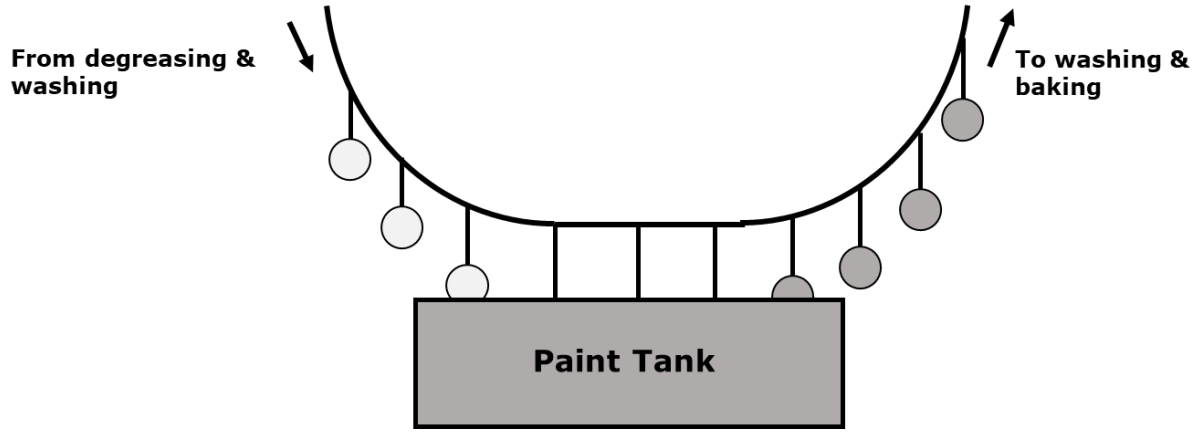


Figure 1: E-Coat Process

To prepare for painting, the workpiece is first washed in water. Then, the surface is degreased using an alkali-based degreaser and washed again. This applies to both iron and aluminum work pieces. If the work piece is made from a non-chrome type of aluminum alloy, a coating agent must be applied to the piece to chemically convert the surface to one that will accept the E-Coat paint. After, the pieces are given a negative electric charge, and immersed in a tank of positively charged paint; the paint is now adhered to the piece. The pieces are then washed again to remove and paint solids that may have adhered to the surface, to ensure a smooth finish. They then move to a drying oven, where the paint will harden. Lastly, the pieces must cool down, and the process will be complete.

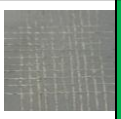
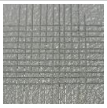
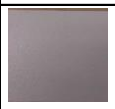
Potential Benefits and Comparative Testing Results

Depending on the quality of the application process the following benefits can be realized:

- Provide protection from impacts
- Resist paint wear from oil exposure
- Stay adhered regardless of humidity
- Won’t chip or peel under extreme temperature changes
- Won’t corrode when in contact with salt water
- Won’t corrode after washdowns with acidic or alkali solutions
- Ensure a uniform coating thickness
    - The flatness of the mounting surface is always uniform

Paint performance testing was conducted, and results that support these claims can be found in Table 3 on the next page.

Table 3: Test Results

Brother Gearmotor E-Coat vs. Comparable Paint Test Results*									
Test Items	**Brother E-Coat**	**Result**	**Brother Powder Coat**	**Result**	**Company 1 (Standard, powder coat)**	**Company 2 (Standard, powder coat)**	**Company 3 (Food)**	**Standard / Test Conditions**	
Adhesiveness	Pass		Pass		Fail	Fail	Fail	Cut the coating to the work surface using a single blade knife, grid pattern (100 squares, 1 mm x 1mm). Use tape with adhesion strength of 10 ± 1 N or more per 25 mm to peel the squares.	
Oil resistant (grease)	Pass		Pass		Pass	Fail	Pass	ISO 2409-1992	100 ° C x 240 hours
Moisture resistance (humidity)	Pass		Pass		Pass	Fail	Pass		50°C, RH98% or more, 240 hours
Boiling water resistance	Pass		Pass		Fail	Fail	Pass		95°C or more, 1 hour
Pencil hardness	Pass	4H	Pass	4H	Pass (2H)	Pass (H)	Fail (F)	ISO/DIS 15184	Determined film hardness using the pencil test
Salt-resistant spraying	Pass		Pass		Fail	Fail	Pass	5% NaCl, 35°C, 240 hours	
Acidic resistance	Pass		Pass		Pass	Pass	Pass	5% H^2SO^4, 48 hours	
Alkali resistance	Pass		Pass		Fail	Fail	Fail	5% NaOH, 48 hours	
Coating film thickness (µm)	15.8		90.2		77.63	97.2	368.8	Film thickness meter (µm)	

Sample size = 1, case material = aluminum

Conclusion

There are three primary methods used for painting gearmotors: spray painting, powder coating, and E-Coat. While all three can be used, the uniform paint coverage that E-coat provides allows it to potentially prevent many problems that may arise with inconsistent coating thicknesses. E-Coat paint has a lower environmental impact, is easy to scale, and provides a hardened, electrically insulated paint coating to protect gearmotors for their usage life.

Brother Gearmotors – Maximizing Performance and Increasing Efficiency

Brother Gearmotors offers E-Coat as a standard coating on almost all gearmotor products. They are permanently sealed for a high-quality finish that ensures consistently tough, water-tight, chemically-resistant units that withstand harsh conditions.

Brother Gearmotors offers a family of gearmotors that increase operational efficiencies and reduce maintenance needs and downtime for long-term energy savings. In addition to being highly efficient, Brother's hypoid/helical gearmotors are compact in size and sealed for life. They are light, reliable, and offer high torque at low speed unlike their worm counterparts. These gearmotors also have multiple standard specifications, options, and mounting positions to ensure compatibility. All Brother Gearmotors products are backed by an industry-best five-year limited warranty.