Motor Selection for Deep Sea Applications

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Like few other hostile environments for industrial components, the deep sea is a forbidding place in which to launch a motion control application. Very cold temperatures, the corrosive effects of sea water and extremely high pressures (as much as 5,000 p.s.i. at 11,600 feet below the surface) combine to create an environment in which off-the-shelf components will quickly fail.

Consider: in order to select a motor for deep sea operation, you must prevent water entry to the motor, assure that motor materials are resistant to corrosion, make allowances for material shrinkage (O-rings and other elastomeric materials compress in the depths), prevent water entry into electrical cables, account for power losses that occur over the 1,000+ ft. umbilical cable from the ship, and choose a filling oil whose thermal properties assure it is still a liquid at high pressures and low temperatures.

Three current deep sea applications by Empire Magnetics make clear some of the problems and solutions in using motors undersea:

* The Bedford Institute in Newfoundland, Canada is using waterproof stepper motors for research it is conducting in the Hudson River. The motors are required to operate at depths of 450 feet in very cold water, and are powered from aboard ship by means of an umbilical cable.

Empire supplied a size 42 frame stepper motor with a stainless steel exterior, featuring an oil-filled motor and a piston pressure-compensated assembly. First specifying a depth of 200 feet, the initial motor design was used successfully at that depth. Now, the application requires operation at depths up to 450 feet, and the motor has been re-worked to meet their needs. The Bedford Institute tests its equipment in a pressure vessel that can be used to test items at up to 5,000 p.s.i. While the previous model operated up to 1,000 p.s.i., the new model's modifications will allow operation at much greater pressures.

* Another deep sea application, at Woods Hole Oceanographic Institute (WHOI), Woods Hole, MA, is even more challenging. Requiring a stepper motor and brake assembly that would be submerged to a depth of 2,000 meters, WHOI specified a motor design for a new, unmanned remote undersea vehicle. The entire vehicle is oil-filled and pressure-compensated, and since it operates by remote control, the drive electronics are also carried in the vehicle. To accomplish this goal, a

stainless steel dry tank keeps the drive electronics at normal pressures, while the rest of the system is subject to the pressure generated 2,000 meters below the ocean surface.

* The Scripps Institute in La Jolla, CA had a similar, but perhaps even more complicated problem. The Institute required motors to drive manned, undersea sleds, or ROVs. Among other complications, the motor assemblies had to provide a lot of power, but be very efficient, in order to maximize battery life. On the other hand, the voltage had to be low, so there was no safety hazard to the divers. The system had to be lightweight enough that the divers could carry the ROVs across the beach; be rugged enough to take the pounding of the surf when the units were being launched and retrieved; be corrosion-resistant and tolerant of sand, sea life and other foreign materials; and be cost-effective, very reliable, fault-tolerant and redundant.

The Scripps project is still a work-in-progress, but their current solution has been to experiment with battery-powered brushed DC motors. This technology meets most of the above requirements except for the reliability. A little water in the brush and commutator area of these motors, and it's up to the diver to swim home. Scripps has tried to fill the DC motors with oil, but the oil gets between the brushes and the commutator, where the insulation properties of the oil causes problems. Although it would be possible to use high voltage to break through the oil film, the high voltage is a safety hazard for the divers. Empire and Scripps are continuing to research the use of brushless motors, but the electronic control package is expensive, fragile, not waterproof and bulky. Development of custom electronics is currently out of the reach of the Scripps' budget.

As science and industry continue to expand their reach to the depths of the oceans, new and challenging requirements for remote controls and automation will continue to appear.

If you would like more information about motors for deep sea applications, or information on other types of motors for hostile environments, contact Empire Magnetics, Inc., 5830 Commerce Blvd, Rohnert Park, CA 94928; (707) 584-2801.