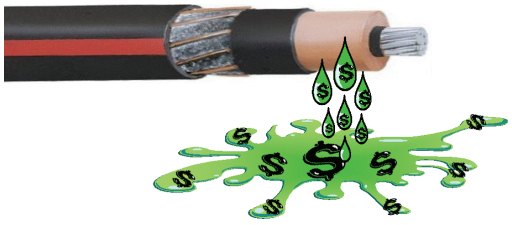
PRYSMIAN CABLES & SYSTEMS

EPROTENAX™

Efficient | Premium | Robust

Dielectric Loss Control

Drip, Drip, Drip - Do you like the sound of a leaky faucet? Neither do we, especially knowing that money is essentially going down the drain! Once you know you have a leak, don't you try to repair it, or at least slow it down as much as possible?



Well in case you didn't know, power cables also "leak" money into the ground. There are three ways to lose energy in a cable: conductor losses, shield losses, and dielectric (insulation) losses. Given the same design across the board, the only one that you can control, as a consumer, is the dielectric loss. How do you do this and save big dollars? We'll explain below.

Innovative Insulation - EPRotenax™

Prysmian's history with ethylene-propylene rubber (EPR) dates back almost 50 years. In the late 1950's, Dr. Giullo Natta, working in cooperation with Montedison and Prysmian (formerly known as Pirelli Cables & Systems), won a Nobel Prize for the development of the first EPR polymer. With this discovery, Prysmian began our own work to utilize this polymer for cable insulation. So, after research and development, Prysmian started producing Medium Voltage (MV) EPR insulated cables in 1963. Higher voltage cables in the ranges of 69 kV and 138 kV followed in 1969 and 1972 respectively. We also added submarine cables to that list in 1972. Today, Prysmian worldwide has produced in excess of 150 million feet of medium voltage EPR cable. And with this experience, we have specially formulated and manufactured our raw material for processability, physical performance, and electrical performance to be the industry leading EPR compound.

Processability

Most major cable manufacturers produce their own EPR compound, consisting of a very complex recipe of materials including inorganic material fillers to achieve improved physical properties. In the early years of using EPR compounds, the mixtures used were soft and tacky, only forming into a viable insulation once it was crosslinked. Compounds were typically compounds, the mixtures used were soft and tacky, only forming into a viable insulation once it was crosslinked. Compounds were typically produced in strips, which were fed into the extruder in an open air environment. However, as issues arose concerning cleanliness of this method, Prysmian searched for ways to use a closed loop system for improved compound handling. Early EPR recipes could not be pelletized due to the tackiness (stickiness) of the compound, which resulted in conglomeration during storage and/or transportation. This was an unacceptable characteristic that had to be overcome. Through time, talent and money in Research & Development, Prysmian found that by adding a small amount of polyethylene (< 2%) as a filler, the compound could be pelletized and therefore used in the closed loop stainless steel material handling systems now located in our plants. These material handling systems allow Prysmian to keep external contaminants out and are part of our North American ISO 9000 certification. Therefore, < 2% polyethylene has allowed Prysmian to pelletize the compound while keeping optimum extrudability characteristics.

Physical Performance

Prysmian's EPRotenax™ gives the consumer toughness and flexibility. The physical characteristics most notably confirmed by industry standards are Tensile Strength and Elongation. The industry standards such as ASTM, ICEA, AEIC, UL, etc. indicate values that EPR compounds must meet. However EPRotenax™ must meet Prysmian's own stringent internal requirements, which equal, or in most cases exceed the industry values. After all, there is nothing "leading edge" when you only meet the requirements of the industry, and that is why Prysmian employs the largest R&D group for cable manufacturers worldwide. It just takes a quick glance at Table 1 to see the value our R&D brings to customer's needs, and that Prysmian strives for excellence above industry requirements.

Table 1 - Prysmian's EPRotenax™

Physical Requirements	Prysmian's Typical Value	Industry Requirements
Unaged		
Tensile Strength (psi)	1800	700 min
Elongation at rupture (%)	350	250
Tensile Strength at 200% Elongation (%)	1450	None
Aged at 121°C for 7 days (168 hours)		
Tensile Stress (% Retained)	105	None
Elongation at Rupture (% Retained)	104	None
Aged at 136°C for 7 days (168 hours)		
Tensile Stress (% Retained)	102	75 min
Elongation at Rupture (% Retained)	107	75 min

Additionally, Prysmian's EPRotenax™ insulation has been tested in cables with Sidewall Bearing Pressures of 3000 lbs/ft of bend radius and passed the follow-up electrical tests with flying colors. That's not a value we usually promote, as it is 150% greater than the AEIC recommended value (EPR insulated with an encapsulated jacket). However, when you need to "push the envelope" during an installation, realize that Prysmian's EPRotenax™ has pushed the envelope in many tests with the data to back it up.

Electrical Performance

Have you ever heard the reference "using polyethylene in EPR compounds makes the insulation more susceptible to electrical stress treeing due to crystallinity"? This is a statement we've heard about our semi-crystaline EPRotenax™, but rest assured that this is not the case with Prysmian's EPRotenax™ insulation. In fact, third party testing has shown TRXLP insulations to be less susceptible to treeing than some amorphous EPR insulations. Prysmian has completed extensive research to show that the quality, quantity, and dispersion of fillers has a far greater affect on a compound's propensity to tree. We are so confident in our EPRotenax™ and it's ability to withstand the propensity to tree, that we use it in our submarine cable designs. EPRotenax™ insulated cables have been installed in wet areas, where indisputably, moisture increases the propensity for electrical trees to grow, and Prysmian hasn't had a cable failure due to stress trees in over 30 years of EPR insulated submarine cable history. Now that's real life data!

Table 2 - Prysmian's EPRotenax™

Eelctrical Requirements	Prysmian's Typical Value	Industry Requirements
Unaged, 80 V/mil, 15.6°C		
Max SIC	2.6	4.0
Max Dissipation Factor	0.2	1.5
Min IR Constant	100,000	20,000
Electrical Stability in 90°C Water @ 80 V/mil		
After 24 Hours		
SIC	2.5	None
Dissipation Factor (%)	0.2	None
After 26 Weeks		
SIC	2.8	None
Dissipation Factor (%)	0.25	None
Stability Factor	0.01	None

Manufacturing

Extrusion of your MV insulation system is key. For instance, triple tandem extrusion, with three separate heads, provides avenues for contaminates to enter the system. Prysmian, however, uses newer technology such as dual tandem or true-triple processes to minimize the avenues for contaminant entrance between the core layers.

Why, you ask, is triple tandem still used? Well, for an all EPR based system, including the shields, a release agent must be added to prevent completely bonding the insulation shield to the insulation. Prysmian's system uses fully qualified EVA shields over our EPRotenax™ insulation. The Prysmian EPR insulation system does not need a release agent; thereby eliminating that possible route for contamination.

Have you ever heard of Acetic Acid evolving from EVA materials and damaging the insulation system? The fact is, it takes temperatures in excess of 250°C to even begin that process and extended periods of time for it to evolve. A system in a short circuit condition (250°C) for an extended period of time has greater issues than acetic acid forming!

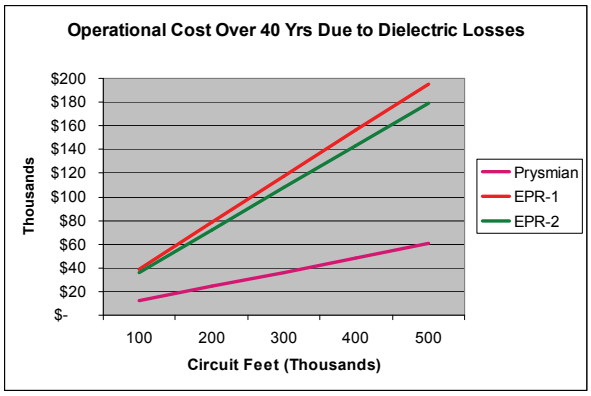
Money / Capital Savings

Let's look at the dielectric losses of EPR and Operational Cost.

Given:

1/0 AWG Conductor @ 105°C Normal Operation
15 kV Phase to Phase Voltage
Three Phase Operation
133% Insulation (220 mils)
500,000 Circuit Feet
$0.05 Cost of Energy per kW-hour
4.0% Average Interest Rate for Years in Service
40 Years in Service

Insulation Compound	Losses in W/1000 ft	$/500,000 Ckt-Ft over 40 yrs
Prysmian EPR	13.98	$60,609
EPR-1	45.11	$185,526
EPR-2	41.39	$179,401



You can see the trend, Prysmian's EPRotenax™ will cost you a THIRD LESS to operate over the years. Additionally, large cable system losses can result in either increased energy costs for industrial plants or the premature need for utilities to build additional power generating capacity to offset the losses. And this is something you control by specifying the premium EPR on the market.

Prysmian's EPR - **E**fficient, **P**remium, **R**obust…

700 Industrial Drive
Lexington, South Carolina
29072
1.800.845.8507
www.prysmianusa.com

PRYSMIAN CABLES & SYSTEMS

137 Commerce Drive
R.R. #3
Prescott, Ontario K0E1T0
1-800-263-4405 (West-CAN)
1-800-361-1418 (East-CAN)
www.prysmiancanada.com