Specialty Motors for Corrosive Environments

In the motion control industry, hostile environments often require specially-designed motors to combat corrosion, and a small company in Rohnert Park, California has built an entire business around this industry need.

Empire Magnetics, Inc., a manufacturer of stepping motors for the motion control industry, is using stainless steel alloys with varying nickel chromium content to manufacture models that will be used underwater and in other environments where ordinary motors are unsuitable.

The company is using alloys ranging from 303 stainless for ordinary submerged applications, to 316 stainless for exposure to caustic or marine environments.

In a recent application, engineers at Arnold Air Force Base were were assigned to identify and qualify motors suitable for use in a vacuum chamber at cryogenic temperatures. The specification called for small motors operating in a vacuum of 10^{-7} Torr at liquid hydrogen temperatures (24^{o} Kelvin). Angular position feedback was a requirement to accommodate closed loop velocity and position controls.

Two major design problems are inherent in this type of application. The first involves the vaporization of lubrication and insulation materials at low pressure. The second problem has to do with the behavior of materials at very low temperatures. The stress of large temperature changes, low temperature brittleness, and varying contraction rates of dissimilar materials work to degrade the structural integrity of motors manufactured from conventional materials.

Empire Magnetics, among other suppliers, contracted to provide a motor for evaluation. A 57 mm diameter step motor was combined with a feedback resolver to meet the unique requirements of the application. Both devices were housed in an exotic nickel

chromium steel alloy frame, selected for thermal stress resistance and dimensional stability. Resolver technology was selected for the feedback system due to the similarity of resolver components with those of the motor.

When used with readily-available motion control electronics, this package would provide shaft positioning resolution of 25,000 increments per revolution of the motor shaft with a feedback resolution of up to 16,384 increments per revolution.

To reduce outgassing at low temperature, insulation materials were made of selected polymers. Magnet and lead wire materials were carefully specified to avoid outgassing or fracture. Bonding agents normally used to build the motors were replaced with adhesives having a low coefficient of thermal expansion.

Each of the metal components of the motor was examined in detail. AlNiCo (Aluminum Nickel Cobalt) magnets were selected in favor of rare earth combinations, since AlNiCo retains magnetic properties better at low temperatures. Stainless steel ball bearings, lubricated with dry film, were used for the same reason. All machined metal parts were stress-relieved.

Sixteen different motors were submitted for testing by multiple vendors. The motor submitted by Empire Magnetics was one of only two operable devices. Finally, the successful functioning of the resolver made Empire Magnetics' stainless steel unit the only complete assembly to operate as required by the original specification.

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This article is written and provided by Rick Halstead, President of Empire Magnetics, Inc. Empire Magnetics provides quality motor products designed to perform in

environments and applications where ordinary motors are unsuitable. For more information about Empire Magnetics, please visit their website at www.empiremagnetics.com.