Designing Medium Voltage Cables with Polypropylene

A Practical Guide to Polypropylene Thermoplastic Insulation Systems

LyondellBasell

PREMIX

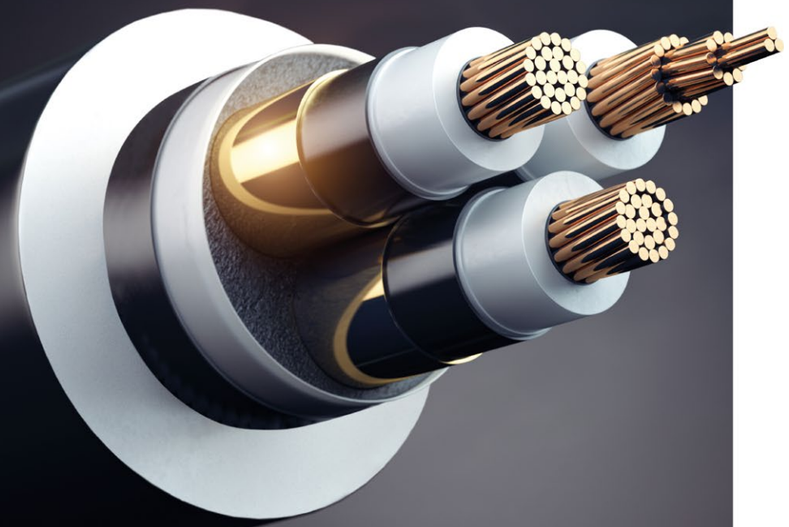
Why Polypropylene-Based Medium Voltage (MV) Cables Matter Now

MV power cables are a critical part of modern energy infrastructure. As electrification accelerates and sustainability requirements increase, cable manufacturers face growing demands for performance, reliability, recyclability, and efficient production.

This guide is designed to support cable manufacturers with **practical material and process expertise** for polypropylene-based MV cable systems. It brings together:

- **Premix** – semiconductive compounds and system expertise
- **LyondellBasell** – polypropylene thermoplastic insulation and jacketing materials
- **Maillefer** – advanced extrusion and cable manufacturing technology

Together, these competencies enable robust, scalable, and future-ready MV cable solutions.



MV Cables: Performance Requirements and Design Fundamentals

MV cables typically operate in the range of **1–36 kV** and are used in power distribution for utilities, industrial installations, renewable energy systems, and infrastructure projects.

Key design requirements include:

- Stable and uniform electrical performance
- Mechanical robustness and flexibility
- Thermal endurance and long service life
- Compliance with international standards
- Increasing focus on recyclability and environmental impact

Design of a PP insulated MV Cable

A modern MV cable is a highly engineered system comprising multiple functional layers, each designed to perform a specific role in ensuring electrical performance, reliability, and safety.

1. Conductor

The conductor carries the electrical current and is typically made from aluminium or copper. In Europe, aluminium is the preferred material for MV cables due to its cost-effectiveness and weight advantages.

Typical designs:

- Stranded design (IEC 60228 Class 2)
- Solid design (IEC 60228 Class 1)

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2. Conductor Screen

A semi-conducting layer applied over the conductor to:

- Smooth out strand irregularities
- Ensure a uniform radial electric field at the insulation interface
- Prevent electrical stress concentrations and partial discharges

This layer is mandatory for cables rated 6 kV and above and must be bonded to the insulation.

Premix semiconductive compounds provide stable volume resistivity, smooth extrusion, and excellent processability.

3. Insulation Layer

The insulation electrically separates the conductor from earth and withstands operating and transient voltages while maintaining a controlled electric field. It ensures long-term thermal and electrical reliability.

LyondellBasell polypropylene thermoplastic insulation solutions enable non-crosslinked insulation systems, capable of being recycled.

4. Insulation Screen

A semi-conducting layer applied over the insulation to:

- Maintain a uniform electric field at the insulation surface
- Confine the electric field within the insulation
- Reduce stress concentrations and prevent partial discharges

Insulation screen can be bonded, or strippable for making jointing and termination of the cable easier.

Premix semiconductive compounds provide stable volume resistivity, smooth extrusion, and excellent processability.

5. Metallic Screen

Provides:

- A path for fault currents and charging and leakage currents
- Provide a solid ground plane

Typical designs:

- Helically applied copper wires + copper tape counter helix
- Helically applied copper tapes
- Longitudinally applied overlapped aluminium foil bonded to PE sheath
- Combination of copper wires + copper tape counter spiral and aluminium foil bonded to PE sheath

6. Outer Jacket / Sheath and Optional Skin Layer

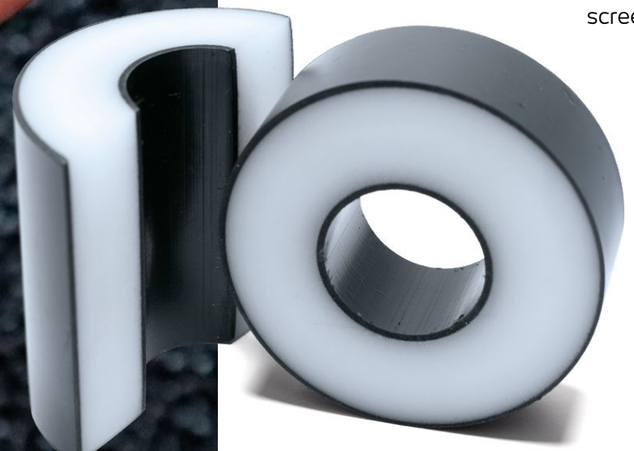
The outer jacket protects against mechanical damage, environmental exposure, and chemical attack.

Optionally, a thin semiconducting skin layer can be applied over the jacket to facilitate jacket integrity testing during manufacturing and after installation.

Polyolefin jacketing solutions from LyondellBasell and polyolefin semiconducting skin layer from Premix complete the system.

In addition to the layers mentioned above, a typical PP insulated MV cable may include a radial water barrier, such as aluminium foil bonded to PE sheath, in order to prevent radial water ingress. For longitudinal water-blocking, water-blocking tapes, yarns, and swellable powders are commonly employed. Additionally, fillers are often incorporated to maintain the circular geometry of three-core cables.

In summary, the design of PP MV cables is similar to that of XLPE and EPR/HEPR cables, with the primary distinction being that the insulation and semiconducting screen materials are PP-based.



Materials That Define MV Cable Performance

Semiconductive Layers: Electrical Stability Starts Here

- Controlled and stable electrical resistivity
- Smooth interfaces supporting triple extrusion
- Long-term performance consistency
- Designed for high-quality, repeatable cable production

Polypropylene Thermoplastic Insulation: A Thermoplastic Alternative for MV Cables

Polypropylene-based insulation represents the next evolution of MV cable design.

Key benefits include:

- High thermo-mechanical strength
- Reliable electrical performance at elevated temperatures
- Enhanced flexibility compared to traditional systems
- Faster, simpler processing without crosslinking
- **100% recyclability,** supporting circular economy goals

LyondellBasell *Catalloy* technology enables polypropelene thermoplastic insulation suitable for demanding MV applications.

Outer Protection: Jacketing Materials for Long-Term Reliability

- Excellent weather and environmental resistance
- High abrasion and stress crack resistance
- Low water absorption and vapor permeability
- Easy and robust processability

From Compound to Cable: Manufacturing and Extrusion Considerations

Successful MV cable production depends not only on material selection but also on optimized processing.

Key aspects include:

- **Triple extrusion** of conductor screen, insulation, and insulation screen
- Carefully controlled temperature profiles and screw designs
- Clean interfaces and smooth layer transitions
- Inline quality monitoring and dimensional control

Advanced extrusion technology plays a critical role in translating material performance into reliable, high-quality cables at industrial scale.

Testing, Qualifications and Standard Compliance

Testing and qualification of MV cables are essential to demonstrate that the cable system will operate safely and reliably throughout its intended service life. Compliance with recognized international and national standards ensures that the design, materials and manufacturing processes meet defined performance and safety requirements.

Example standards for PP insulated cables include:

CEI 20-86 (Italy)

This Italian national standard was the first to include PP-insulated cables in a national specification. Within the standard, PP insulation is referred to as High Performance Thermoplastic Elastomer (HPTE).

HD 620 S3 (Europe)

A harmonized European standard published by CENELEC. Part 12 of this standard covers PP-insulated cables:

- Sections I & J: PP insulation is designated as Polypropylene Thermoplastic Elastomer (PP-TPE).
- Section K: PP insulation is designated as Polypropylene Thermoplastic (PP-TP).

SS 424 14 20 (Sweden)

This is the Swedish implementation of Part 12 of HD 620 S3, specifically for PP-insulated cables. In this standard, PP insulation is referred to as Polypropylene-based (PP-based).

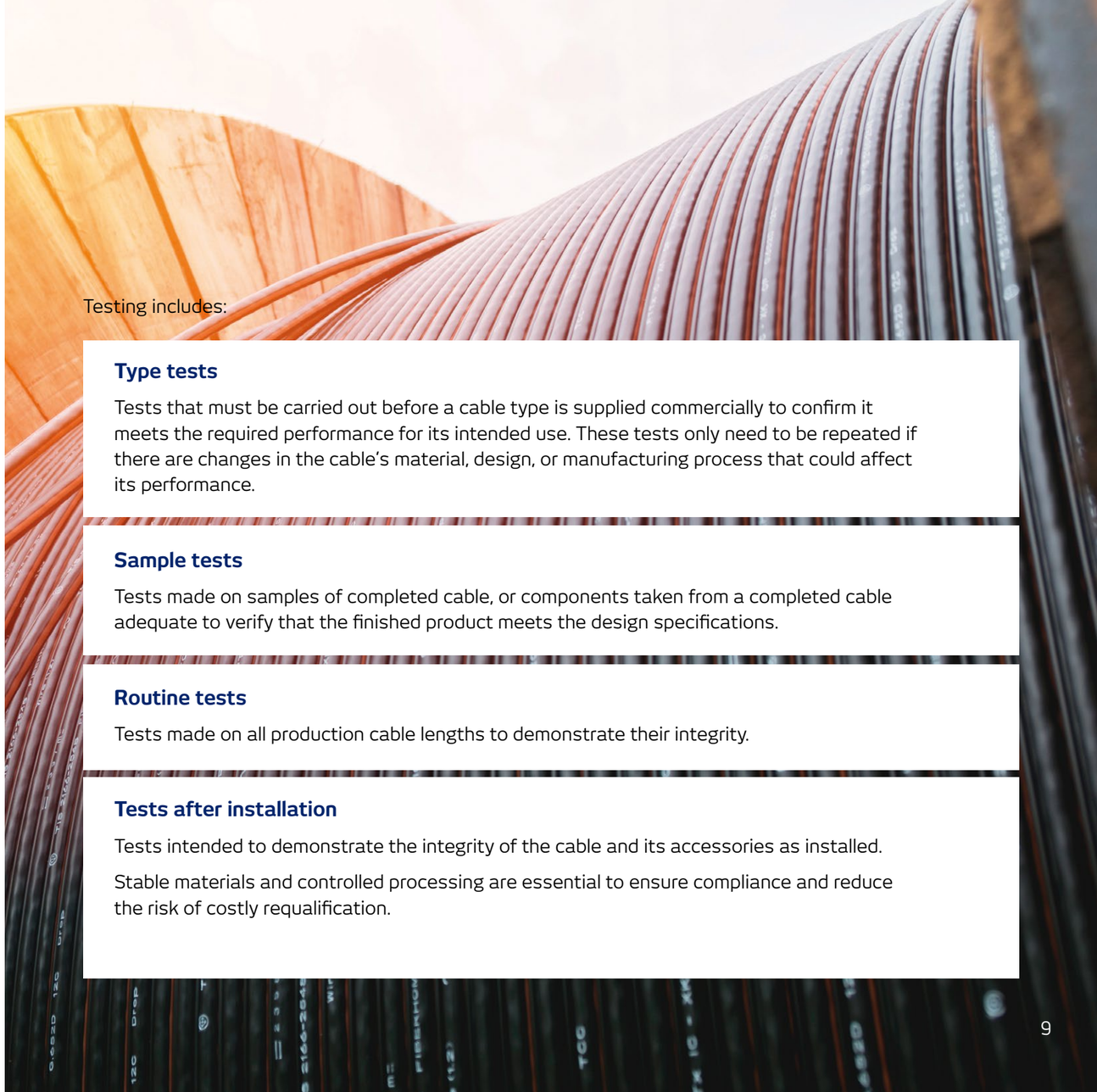
Other National Implementations

Several other countries have adopted PP insulation specification from HD 620 in their national standards, including:

- NEN-HD 620 (Netherlands)
- NEK HD 620 (Norway)

Upcoming Development

A project is currently underway to incorporate PP insulation into the German national standard DIN VDE 0276-620 (Part 12-C).



Testing includes:

Type tests

Tests that must be carried out before a cable type is supplied commercially to confirm it meets the required performance for its intended use. These tests only need to be repeated if there are changes in the cable's material, design, or manufacturing process that could affect its performance.

Sample tests

Tests made on samples of completed cable, or components taken from a completed cable adequate to verify that the finished product meets the design specifications.

Routine tests

Tests made on all production cable lengths to demonstrate their integrity.

Tests after installation

Tests intended to demonstrate the integrity of the cable and its accessories as installed.

Stable materials and controlled processing are essential to ensure compliance and reduce the risk of costly requalification.

Why Polypropylene Is Reshaping Medium Voltage Cable Design

Polypropylene-based MV cable systems offer a compelling alternative to traditional crosslinked designs:

- Thermoplastic and recyclable insulation
- Reduced energy and time in manufacturing
- Potential for smaller cable dimensions and higher power density
- Improved sustainability profile across the cable lifecycle

These advantages make PP-based systems increasingly attractive as the energy sector evolves.

Our Integrated Approach: Materials, Processing, and Technology

The combination of **Premix, LyondellBasell, and Maillefer expertise** provides cable manufacturers with a complete, integrated solution:

- **Materials:** semiconductive compounds, insulation, and jacketing
- **Compounding & processing know-how**
- **Extrusion and manufacturing technology expertise**
- **One-stop technical support** from development to production

This collaboration helps customers:

- Accelerate development timelines
- Improve process stability and product quality
- Enhance supply security
- Meet sustainability and regulatory expectations

Let's Build the Next Generation MV Cables - Together

Polypropylene-based MV cable systems represent a future-ready solution for power transmission and distribution. By combining advanced materials, proven processing technology, and deep application expertise, cable manufacturers can achieve high performance, scalability, and sustainability.

Next steps:

- Contact Premix for semiconductive material solutions and system support
- Engage with LyondellBasell for PP insulation and jacketing materials
- Explore extrusion and processing solutions with Maillefer

Engage with LyondellBasell for PP insulation and jacketing materials at wireandcable@lyondellbasell.com.
Engage with Premix for semiconductive material solutions at cables@premixgroup.com.

To learn more and get in touch:
Visit www.premixgroup.com or www.lyb.com

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