Hyperelastic high voltage composite conductor

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Abstract
Integration of electric conductors into the wall of a spoolable fatigue resistant thermoplastic composite tube for electric drilling applications within the field of oil & gas causes axial stresses. No fatigue resistant electric conductor solution was available to withstand the excessive axial elongation and compression induced by spooling operations. Based on theoretical models and experimental verifications a new type of highly elastic electric conductor was developed and capable of 5 kV rated voltage and 20 A continuous current. The shielded conductor consists of a highly elastic polymeric core, metallic helically wound conductors, an elastic insulation, a metallic helically wound electrical shield, and an outer sheath for mechanical protection. The main concept is based on synchronous radial contraction of all multilayer elements when subjected to axial elongation and bending. The performance of the conductor was verified by tensile tests, alternating bending tests on the whole system, integrity control of electric conductors with resistance measurements. In comparison to a conventional solid conductor a very high degree of axial flexibility and high tensile capability of the new concept could be achieved. For the new element containing an elastomeric core a maximum elastic tensile strain of over 40% was obtained. In comparison, the elastic range of conventional annealed copper used in the electric industry was measured independently and reached to about 0.1%. The hyperelastic elements may function as components for energy transmission and also sensors as well as actuators in intelligent composite material systems. Due to its unique axial elasticity, the complete structure can be exposed to high mechanical stress without damaging the embedded electric system. The new concept is not limited to high voltage conductors; it can be implemented into various other electric and electronic applications where a broad range of new applications are made possible.