

Void-Free Encapsulation

The key to preventing water ingress and partial discharge in MV splices

Introduction

In wet and flooded environments, MV splice reliability is rarely determined by the cable insulation itself. Instead, failures concentrate at splices where interfaces, sealing zones and installation quality define long-term performance.

One installation factor stands out consistently: whether the splice is encapsulated without voids.

Voids and unfilled gaps are not just cosmetic defects. Under hydrostatic pressure, they become initiation points for water ingress and can trigger electrical degradation mechanisms such as partial discharge.

This document explains why void-free encapsulation a primary design and installation requirement for MV splices in water-logged areas is, and why it matters even more under temperature cycling.

Why void-free filling matters in flooded conditions

Under hydrostatic water pressure, moisture will exploit the path of least resistance. In MV splices, that path is usually not through solid bulk material but along discontinuities: micro-gaps at interfaces, air pockets, and connected porosity.

When these discontinuities exist, water can migrate deeper into the splice over time, initiating degradation that may only become visible months later as a delayed outage.

That is why void-free encapsulation should be treated as a reliability requirement, not a “nice to have.”

The failure chain: from voids to outage

A void is rarely an isolated issue. It can start a sequence of events that escalates under wet service conditions.

The source document describes how water ingress into a splice can initiate:

- reduced insulation resistance
- increased dielectric losses ($\tan \delta$)
- partial discharge and water treeing
- accelerated thermo-electrical ageing at material interfaces

Voids intensify these mechanisms in two ways:

- they create local spaces where moisture can accumulate and persist
- they concentrate electric field stress, increasing the likelihood of partial discharge inception

In other words, void-free encapsulation helps prevent both the mechanical entry of water and the electrical conditions that lead to progressive insulation damage.

Where voids come from (and why they are common)

Voids and unfilled gaps typically originate from installation and processing behaviour.

Two resin characteristics strongly influence whether a cavity fills completely: viscosity and working time (pot life).

If viscosity is too high, the resin may not wet complex geometries or narrow interface regions, leaving micro-gaps.

If working time is too short, installers may be forced to complete the process before full wetting and levelling are achieved, increasing the risk of trapped air and incomplete filling.

The document highlights that controlled viscosity and sufficient pot life support complete wetting and accurate filling of complex splice geometries, helping eliminate voids and interfacial gaps.

Void-free also means bubble-free curing

Even if a cavity is filled initially, curing behaviour can still create internal discontinuities.

If curing produces bubbles or connected porosity, hydrostatic pressure can use those structures as capillary pathways for water migration.

The source text stresses that the absence of connected porosity helps prevent long-term pressure-driven water migration.

For wet applications, the goal is a dense, continuous polymer structure after curing, not a material that looks solid from the outside but contains internal pathways.

Why void-free quality is critical under high temperature cycling

Temperature cycling introduces repeated expansion and contraction of materials in and around the splice.

Over time, thermal cycling can increase mechanical stress at interfaces and accelerate ageing effects.

When voids exist, temperature swings can worsen reliability because:

- mechanical stress concentrates around discontinuities
- moisture inside voids can change local conductivity as temperature varies
- partial discharge risk increases when field intensification occurs around void edges

The source document links wet-condition performance to a coupling between mechanical sealing and electrical reliability: void-free filling suppresses partial discharge inception and supports stable dielectric behaviour over service life.

Practical quality outcomes to aim for

Void-free encapsulation is not a single checkbox; it is the result of consistent process control.

Based on the mechanisms described in the source document, high-quality outcomes typically include:

- complete cavity filling with no trapped air pockets
- full wetting of substrates and interface regions
- a cured structure without connected porosity pathways
- sealing continuity that remains stable under ageing and service stresses

These outcomes reduce both immediate water-ingress risk and delayed electrical degradation.

Conclusion

Void-free encapsulation is one of the most decisive factors for MV splice reliability in wet and flooded environments.

Voids and unfilled gaps act as initiation points for pressure-driven water ingress and partial discharge, accelerating the degradation chain that leads to delayed outages.

A splice that fills completely and cures into a dense, continuous structure is fundamentally better positioned to maintain mechanical sealing and electrical stability over its service life.