GECC-1 is a coating used for corrosion prevention on steel and stainless steel turbine components. Composed of an aluminum base coat and a ceramic top coat, the coating provides a galvanically sacrificial layer to protect the substrate from corrosive environments.

GECC-1 has been in use for over 30 years and has a robust operating history. The chemistry and process control elements of the GECC-1 coating are discussed, as well as visual appearance and surface finish characteristics of this class of protective anti-corrosion coatings.
Mechanism of Corrosion Prevention

Both classes of GECC-1 provide sacrificial (cathodic) protection of underlying ferrous base metal. Steel and aluminum have different electrode potentials. When in contact with one another in the presence of a corrosive electrolyte such as salt water, the aluminum will be preferentially attacked due to its higher potential, even when the steel is exposed directly to the corrosive environment. The aluminum base coat in GECC-1 is burnished and compacted to ensure it is electrically conductive and galvanically sacrificial. Burnishing is critical to assure there is an electrically conductive path between the aluminum coating and the steel substrate so preferential galvanic corrosion occurs in the protective coating, rather than the part.

Process Control Elements

The GE process specification for GECC-1 has five main controlling CTQ (Critical To Quality) measurements that are taken during the coating application process to help ensure the performance and effectiveness of the coating for corrosion protection:

- Base coat burnishing for densification
- Base coat conductivity check to ensure effective burnishing
- Total coating thickness (base coat + top coat)
- Water swell test to confirm coating layers were properly cured
- ASTM B117 salt fog (during qualification phase at new vendors)

In addition, the specification outlines acceptable surface features and limits to that acceptance. Allowances in process specification are as follows:

- Fish eyes
- Pimples
- Dimples

The specific surface features above are acceptable provided they do not exceed a size threshold and do not exceed an average occurrence per unit area defined in the specification. Touch-ups on GECC-1 coated blades are also permitted by GE to correct these imperfections and do not affect the performance of the coating.

Physical Characteristics

Color Variation

The GECC-1 coating has a distinct blue appearance which is imparted by an oxide pigment with the same chromate/phosphate binder utilized in the aluminum-ceramic base coat. This blue color variation does not affect the protective properties of the coating.

Surface Condition and Surface Finish

The primary application for GECC-1 coating is corrosion protection of forward compressor blades. The coating process, like other spray and cure galvanic sacrificial coatings, entails a grit blast preparation step to remove surface oxides and to roughen the surface for mechanical adhesion of the coating to the blade surface. This step will increase the airflow roughness to a certain extent. The base coating application is next and based on the loosely packed aluminum particles present also leads to some roughness. The top coat sealer which is used to passivate and make the overall coating system more protective does smooth the final coating slightly. In general, a coated blade finish is 20–30 Ra more rough than a GE super-finish airfoil.

The GECC-1 coating process will typically produce a surface finish in the 30–60 Ra range, depending on a host of factors from uncured surface finish, to blade geometry, to local vs. spatially averaged measurements. Blades that are super-finished would see an increase in surface roughness due to the grit blast surface preparation and coating application. GECC-1 should be considered to have limited surface finish debit on blades that are not super-finished. Over its lifetime, GECC-1 coating tends to maintain its surface finish—compared to a surface that may over time become rough from surface corrosion and pitting.

Summary

Our GECC-1 coating has been in use for over 30 years, providing sacrificial corrosion protection on compressor airfoils and rotor components. This two-part coating consists of an aluminum base coat and a ceramic top coat that work in tandem to provide robust corrosion protection. GECC-1 has a specification to ensure that the performance and corrosion protection of the coating are maintained. Allowances are made for certain characteristics and features—including color and surface imperfections. As such, some variation in the finished product is expected, both with respect to color and surface finish. These variations do not affect the protective properties of the coating.

As a leader in materials science, GE seeks new and innovative ways to address the challenges our customers face—to GECC-1 was created firmly in that spirit, and 30 years on, it continues to fill a niche in the protection of heavy duty gas turbine compressor components.
Imagination at work