A Comprehensive Review on Electro-Thermal Analysis on Multilayer Winch-Wound Electro-Optic Umbilical Cable

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Abstract:
Remotely Operated Vehicles (ROVs) and deep-sea mining machines are widely used for the exploration and harvesting of the deep-sea mineral resources. Umbilical cables are critical components that provide electrical power, control, and communication between surface facilities and underwater vehicles. These cables are typically wound on a high-torque winch mounted on a ship. During deployment, a portion of the umbilical cable remains wound on the winch drum. During underwater vehicle operation, excessive heating can occur in the winch-wound cable due to resistive heat generation and poor heat dissipation. Such excessive temperature rise may lead to insulation degradation, reduced ampacity, and premature cable failure. This paper presents a comprehensive review of electro-thermal analysis techniques applied to multilayer winch-wound umbilical cables. Analytical, numerical, and experimental approaches reported in the literature are critically examined, with emphasis on heat generation mechanisms, thermal modeling strategies, and material properties. Existing research gaps and future research directions are identified to support the safe, optimized design of high-current subsea umbilical systems.

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