Thermal Performance of High Voltage Power Cables

J. A. Pilgrim[1], D. J. Swaffield[1], P. L. Lewin[1] and D. Payne[2]
[1]University of Southampton, UK [2]National Grid
*E-mail: jp2@ecs.soton.ac.uk

The UK high voltage electricity transmission network continues to face annual rises in demand, with ever greater volumes of power supplied to load centres throughout the country. To operate this network effectively, it is vital to accurately calculate the maximum allowable electric current which can be safely carried by each component in the power system. In high voltage power cables, this limit is defined by the maximum operating temperature of the cable insulation. Specify this current rating to be too low and the cable asset will never be used to its full potential; conversely setting the rating to be too high risks damage to the asset as the excessive heating can cause premature failure. Thus the rating calculation must be optimised to maintain security of supply by minimising the risk of cable failure, while also maximising the returns from capital investment on the power network.

This project has employed a variety of mathematical techniques to improve the methods by which current ratings are calculated. Modern computational techniques such as finite element analysis (e.g Figure 1) and computational fluid dynamics are used to create more advanced circuit rating techniques. These have been compared and refined with input gained from field data. By eliminating simplifications from existing methods, it has been possible to identify ways of increasing the utilisation of the existing network. In addition the new techniques allow examination of the potential benefits of future developments in cable technology.

Benefits are being derived from this work on both a day to day and strategic planning levels. For instance, by re-evaluating the current rating method for cables installed in tunnels, it has proved possible to consider the benefits from co-locating more cables in one tunnel to best use these expensive assets. The application of this method has allowed the quantification of the benefits which might be available from next generation cable technologies, enabling the prioritisation of future research effort in cable materials. Upon completion, the knowledge gained from this work is to be used to revise the international standard on calculating current ratings in cable tunnels. Techniques such as these underpin the concept of smart grids with improved operational flexibility and capability. Simultaneously the requirement to build expensive new components into the network is limited, whilst still meeting the need to supply ever increasing volumes of power across the country.

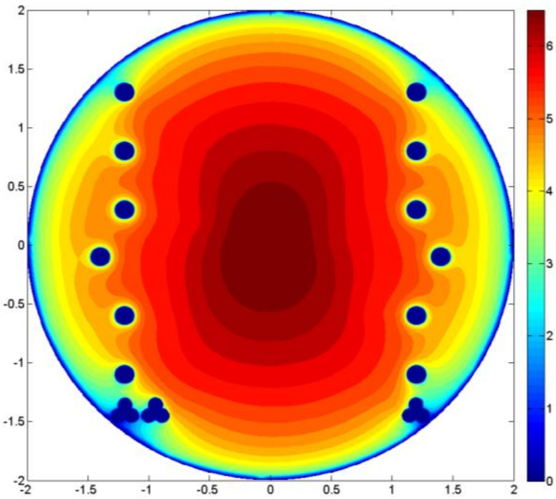

Figure 1: Contours of air velocity within a cable tunnel