Ceramic Penetrator Development to Power Submersible Pumping Equipment

Teledyne ODI

Interconnect

Product:
P10-250

Application:
Subsea Pumping and Boosting

Project:
High Pressure/High Temperature/Medium Voltage Ceramic Penetrator

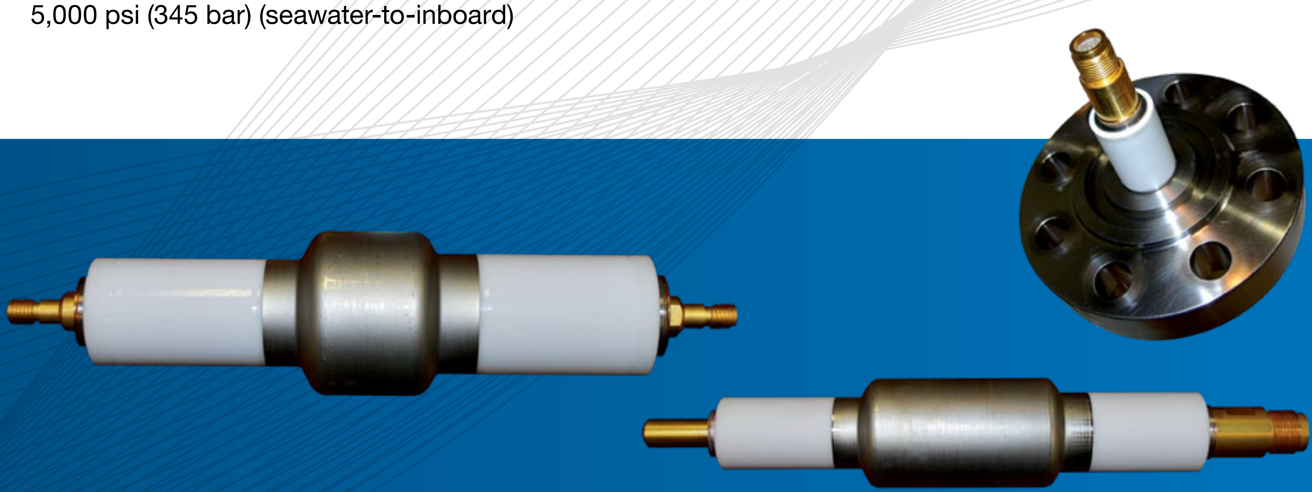
Client:
FMC/Petrobras

Background

Trends in subsea oil and gas production are moving towards deeper water and longer step-out distances. These trends drive demand for higher power equipment and higher power delivery and distribution capabilities subsea in extreme pressures and temperatures. Electrical penetrators are used in subsea systems to power subsea boosting or submersible pumps, and other electrical equipment. The penetrator extends through the wall or bulkhead of the vessel in which the equipment is located and is connected to high voltage cables for connecting the equipment to an external power source. In this subsea boosting pump application, the penetrator is also exposed to the pumping pressure which creates a harsh environment in terms of pressure, temperature and medium voltage. The penetrator must transfer power to the motor as well as maintain a pressure barrier between the internal pressure of the motor and the external seawater pressure.

Penetrator needed to withstand the extreme internal pressures (12,880 psi) with harsh pump fluids operating at high temperatures (121°C) and at high voltage (10 kV U). Specifications as follows:

- Water Depth (rated): 10,000 ft. (3,048 m)
- Operating Temperature Range: 35°F to + 250°F (-1°C to 121°C)
- Storage Temperature Range: -4°F to + 140°F (-20°C to 60°C)
- Design Pressure: 12,880 psi (888 bar) (inboard-to-seawater) 5,000 psi (345 bar) (seawater-to-inboard)
- Test Pressure: 16,100 psi (1,110 bar) (inboard-to-seawater) 6,250 psi (431 bar) (seawater-to-inboard)
- Voltage Class IEC: 6/10/(12)kV Uo/U (Um)
- Amperage: 250A



Highlights:

- Teledyne ODI worked closely with research partner Teledyne Scientific to select a specific ceramic compound that would withstand the high differential pressures and extreme temperatures within a subsea pump.
- Team won "FMC's Engineering Achievement Award"

What were the project challenges?

Due to the extreme pressure and temperature conditions, traditional materials would not provide the required reliability requirements. The project team had to research and design a new penetrator system using new materials and worked closely with Teledyne Scientific to develop innovative ceramic solutions for the environment. The new innovative design was created to handle the thermal expansion of the copper conductor while the ceramic material withstood the extreme pressures. New innovative boot seals also needed to be designed and qualified to withstand the harsh pump fluids and provide the necessary electrical stress control for the high voltage E-Fields.

What was the final engineered technical solution?

The team developed a very innovative ceramic penetrator that is now the baseline technology for all future high pressure and high temperature solutions.

What were the benefits of selecting this particular approach/solution?

The team involved Teledyne Scientific and leveraged cross-functional teams to solve this problem. We used industry leading experts in ceramics and placed ceramic material experts directly on our team. We also involved Teledyne Scientific during the selection process of the materials, not just ceramics. And, in addition, placed TSC ceramic experts on our quality auditing team during the ceramic vendor selection process.

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