Potential use of new water tree retardant insulation in submarine cables.

Stephen **CREE** (1), Paul **CARONIA** (2), Timothy **PERSON** (2)

1 Dow Electrical & Telecommunications, Bachtobelstrasse 3, Horgen, Switzerland, CH 8810. cree@dow.com

2 Dow Electrical & Telecommunications, 400 Arcola Rd., Collegeville, Pennsylvania, PA 19426, USA. caronipj@dow.com, persontj@dow.com

As the renewable energy industry considers larger wind turbine spans and larger arrays with more turbines per array, the issue of the need for higher voltage array cables that have low electrical energy losses is brought into consideration. For example a move from 33kV to 66kV array cables is leading to the evaluation of ethylene-propylene rubber (EPR) insulated cable cores. However they may not be the only option for a robust tree retardant submarine cable insulation at this voltage level.

This paper looks at the option of using additive water tree retardant cross-linked polyethylene as the insulation material of choice for submarine cable cores up to 69kV. In addition to an insulation having good resistance to the growth of water trees, the insulation should also maintain a high dielectric strength while in a wet environment and a low loss factor. As part of this evaluation we present data on the performance of the new medium voltage cable insulation DOW ENDURANCE™ HFDC-4202 EC. This compound exhibits superior retention of breakdown strength following wet aging testing, both to ICEA and CENELEC protocols. This paper also shows that unlike other insulation systems, such as water tree retardant copolymer and clay filled EP, additive water tree retardant 4202 shows a limited increase in dissipation factor as temperature and stress level is increased. In addition as shown in Figure 1, unlike copolymer water tree retardant cable insulation systems, additive water tree retardant insulation systems maintain a relatively low dissipation factor following wet aging under electrical stress.

Water tree retardant “4202” has also demonstrated excellent performance when operated with high conductor temperatures in both dry and wet environments. As shown in Figure 2, when operated at a 105°C conductor temperature in a dry environment, “4202” has a stable and low dissipation factor across a broad temperature range. As shown in Figure 3, at electrical stresses up to 7kV/mm, “4202” TR-XLPE has a loss factor that meets the requirements for a homopolymer XLPE insulated cable. At higher electrical stresses, the dissipation factor of the “4202” TR-XPLE increases due to the influence of the water tree retardant technology. This demonstrates that for cables operated up to 7kV/mm stress (or about 138kV), “4202” TR-XLPE is an excellent insulation for enhancing a cable design’s capability to meet the cable users expectations for a long life cable system while providing an insulation that is robust to resisting the impact of water on the cable that may be encountered if the cable metallic barrier is damaged.

As shown in Figures 4 and 5, after being operated in a wet environment with a 105°C conductor temperature for 1095 days, the “4202” TR-XLPE insulation maintains a high dielectric strength and lower dissipation factor than clay filled EP insulations. The “4202” water tree retardant insulation meets the ICEA requirements for a class III 105°C insulation.

In summary the data in this presentation proposes that submarine cable makers and utilities consider the use of an additive water tree retardant polyethylene as insulation for higher voltage submarine wind farm array cables.

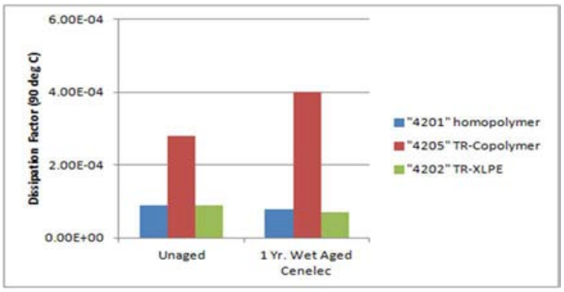

Figure 1: Cable Insulation Dissipation Factor as a Function of Insulation Type and Wet Aging Time.

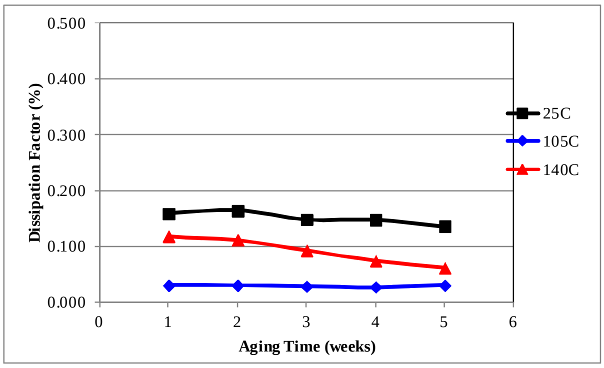

Figure 2: **"4202" TR-XLPE Cable Ageing; Dissipation Factor versus Temperature.**

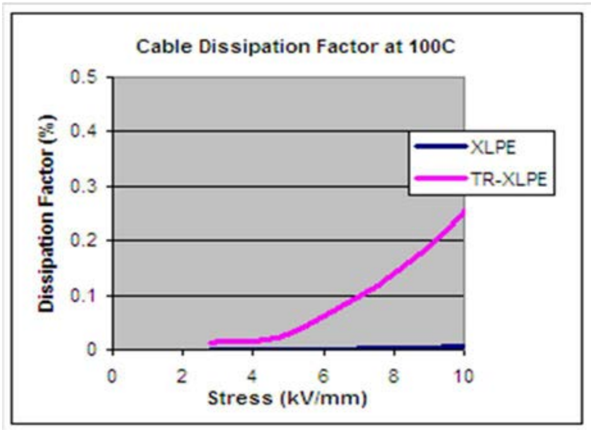

Figure 3: **Cable Dissipation Factor at 100°C as a Function of Electrical Stress Level**

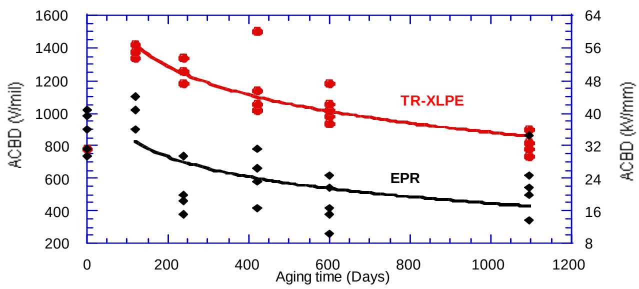

Figure 4: **Dielectric Strength as a Function of Aging Time and Insulation Type while Aging in Water with a Conductor Temperature of 105°C.**

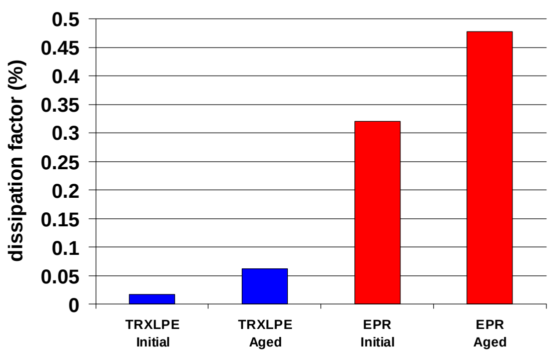

Figure 5: **Cable Dissipation Factor Following 1095 Days Ageing in Water**