Linear Position Sensors' Corrosion Resistance Aids in Offshore Applications

With no moving parts to wear out and the ability to operate from the sea level to 15,000 feet below under tremendous pressure, the LVDT-based linear position sensor is becoming a popular alternative to less reliable technologies when it comes to position measurement in harsh environments such as offshore applications.

When designed and constructed to specific requirements, LVDT-based linear position sensors (see Figure A) can provide highly accurate measurements in environments with high pressure and corrosive atmospheres, both found in offshore and subsea applications. Offering friction-free operation, environmental robustness and unlimited mechanical life, linear position sensors offer a reliable and cost-effective choice for offshore applications.

Accurate, non-contacting measurements can be made while sensors are embedded in oil, grease or water. As the linear position sensor is a friction-free structure with no contact between the unit's core and coil structure, there are no parts that can rub together or wear out. Offering unlimited mechanical life, unit durability, even under harsh conditions, remains excellent. The absence of friction during operation also permits a linear position sensor to respond very quickly to changes in core position for a fast dynamic response. This makes for a highly dependable feedback device.

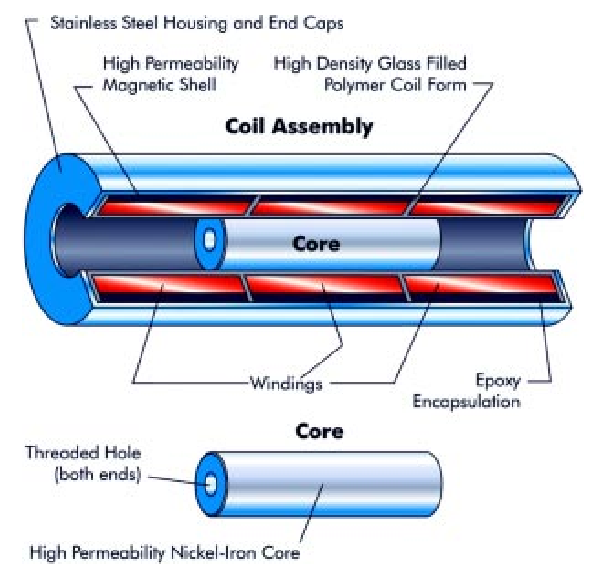

Figure A: An LVDT-based linear position sensor can convert the rectilinear motion of an object to which it is coupled mechanically into a corresponding electrical signal. LVDT linear position sensors can measure movements as small as a few millionths of an inch up to several inches, but are also capable of measuring positions up to ±20 inches (±0.5 m). Unit construction involves three sets of winding: one primary and two secondaries. There is one core, magnetic material based on nickel alloy that is usually attached to a moving member that needs to be sensed. The primary coil is driven from an AC signal, normally between 3 and 6 kHz. The secondary coils will pick up the signal, through magnetic induction, as the core moves.

The materials and construction techniques used to assemble an LVDT result in a rugged and durable sensor robust to a wide variety of environmental conditions. Bonding of the coil windings is followed by epoxy encapsulation into the case, resulting in superior moisture and humidity resistance, as well as the capability to take substantial shock loads and high vibration levels in all axes. An internal high-permeability magnetic shield minimizes effects of external AC fields on LVDT operation.

Both the case and core of the linear position sensor are made of corrosion resistant metals, with the case also acting as a supplemental magnetic shield. For applications where the sensor is exposed to elevated temperatures and extreme environments, or must operate in pressurized fluid, the case and coil assembly can be hermetically sealed using a variety of welding processes. This construction lets the core of the linear position sensor move freely while protecting the windings from the environment. The life and reliability of a linear position sensor would be impaired if such media were permitted to enter the windings. Typical hermetically sealed linear position sensors can withstand operating pressures up to 3000 psig. The hermetically sealed construction also lets the core withstand temperatures to 400°F.

Figure B shows a linear position designed for use in offshore applications. The units is hermetically sealed with a welded subsea connector that is gold plated and rated up to 7500psi. Dependent upon ocean temperature and depth levels, the casing of the linear position sensor is typically composed of a special alloy that supports long-term operation in different elements. When measurements must be obtained in seawater depths down to 7500 ft., with external pressure of approximately 3800psi and service life requirements are a minimum of 20 years, linear position sensors are constructed from 316SS and Inconel 625 for pressure and corrosion resistance. These materials enhance the already high-reliability of a LVDT assembly, ensuring it will continue to operate for minimum life requirements, even if the device is fully exposed to seawater. As housing and core carrier made from stainless steel will not survive well in shallow warm waters, Monel is best rated for these conditions as its metal composition resists sea life from forming on it.

Growing Offshore Applications for Linear Position Sensors

Linear position sensors are becoming the first choice for tough applications, replacing load cells, in marine and offshore applications such as mooring cables and elongation measurement. As the search for oil and gas goes into deeper water, linear position sensors are more dominantly used in subsea applications due to its excellent performance and cost of ownership. The projected MTBF (Mean Time Between Failure) for the submerged LVDT is in excess of 1 million hours.

In one offshore drilling application, for instance, LVDT-based linear position sensors are being used for safety monitoring of the structural integrity of offshore platforms. To ensure the ongoing stability of offshore drilling platforms, pipes and tubes, including production risers, catenary risers, tendons

Figure B. High-pressure and seawater-resistant LVDT-based linear position sensors are incorporated into a variety of subsea measurement systems. As measurements must often be obtained in seawater to depths of 15,000 ft. and at external pressures of approximately 7500 psi, high-pressure and seawater resistant LVDT-based linear position sensors are constructed from Monel, Inconel, and Stainless Steel for pressure and corrosion resistance. These materials enhance the already high-reliability of the LVDT assembly, ensuring that it can meet service life requirements of at least 20 years, even if the device is fully exposed to seawater.

and platform legs and braces, position must be constantly monitored. Linear position sensors can provide measurements with resolution to a fraction of a microstrain. For the huge loads on these structures, the total movement being measured is typically less than 2 mm.

To withstand the harsh environment of these types of applications, linear position sensors are designed with stainless steel and other exotic materials such as Inconel, Monel, Titanium and Hastelloy that offer pressure and corrosion resistance as measurements must be obtained in seawater depths down to 7500 ft. These materials enhance the high-reliability required of this instrument so that it will continue to operate for at least 20 years, even if the device is fully exposed to seawater.

To get a useful signal back to the surface for monitoring, recording and controlling thrusters and ballast transfer pumps, a 4-20mA two-wire, loop-powered I/O is utilized along with the linear position sensor as it minimizes any noise over long transmission lines. Offsets can easily be made in the data acquisition system on the platform above. The extraordinary reliability of the sensor, regardless of offsets due to pressure and/or temperature, permits those offsets to be easily corrected in the data acquisition system on the platform above.

Linear position sensors are also providing linear displacement measurements from micro inches to 2 feet with excellent repeatability and accuracy in applications that include monitoring structural movement for long-term FEA (Finite Element Analysis) of pipelines, derricks, moorings and other critical high-stress members on offshore oil platforms. Depending on the application, linear position sensors can be designed for use in either pressure-balanced, oil-filled containers or directly in seawater. Even if the container should leak and become contaminated with seawater, the linear position sensor would continue to function for many years.

In addition, linear position sensors are being used in subsea applications where the environment poses several performance criteria for the feedback sensors including operation in high pressures and resistance to chemically hostile seawater.

For example, a seawater corrosion-resistant, high-pressure, spring-loaded LVDT was built for use in a 5,000 psi pressure-balanced, oil-filled container that ensures accurate control of "Christmas Tree" chokes used to monitor the opening and closing of oil pipes as they bring oil from the sea bed. These chokes are part of a 'Christmas Tree', a name given to the assembly of valves, actuators and manifolds that sit on the seabed and, in formation, resemble a decorated tree. The function of the "Christmas tree" is to prevent the oil or gas release from an oil well, while directing the flow of the fluids from the well. Chokes on the Christmas tree are remotely controlled either by hydraulic or electric actuators. Position feedback is required for monitoring and controlling the choke status.

The linear position sensors offer extraordinary repeatability, regardless of offsets due to pressure and/or temperature, which is of paramount importance to ensure that when the chokes are nearly closed, flow is entirely shut off. Failure to completely close a choke could result in an environmental disaster. While there are several sizes of sea chokes, typical full strokes range from 2 to 12 inches.

Designed from stainless steel and nickel-based super alloys for pressure and corrosion resistance, the high reliability of the sensor assembly ensures continued operation for many years, even if the device is fully exposed to seawater. A key element of the linear position sensor design is its zero leakage pressure sealing, verified by helium mass spectrometer leak testing.

Linear position sensors are also used is in subsea towers to monitor extension of safety cables. Here, the sensors provide critical information in case of severe weather or earthquake, leading to the evacuation of the drilling platform and closing of the oil well. This application came about as a result of safety and environmental policies mandated by oil and insurance companies.

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