# HyPremo – Saltwater Resistance

**The following provides a comprehensive corrosion risk assessment for AISI 316Ti based on the intended global deployment of the fully submerged HP pressure probe in freshwater and saltwater (excluding extreme artificial heating, such as in thermal wells). The assessment factors in temperature, immersion type, and biofouling/stagnation conditions.**

## Sensor Body/Housing

### AISI 316Ti Corrosion Behavior in Coastal & Marine Scientific Applications

Key Corrosion Mechanisms:

- **Pitting corrosion**: Initiated by chlorides in stagnant or poorly oxygenated zones.
- **Crevice corrosion**: High risk where gaps or biofouling create localized differential aeration.
- **Biofouling-assisted corrosion**: Biological activity can reduce local pH and oxygen, promoting crevice/pitting.
- **Sensitization risk:** 316Ti resists sensitization better than 316L due to titanium stabilization.

**Table 1 - Temperature-Dependent Corrosion Risk Thresholds**

| Deployment Conditions | Water Temp. Range | Corrosion Risk Level | Notes |
|---|---|---|---|
| Fully submerged, flowing seawater | 0–30°C (32–86 °F) | Low | Stable passive film; good oxygenation; suitable for most oceanographic deployments. |
| Fully submerged, flowing seawater | 30–40°C (86–104 °F) | Moderate | Warm waters accelerate corrosion rates; consider shorter service intervals. |
| Fully submerged, flowing seawater | >40–50°C (104–122 °F) | Elevated / High | Above 50°C, even flowing water promotes pitting; rare in open ocean except geothermal sites. |
| Fully submerged, stagnant or low-flow seawater | 0–30°C (32–86 °F) | Moderate | Risk of crevice corrosion increases due to oxygen depletion and microbial activity. |
| Fully submerged, stagnant or low-flow seawater | 30–40°C (86–104 °F) | High | Warm + stagnant = ideal for microbial corrosion, biofouling, and under-deposit corrosion. |
| Fully submerged with biofouling/organic buildup | Any (esp. >20°C/ 68 °F) | Moderate to High | Fouling causes localized anaerobic zones and acid production, increasing corrosion risk. |

### HyPremo fully-submerged pressure probe housing

- Consistent immersion in seawater maintains a stable, oxygenated environment.
- No drying or salt concentration on the surface.
- Lower risk of differential aeration cells that cause localized corrosion.
- If water is flowing or periodically refreshed, corrosion risk is further reduced.
- Subtidal zones (oxygenated, continuously immersed): 316Ti generally performs well.
- Risk of corrosion in scientific, nearshore marine environments begins to notably increase at ~40–50°C, especially in stagnant or biofouled conditions. Uncommon in natural environments unless geothermal or industrial heating is present.

### Key Notes for Global Deployments:

- In cold seas (e.g., Northsea, English Channel, most of the Atlantic, Baltic, Arctic): 316Ti performs very well when fully immersed.

- In warm/tropical waters (e.g., ***equatorial*** Pacific/Atlantic): corrosion risk is higher; periodic cleaning or antifouling measures recommended.
- In low-flow or sediment-heavy areas, be wary of microbially influenced corrosion (MIC) and under-deposit corrosion, even in cooler waters.

## Remaining Components of the HyPremo

**Table 2 - Material Compatibility in Fully Submerged Saltwater Conditions (Scientific, Global Use)**

| Component | Material | Water Temp Range (°C/°F) | Corrosion / Degradation Risk | Notes |
|---|---|---|---|---|
| ***Pressure Cell Diaphragm*** | Stainless steel AISI 316 Ti (DIN 1.4571), | 0–30 °C (32–86 °F) | Low to Moderate | Good corrosion resistance |
| | | 30–40 °C (86–104 °F) | Moderate | Risk increases in warm water, especially with fouling. |
| | | >40–50 °C (104–122 °F) | High | High risk of pitting/crevice corrosion in hot seawater or under-deposit conditions. |
| ***O-ring*** | Viton® FKM, Shore A | 0–30 °C (32–86 °F) | Low | Excellent chemical and seawater resistance. |
| | | 30–40 °C (86–104 °F) | Low to Moderate | Still effective; minor long-term softening possible. |
| | | >40–50 °C (104–122 °F) | Moderate | Accelerated aging; sealing effectiveness may decline over time. |
| ***Cap*** | POM Polyoxymethylene | 0–30 °C (32–86 °F) | Low | Stable and resistant to seawater and UV. |
| | | 30–40 °C (86–104 °F) | Low to Moderate | May swell slightly or creep under stress. |
| | | >40–50 °C (104–122 °F) | Moderate | Possible deformation or fatigue under mechanical load in hot seawater. |
| ***Cable Jacket*** | PUR Polyurethane | 0–30 °C (32–86 °F) | Low | Excellent abrasion and seawater resistance. Flexible and durable. |
| | | 30–40 °C (86–104 °F) | Low to Moderate | May stiffen or yellow slightly with UV/oxidation over time. |
| | | >40–50 °C (104–122 °F) | Moderate | Risk of hydrolysis or embrittlement increases slightly in warm seawater. |

### Key Takeaways:

- Viton® performs well in marine environments, but may degrade slightly at high temperatures (>50 °C) or with long-term exposure to strong oxidizers (e.g., hypochlorite).
- POM (Delrin®) is chemically resistant and durable, but not ideal in warm, high-stress marine applications without reinforcement.
- PUR: High mechanical durability, excellent for submersed cables in marine environments. Sensitive to long-term UV exposure and hydrolysis at high temperatures — protective sleeve for submersed cable may be required.

## Deployment in Hypersaline Lakes

**Do not deploy HyPremo in Hypersaline Lakes!**

Materials like AISI 316Ti, Viton, POM, and PUR are not suitable for long-term deployment in hyper-saline inland lakes, such as:

- The Dead Sea (Jordan/Israel/Palestine)
- Lake Assal (Djibouti)
- Great Salt Lake (USA) (especially at high salinity concentrations)

**Table 3 - Why Deployment in Hypersaline Lakes Is Problematic**

| Factor | Effect on Materials |
|---|---|
| ***Extremely high salinity*** | Far exceeds typical seawater (~3.5%); Dead Sea is ~34% — creates aggressive corrosion. |
| ***High chloride concentration*** | Accelerates pitting and crevice corrosion in all austenitic stainless steels (316Ti). |
| ***Warm stagnant water*** | Enhances microbial activity, crevice corrosion, and Viton degradation. |
| ***Low oxygen levels*** | Prevents stainless steel from maintaining its passive oxide layer. |
| ***Mineral deposits*** | Can clog or insulate sensors, triggering under-deposit corrosion or swelling in POM/PUR. |

### Specific Material Failures in Hypersaline Waters:

- 316Ti: Rapid pitting, especially in crevices, welds, and threads. Completely unsuitable for long-term immersion.
- Viton®: Softens or chemically degrades faster under chloride and oxidative load, especially in warm or acidic brine.
- POM (Delrin): Swelling or microcracking over time; mechanical degradation due to concentrated ions.
- PUR: Though resistant to salt spray, PUR cables can degrade by hydrolysis or embrittlement in long hypersaline exposure.