

ENHANCED SAFETY and EFFICIENCY through ACTIVE LIGHT

Mine operators are faced with challenges in terms of safety and productivity. Open-pit mining is often carried out, with notable intensity and in regions with often low levels of daylight. This places special demands on the protection of switching and supply lines. Faulty or defective cables in open-cast mines often can lead to unexpected downtimes of the equipment still to this day.

Prysmian Group has solved this problem with the actively illuminated Tenax-Lumen cable.

Our system (power provided by an external inverter) offers a decisive advantage over the methods used up to now on the market. Thus, the active illumination of the cable is possible even when the equipment is at a standstill. The permanent illumination can significantly reduce damage to cables in open pit mines, especially when it is dark.

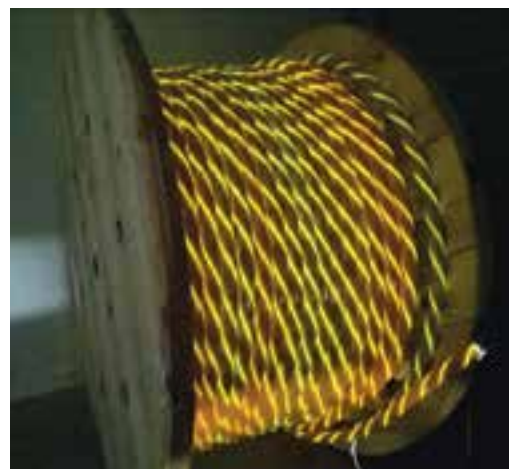
Underground cables are usually located along tunnel walls, but in open-pit mines trailing cables are distributed over the entire site and are often difficult to locate, especially in the dark.

These cables are therefore constantly exposed to the risk of being run over resulting in damage, increased health risks for workers, high repair costs and incurred outage times.

However even if no cables were to be damaged, the increased caution that excavators

and trucks must exercise also reduces productivity.

The innovation of Prysmian Tenax-Lumen cable is its active illumination. This makes the product fundamentally different from the other technical principles of illuminated cables that are available in the market, based on the reflection. Here, the usual electrical cables are wrapped with a simple reflective tape and covered by a transparent outer sheath.



TENAX-LUMEN on the cable drum.

By reflecting light waves back, the cable can then be recognized in darkness, where normally there are no additional light sources than truck headlights.



Open-pit mine at night: The medium-voltage cables are difficult to locate in insufficient lighting.

In addition, there is a risk that during operation, mobile equipment will repeatedly block the light waves and prevent them from reaching the tape.

Another weak point: trailing cables get dirty quickly and their surfaces damaged by abrasion. In such cases, the luminosity of the reflective tape is often insufficient to penetrate the covered areas or those damaged by abrasion.

Customers from Russia approached Prysmian with precisely this problem. The cables were constantly damaged during the removal of raw materials, which led to long outage times.

The solution with reflective strips was not expedient, because they were dirty and did not reflect the light even when the headlights were illuminated.

PRINCIPLE OF ELECTROLUMINESCENCE

For Tenax-Lumen, Prysmian has opted for electroluminescent wires wound around medium voltage cables. In this process, a solid body is stimulated to emit electromagnetic radiation, in this case, in the form of light, by applying an electric field or voltage.

The light intensity is so high that even if the sheathing is dirty, it is sufficient to illuminate the cable at a distance.



◀ **The TENAX-LUMEN has an active light element which is encased in a transparent polyurethane outer sheath. The illumination is independent of the operation of mobile vehicles.**

Electroluminescent wires (EL wires) generate light with applied alternating current.

An EL wire consists of several main components;

The first is a wire core of solid copper (component 1) coated with phosphorus

(component 2). A wire or a pair of wires (component 3) is wound around it in a spiral. A transparent PVC cover wraps this copper core, phosphorus, and fine copper wire “sandwich” (component 4).

Finally, this thin and clear PVC sleeve is covered by another clear, colored, translucent, or fluorescent PVC sleeve (component 5).

An alternating electric potential of roughly 130 V at about 800 to 1,300 Hz is applied between the copper core wire (component 1) and the wire surrounding the copper core (component 3).

The copper core wire and surrounding wire form a capacitor whose rapid charging and discharging stimulate the phosphorus (component 2) to emit light.

ACTIVE SOLUTION FOR PERMANENT ILLUMINATION

The principle of self-illumination is also used in products from other manufacturers, however with one difference: In these products, LED strips are illuminated by the inductive current, i.e. the electromagnetic field induced by the cable itself.

This means that the vehicle must be in operation in order to supply the lighting element with voltage. This is a so-called passive system.

In contrast to this variation, Tenax-Lumen enables an active solution because the voltage is supplied by external sources. This enables cable illumination even when the equipment is not powered.

The voltage is generated independently of the excavation operation.

The EL wires are fed by inverters, generating an alternating voltage of about 100V at 500 Hz to 1 kHz.

The maximum current consumption under these conditions is approximately 10 mA per meter.

Unlike for LED, this energy conversion does not require a current-carrying junction. As a result, measurements have shown that hardly any heat is generated.

The lifespan of the lighting element in the Tenax-Lumen cable is approximately 10,000 h at a voltage of 110 V and at a frequency of 900 Hz. The maximum voltage is approximately 180 V at a frequency of 1,200 Hz.

The Tenax-Lumen cables used in Russia had a length of 300 to 500 m. Prysmian currently estimates a maximum length of 1.5 km without the light becoming weaker.

It is a challenge in bringing the light over a longer distance than 1.5 km. currently working with component suppliers to test which voltage and frequency will enable the optimum distance to cover.

TRANSPARENT SHEATHING MADE OF POLYURETHANE

It is not enough to bring in the illuminating element. The sheath must also be transparent. This was one of the biggest challenges in the development of Tenax-Lumen.

Prysmian was faced with the question of how to make the sheath transparent.

The materials specified in the corresponding VDE standard did not meet the criterion of transparency. In the end it worked in meeting the properties specified in the standard with a mixture that resulted in a transparent sheath made of polyurethane (PUR). This enabled to achieve the quality standard of the VDE guidelines.

In addition to the transparency of the PUR sheathing, flexibility was another decisive factor in product development. The cables are exposed to extreme conditions. They are bent, dragged, and have to withstand widely varying climate conditions.

To test the resistance of the material, a sample was produced and subjected to intensive bending tests in a test facility. In the process, the cable was bent 8,000 times while being actively driven.

Prysmian prepared samples and began field testing in Siberia. During the pilot phase, the PUR sheathing proved to be extremely robust. It is characterized by excellent resistance to mechanical stress such as abrasion, bending or compression and high resistance to oil, ozone or moisture.

Furthermore, experience in Siberia has shown that PUR retains unlimited flexibility even at temperatures as low as -50 °C. Table 1 summarizes the most main features of Tenax-Lumen.

MAIN FEATURES

- brightly self-luminous in dark areas
- exceptional cold resistance down to -50 °C
- excellent impact and abrasion resistance
- resistant to oil, ozone and moisture



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Pic:1 TENAX-LUMEN after one year of use (left). The surface shows the usual abrasion.
Pic: 2 The same cable in the illuminated state in the dark: TENAX-LUMEN is clearly visible even with a dull sheath.