TELE-FONIKA CABLE AMERICAS

Continuous Vulcanization Cured Rubber

- Versus -

Lead Cured Rubber

- For -

Neoprene Extra Heavy Duty (EHD) Mining Cables

TF Kable laboratory studies and world-wide installed product base confirms that TF Kable mining cables offer superior performance for all mining applications.

Manufacturing Mining Cable Experience since 1928

TF Kable has many years of mining cable production experience in both the older obsolete lead-cured technology and the newer CV replacement technology. The company has evolved to convert the production over to the "clean" processing for obvious environmental reasons and has successfully developed a range of products which provide better performance than its predecessors and current competitors.

This report contains information on TF Mining Cables as tested:

1. ICEA requirements for Tensile Strength, Elongation and Tear Resistance
2. Performance in reeling – unreeling applications
3. ISO Abrasion Resistance for Cable -Trailing applications
4. Ground Check Options

The following report is a summary of our findings.

TF Kable Polychloroprene (Neoprene*) Outer Jacket

I. <u>Physical Properties – Mining Cables as tested against ICEA requirements</u>

- **Tensile Strength 2520 psi up to 2700 psi**

  Tensile strength of 2520 psi is a minimum that Tele-Fonika obtains in production of EHD jackets in comparison of ICEA minimum standard of 2400 psi. Although the company's minimum values are set at 2520 psi actual production runs often yield a much higher value of 2700 psi, which is our minimum standard for the higher grade premium Polychloroprene (Neoprene) colored jackets.

- **Tear Resistance 70 lbs / inch up to 90 lbs / inch**

  Tear resistance on Tele-Fonika black EHD jackets is 70 lbs/inch in comparison of ICEA minimum of 40 lbs/inch. Tear Resistance on color jackets reaches an astounding 90 lbs/inch.

TF Mining Cables far exceed all ICEA performance attributes (as per below table)

Property Description	ICEA minimum for EHD jackets (ICEA S-75-381)	Tele-Fonika Cable Polychloroprene (Neoprene*) EHD jackets
Tensile Strength	2400	2520
Elongation (%)	300	730
Modulus at 200% elongation (psi)	700	750
Tear Resistance (lbs/in)	40	70

** Neoprene is a registered trademark of DuPont.*

- **Abrasion Resistance**

TF Kable provides superior performance

Jacket abrasion resistance is a crucial parameter for trailing mining cables. Below comparison shows abrasion resistance of cable jackets manufactured in different TF curing technologies. The method used for abrasion measurement was method A according to ISO 4649 standard.

Vulcanization Technology	Abrasion Resistance as relative volume loss [cc]*
CV-Cured	0.251
Lead - Mold Cured	0.320

** cc – cubic centimeters*

The abrasion resistance is better for cables manufactured in CV curing process

II. Lead Curing Process as compared to Continuous Vulcanization

Before the lead curing process starts, the complete length of the cable is enclosed in an uncured rubber jacket with a temporary lead jacket covering it. It is rolled on a reel and placed in an autoclave. Vulcanization then begins due to the pressure and temperature that is applied to the cable.

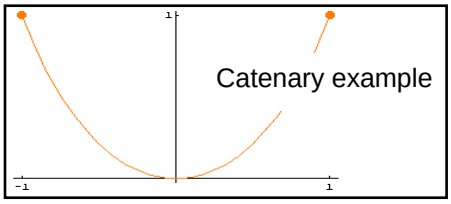
REELING - UNREELING

Negative Effects of Lead Cure Processing – Induced Torque:

Lead cured cables are cured on a reel during the autoclave process. The cable takes a “set” and memorizes the coil shape of the reel. This memorization of the reel eventually causes cable damage due to torque binding when the cable is reeled-unreeled or dragged in a particular application. The final result produces a twisting or cork-screwing effect more quickly results in cable failure. The limitations of autoclave reel shape memorization is especially disadvantageous for use in the underground heavy mining equipment (long-wall miners, continuous miners, etc.) and shovels

Positive Effect of CV Catenary Processing

The Continuous Vulcanization production process of mining cables reduces torque induced stress. CV cable jackets are vulcanized and cooled in a natural catenary relaxed position along the vulcanization tube, and along cable’s axis. Therefore when it is reeled-unreeled or dragged, it does not bind and there is no induced torque resulting from the manufacturing process.



TF Kable Catenary Extrusion Process

CABLE TRAILING

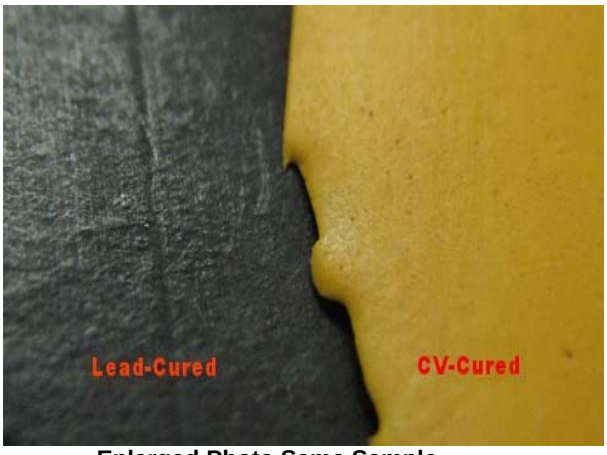
Abrasion Resistance, the performance of the cable in cable trailing applications and the impact of the jacket smoothness and morphological structure of the jacket compound on cables trailing and ageing effects related to cables bending.

Negative Effects of Lead Cure Processing – Porosity and Micro-cracks:

A cable's jacket surface smoothness has a significant impact on abrasion resistance and emergence of micro-cracks in the jacket's outer surface. After putting the cable into operation, moisture and other contaminations penetrate into emerging micro-cracks causing further degradation of the jacket. This results in sudden and rapid decrease of mechanical performance, water absorbability and abrasion resistance, the combination of which decreases the cable life expectancy (see pictures below).

These following pictures show the outer surface of mold cured jackets extruded in lead curing process (black sample) and TF Kable EHD jackets extruded in CV curing process (yellow sample).

Lead Cured (Black) CV Cured (Yellow)



Enlarged Photo Same Sample

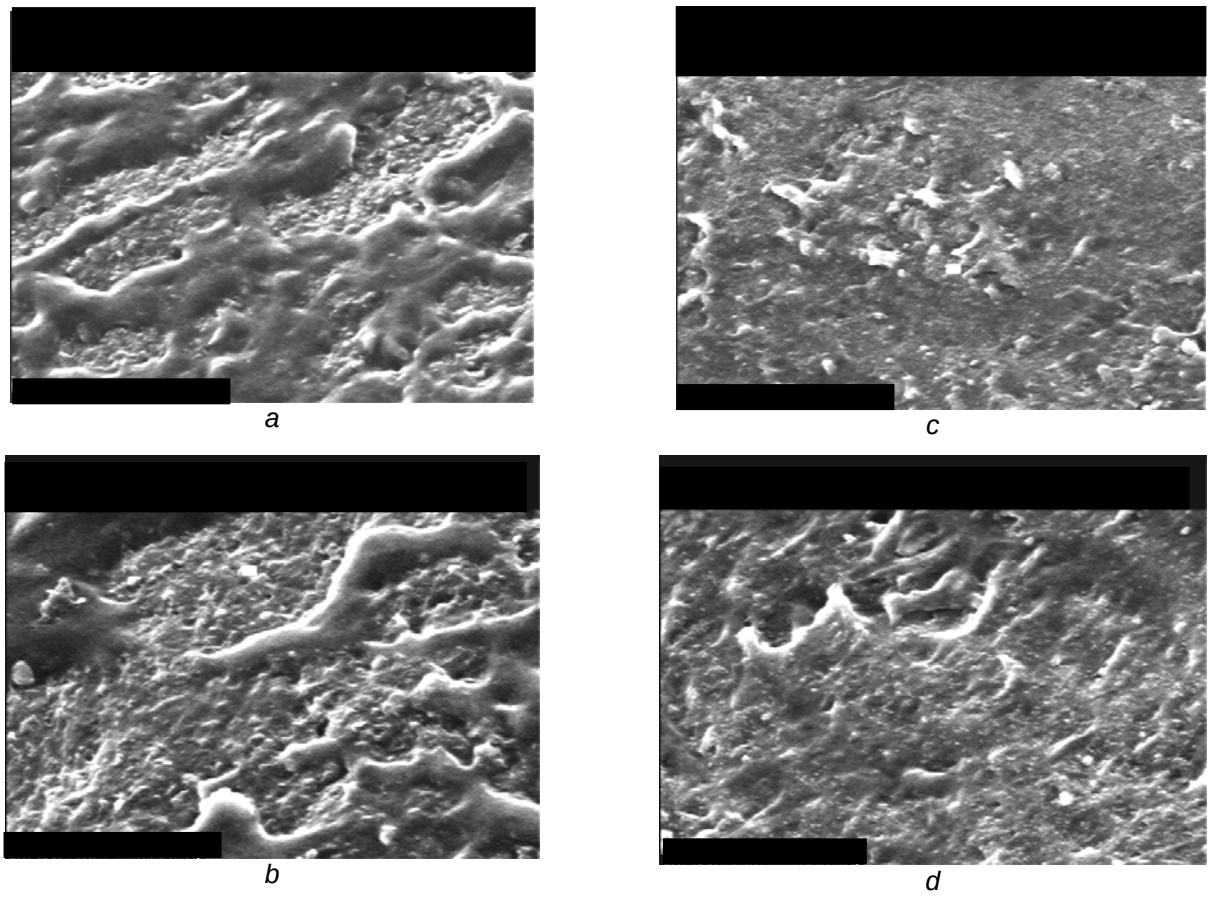
Comparison of cable jacket surfaces - lead cured on the left; CV cured on the right

To further show this dramatic difference, the following pictures taken with a scanning electron microscope, shows the structure of extruded cable jackets with lead curing technology (left side photo – black) and steam curing technology (right side photo - yellow).

Positive Effect of CV Catenary Processing – smooth and homogenous jacket

Microscopic magnification allows one to observe that the rubber compound processed with CV technology is more homogeneous, and the molecules are more comminuted. Rubber compounds

with better homogenization level give better mechanical and ageing parameters and are more micro-crack, abrasion and tear resistant.



a *c*

b *d*

Cable jacket outer surface under electron scanning microscope

a, b - lead-cured sample c, d - CV-cured sample

DOUBLE LAYER JACKET

- TF Kable developed a chemical linking technology between the inner and outer layer of the jacket. Due to special chemical substances used, the two layers of jacket form homogenous, inseparable layer of the rubber
- In between the inner and outer layer, TF Kable uses thermal and highly mechanical resistant polyamide reinforcing braid

III. TF Kable Ground Check Conductor

- **Polypropylene**

TF Kable provides a reliable Polypropylene insulated ground check

SUMMARY

Years of field trials combined with the continuous service of TF Kable installed product base bring a 100% proven reliability factor to mine operators. TF cables are utilized all over the world without any prolonged downtime and are equal or superior in performance to other world class manufacturers of mining cable.

REPORT SUMMARY – TF MINING CABLE DESIGNS OFFER EXTENDED OPERATING LIFE

Attribute	Method	Measurement	Result
Tensile Strength	ICEA	2520 psi	Meets or Exceeds Standard
Elongation %	ICEA	300% - 730%	Meets or Exceeds Standard product attribute is dependent on application
Modulus at 200% elongation	ICEA	750psi	Meets or Exceeds Standard
Tear Resistance	ICEA	70 lbs/ sq in	Meets or Exceeds Standard
Abrasion Resistance	ISO 4649 Method A	0.251 cc	Meets or Exceeds Standard
Cable Trailing	Electron Scanning Microscope	Homogeneous Outer Jacket	Extended Cable Life
Reeling-Unreeling	Production Data	Free Flexing	Extended Cable Life

TF Kable – The Leader in Mining Cable Quality and Performance