Smart Technology
PEEKshrink®
For Energy Exploration

How Zeus technical support and extrusions improved performance and protection for Novatek’s IntelliServ® project engineers.

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ABSTRACT

**Novatek engineers needed a material to protect sensitive wiring from extreme temperatures, pressure and dielectric interference during deep-well oil drilling.**

This test report reviews the results of common and routine performance testing carried out on an electric motor before and after rebuilding the motor with Zeus-manufactured products including PEEK-coated crystalline magnet wire and PEEK Lay-Flat tubing used as insulating material.

Motor performance using the originally installed industry standard products and materials including standard magnet wire, Nomex®, Nomex® laminate, and Dacron®-Mylar®-Dacron® (DMD) insulation materials was compared to performance using Zeus products after rebuild. Evaluation was performed using Electrical Signature Analysis (ESA) and Motor Circuit Analysis (MCA). Additional high voltage testing was done to include high potential testing, surge comparison, and surge partial discharge as outlined in IEEE Std 1415-2006.

The rebuilt motor using Zeus-manufactured products showed improvements in Q factor, capacitance, and partial discharge compared to the originally installed motor components. Additionally, the Zeus-rebuild motor exhibited lower leakage, shorter absorption times, and appeared to operate with greater efficiency compared to the original motor.

**NOTABLE BARRIERS**

- Temperature
- Pressure
- Dielectric Interference
Since 1997, Novatek researchers have been working to develop an intelligent drill-string system for the high-speed, bi-directional transmission of real-time data to assist in identifying previously undiscovered pockets of oil in existing wells. Funded in part by the U.S. Department of Energy, the new technology – called the IntelliServ® Network – replaces mud-pulse telemetry: a slow, unreliable technology currently used in down-hole exploration.

In early 2000, Novatek researchers found themselves in a quandary. The materials they had been using to protect the wiring in a data transmission antenna would fail under the harsh drilling conditions. For the IntelliServ® Network to work, they needed an alternative material to protect sensitive wiring at the drill end of the pipe.
Zeus, a world leader in the design and production of high performance fluoropolymer extrusions, provided the solution: PEEKshrink® tubing. Since the 1980s, Zeus has been extruding PEEK polymers supplied by Victrex® in a range of commercially successful formats for medical, electrical, fluid handling and mechanical applications.

Zeus’ PEEK extrusions are renowned for their precise, tenacious performance in extreme applications, delivering tensile, mechanical and dielectric strength; hydrolytic stability in hot water, steam, solvents and chemicals; and resistance to stress cracking and bursting. Zeus’ PEEKshrink® tubing delivered these properties to the IntelliServ® application.

**SOLUTION BENEFITS**
- Product Life Extension
- Shrink Range 575°-725°F
- Consistant 1.4:1 Ratios

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THE STORY

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It is called “smart drilling,” and it’s the modern approach to oil exploration that allows oil companies to drill safer, more productive wells by using high-speed, down-hole communications systems. These systems, which employ various types of sensors and telemetry units, transmit data from downhole tools to the surface as the well is drilled. This includes information like temperature, geology, pressure and rate of penetration those on the surface use to make decisions on where to drill, when to stop and when to proceed.

Oil companies have relied on mud-pulse telemetry as the industry standard for data transmission from the drill site to the surface. The technology is slow - it typically functions at three to twelve bits per second - and has limited capability to receive commands from the surface. While serviceable, it does not deliver the speed and accuracy demanded by oil explorers.

With partial funding from the U.S. Department of Energy, Provo, Utah-based Novatek Engineering has spent the last eight years developing an intelligent drill-string system for the high-speed, bi-directional transmission of real-time data.

The technology is light years ahead of mud-pulse telemetry, transmitting data to and from the surface to the drill head at rates of up to one million bits per second. This technology, now called the IntelliServ® Network, which was acquired in 2005 by Grant Prideco, a Houston-based drill pipe technology leader, enables drilling operators to instantaneously and more precisely direct the drill bit toward pockets of oil and away from dead ends.

Key to IntelliServ® is the high-speed data cable inside of a high-pressure conduit. Ensuring the integrity of key wiring used inside each joint of pipe and preserving its ability to transmit in a robust fashion under extreme conditions posed a significant challenge for project engineers. The proprietary wire had to be protected from extreme heat, pressure, friction, salt...
water and steam. However, the wire had to be cosseted from electrical interference that might compromise its data transmit capability.

Project engineers knew the material selected to protect the wire had to provide lap shear bond strength, as any type of separation between the wire and the coating would result in a costly failure. The first material tested was a spray-coated, non-stick polymer. Pressure from water and steam caused the coating to flake off.

Kapton® polyimide dispersion coating was tested next. Though proven to perform in electrical applications for more than 30 years and recognized for its stability at elevated temperatures, the Kapton® coating also failed.

Representatives of Victrex, a leading producer of PEEK polymer, suggested the Novatek project engineers contact Zeus, a leading producer of high performance, precision PEEK tubing. Zeus’ success with PEEK across a wide range of challenging applications was well known to Victrex, and the project appeared well suited to Zeus’ problem-solving abilities. Zeus R&D scientists and polymer engineers recommended PEEKshrink® tubing. PEEK is widely regarded as the highest performance thermoplastic material.

What sets PEEK apart from other polymers is its ability to retain its mechanical properties at extremely high temperatures (continuous service temperature of 500°F/260°C). PEEK is also exceptionally strong, yet flexible and highly resistant to organic and inorganic solvents.
With wire samples from Novatek, Zeus’ R&D department set about testing PEEKshrink® requirements of PEEKshrink® tubing. Their objective was to create a homogenous bond between the wire and the PEEK tubing, recognizing the tighter the bond, the less likelihood of failure. The scientists determined that by changing the morphology of PEEK and altering the structure of the polymer crystals, the heat-shrinkable tubing delivered the required lap sheer bond strength, forming an impenetrable shield around the wire. The IntelliServ® project engineers had their coating.

Tubing was just one aspect of Zeus’ total solution. A technical team traveled to Utah to assist with the set-up of the processing operation and to ensure optimal processing rates. When the project engineers began experiencing unacceptably high scrap rates, Zeus’ troubleshooting uncovered the problem. Cleaning the wire prior to processing improved quality and reduced scrap.

In its first commercial test, about 6,400 feet of IntelliServ®’s IntelliPipe® telemetry drill pipe was used in an Oklahoma well for 500 drilling hours. A high-speed data link was successfully established with above ground receivers, putting IntelliServ® tubular products on the fast track for commercialization.
Zeus may be able to help you reach similar results. If you think you have a process, production, or design problem we can help with, contact us to request Z-Team support.