

Preface

For more than a hundred years, energy transmission by means of electricity has by far provided the most environmentally sound solution compared to other energy carriers. It is therefore of no surprise that a relatively high level of attention has been paid to the development and installation of transmission lines within the electrical energy sector. As early as 1891, the first high-voltage line of 10 kV was constructed in Germany over a length of 176 km. At that time, of course, it was unimaginable that 1,100 kV AC overhead lines would span distances of 1,000 km and more or that several thousand kilometres would be able to be bridged by 800 kV of DC lines at 6,000 MW. Starting with 110 kV in 1912, an operating voltage of 765 kV had already been achieved by the 1970s in what is a remarkable history of events. Apart from a few unsuccessful attempts with a considerably higher voltage, development stalled at this level until recently; this can be partly explained by the stagnation of electrical energy requirements over the last 30 years. The flawless introduction of the 1,100 kV level in China in 2009 refreshed optimism however, and transmission of even higher voltages is now being contemplated and quite a few innovative projects are presently concerned with an increase in voltage level.

A good example is the introduction of an “eight bundle” conductor, and other major improvements in line technology. With regard to the construction and design of towers, considerable progress has been also made. Simulation and testing methods have been developed in order to understand and master the mechanical and electrical phenomena which occur upon interaction between the electrical network and the surrounding environment. Since the beginning, the traditional material for insulators has been porcelain for longrod and cap and pin insulators. For cost reasons, and partly due to technical considerations, glass was later also used for cap and pin insulators.

Among the various technical improvements and advances in development which have been made over the last hundred years of overhead transmission line history, one component stands out and, for sure, constitutes one of the most significant innovations for the high-voltage electrical insulating system. This element, known as the composite insulator, heralds a change from natural insulating materials, such as porcelain and glass, to composites, which is associated

with a wide range of advantages. Composite materials are easier to work with and demonstrate improved tolerances compared to conventional components. Improvement in the mechanical properties, pollution behaviour and comparatively low weight lead to small dimensions. For example, the latter has enabled the development of “compact lines”, which are slimmer and also more cost effective in cases of restricted right of way. Composite insulators are more resistant to the bullet shots of vandalising gunfire, which increases the availability of substations and overhead lines in critical regions affected by this problem.

As is the case with all technical developments, the path of success of the composite insulator has been full of twists and turns. In the past, a series of substantial obstacles had to be overcome. Key examples include brittle fracture, the design of interfacial zones, the initial sensitivity to corona or solar radiation, the occasional loss of hydrophobicity after heavy rainfall, power arc resistance and, last but not least, damage caused by birds. Engineers have also long been preoccupied with the question of how such new insulators are to be tested. These challenges have now been overcome and the technology is now fully developed and polished. As an important, key element of a high-voltage or extremely high voltage overhead transmission lines, the composite insulator enjoys increasing popularity among line designers and constructors. The manufacturers of electrical apparatus also appreciate the use of composite hollow core insulators in many fields. A good proportion of composite hollow insulators are thus now used as supporting and insulating housings for bushings, instrument transformers, surge arresters and also circuit breakers.

The present book investigates the many aspects of composite insulators in a detailed and comprehensive manner. The properties of the materials used and the corresponding production processes are presented clearly. Advantages of composite insulators and the initial phases of the learning process are also described. Topics such as the mechanics of the metal fittings and of the glass fibre rod, corona resistance and power arc protection are dealt with in detail. Examples of design and application of overhead transmission lines are also given, even for specialised cases such as compact lines and interphase spacers. Correct testing of composite insulators is considered. A successful mixture of the theory behind an extremely wide range of technological aspects and suitable practical application is thus provided. Newcomers will gain knowledge in many fields of overhead transmission line construction, in particular with regard to composite insulators. Many important details are collated and summarised and would only otherwise be accessible to an experienced high-voltage engineer as a result of in-depth study of the vast technical literature. Personally, I have no knowledge of any other document which discloses such a well-rounded and comprehensive overview of the state of the art technology of composite insulators and their application.

Prof. Klaus Fröhlich
CIGRE President
Technical Committee

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Papailiou, K.; Schmuck, F.

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