Thermal rating method of J tubes using finite element analysis techniques

Richard **CHIPPENDALE**(1), Priank **CANGY** (1), James **PILGRIM**(1)

1 Tony Davies High Voltage Laboratory, University of Southampton, Southampton, UK, rd.chippendale@soton.ac.uk, pc8g11@soton.ac.uk, jp2@ecs.soton.ac.uk

The installation of offshore wind farms presents a unique set of cable challenges which need to be considered, as compared to standard on-shore cable installations. Some areas of special consideration are thermal rating methodologies, mechanical protection of cables and connection of supply to land. This study investigates the thermal profile of the export cable from a wind farm as it passes through the J tube of an offshore platform. This section of the cable route may often present a limit on the current carrying capability of the whole route.

Whilst there are published standards to predict the thermal rating of a buried cable, there are no internationally agreed standards for predicting the thermal rating of an export cable within a J tube. Therefore this study has considered a series of modeling approaches to investigate the thermal profile within the J tube.

The study has initially developed a 3D finite element analysis (FEA) model to investigate the temperature profile within a typical J tube. The J tube is comprised of three main sections:

1) Below sea level, where the gap between the J tube and cable is filled with water
2) Above sea level but below the offshore platform, where the gap between the J tube and cable is filled with air
3) Above the offshore platform, where the individual phases from the export cable are separated and installed in air

A typical conductor profile from this model is presented Figure 1, and shows that the thermal pinch point within a J tube occurs in the middle J tube section, between the sea level and the offshore platform.

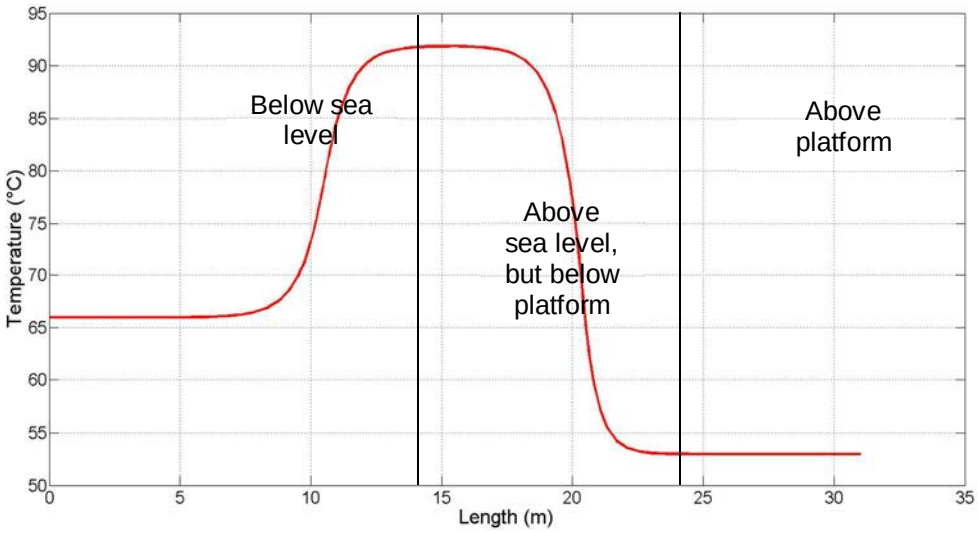

Figure 1 - Conductor temperature profile within J tube.

This increased temperature is caused by the sealed air gap between the cable and the J tube, which acts as a good thermal insulator. Any solar radiation incident upon the J tube surface will also play a significant role in increasing the conductor temperature within this section. The thermal performance of the J tube has been further investigated by varying the length of each J tube section, the conductor and the J tube cross sectional area.

This more physically rigorous 3D FEA model is then compared against a selection of previously published analytical methods [1, 2] for predicting the continuous thermal rating. By comparing the FEA model with these previous studies it is evident that there predicted ratings are not in close agreement with the FEA results. Therefore an improved method has been developed to predict the continuous rating, which is presented in this paper.

References

[1] R. A. Hartlein and W.Z. Black, "Ampacity of electric power cables in vertical protective rises", IEEE transaction on power apparatus and systems Vol PAS-102 no.6 June 1983

[2] M Coates, "Rating cables in J tubes", ERA technology, report number 88-0108