

HTV Silicone Composite Insulators for MIND and SCFF Cables

Ben Kristian **JOHANSEN**, Specialist Engineer, Nexans, Norway, ben.kristian.johansen@nexans.com

Widar **SKÅRNES**, Senior Engineer, Nexans, Norway, widar.skarnes@nexans.com

Gry **GRANSTEDT**, Specialist Engineer, Nexans, Norway, gry.granstedt@nexans.com

ABSTRACT

For HV Paper insulated cables, porcelain has been the only material for sealing MIND/SCFF cables. Difficulties of obtaining porcelain insulators and the development of HTV silicone composite insulators give an opportunity to provide HTV composite insulators for MIND/SCFF-Cables. The HTV composite insulators have proven to have excellent pollution performance on HVAC and HVDC and provide a superior safety feature during service. This paper describes experiences with HTV composite insulators for MIND cables in particular, but also SCFF cables. In addition, design aspects as well as a view of the product combination maturity is presented. Plans for further work are included.

KEYWORDS

HVDC, HVAC, MIND Cables, SCFF Cables, HTV Silicone, Composite Insulators, Testing

INTRODUCTION

Since the beginning of High voltage Paper insulated cables in the early twentieth century, porcelain has been the only suitable insulation material for sealing MIND and SCFF



Fig. 1: Retrofit insulator

cables. The insulator shed-shape used on big hollow core insulators has typically been deep under-rib for HVDC applications and alternating shed for HVAC applications. For HVDC applications, the insulator shed design "Deep Under-rib" has proven to be difficult to manufacture with modern manufacturing methods (i.e., wet extrusion) which has resulted in excluding porcelain insulators for HVDC MIND cables. Porcelain insulators also introduce a safety hazard to personnel and equipment in vicinity of the cable termination if an internal failure occurs.

With this background, the HTV composite insulator appeared as a desirable option and initiated testing of this insulator type for use on MIND and SCFF cables (both for DC and AC applications). Tests have been performed on HTV silicone composite insulators over the last decade, aiming to provide this insulator type for installation in future projects and as a retrofit to existing cable systems as seen in figure 1. The HTV silicone composite insulators, tested for this application has excellent pollution performance both under HVAC and HVDC stress and potentially provides a superior safety element in case of an internal failure of the sealing end

compared to porcelain insulators.

HTV silicone composite insulators are used in laboratory environment and have been in laboratory service on HVDC MIND cables for more than a decade. The laboratory insulators have been filled with medium to low viscosity cable oil. Compatibility and accelerated aging tests in Cable Insulation Oil (mineral and synthetic oil) have been performed. Furthermore, salt fog test with DC voltage has been performed on a complete sealing-end assembly including a field control unit designed for 525 kV HVDC MIND cables.

A type test of a complete sealing end including an HTV silicone composite insulator at 525 kV DC level has been performed according to Cigre recommendations and further type tests are planned in the near future, as well as seismic testing and internal arc testing. A type test on 420 kV HVAC according to [1] is successfully completed. The field control unit included in this test assembly is enhanced to a field strength comparable to 550 KV AC in order to test the insulator assembly for the highest AC voltage on SCFF cables.

A retro-fit project on an existing HVDC link has been realized, installed and has been in service for more than one year. Two existing outdoor porcelain insulators were replaced with two new outdoor HTV silicone composite insulators that were retrofitted on the cable ends. This is the first HVDC MIND cable with HTV silicone composite insulator in service today.

AGING TESTS

A series of aging tests were performed on composite specimens in different types of cable oil. The purpose of the tests is to determine if the epoxy deteriorates or affects the cable oil negatively through the lifetime of the cable termination.

Aging test with composite samples in mineral oil

Table 1 shows the dissipation factor value of three reference cable oil types. T3570 and T3588 is extra low viscosity oil used normally for SCFF cables, but also as insulation oil for MIND cable terminations. T3709 is a medium to high viscosity mineral oil used i.e., as an impregnant for paper cones, etc.

Table 1. Dissipation factor value for new reference oil

| Spec. | Description | Notes | Oil type | Tan Δ |
|-------|-------------|-------|----------|--------------|
| 1 | Reference | | T 3570 | 0.0022 |
| 2 | Reference | | T 3588 | 0.0028 |
| 3 | Reference | | T 3709 | 0.0010 |