New issues in current rating of power cables installed in unventilated tunnels

Eric **DORISON** (1), Wilfried **FRELIN** (1), George **ANDERS** (2), Olivier **MOREAU** (3)

1 EDF R&D, Moret-sur-Loing, France, wilfried.frelin@edf.fr, dorison.eric@orange.fr
2 Lodz University of Technology, Poland, george.anders@bell.net
3 EDF CIST, Dubai, olivier.moreau@edfgroup.ae

The current rating of power cables installed in free air is addressed by IEC standards 60287 series: the general formula to calculate the permissible current is given by IEC 60287-1-1. Then external thermal resistance of an insulated cable installed in free air and ratings for groups of cables are described in IEC60287-2-1. Finally IEC 60287-2-2 extends the scope to even larger groups of cables.

In these standards, the cables are assumed being of equal diameter and emitting equal losses. Also the ambient temperature is supposed to be known. Moreover, in IEC 60287-2-2, dielectric losses are neglected.

In the proposed paper, first, the IEC method for rating cables installed in still air is reviewed and considerations are given to the modelling of various modes of heat transfer with the aim for deriving the IEC formulae as there are no published sources how these equations were obtained.

Special attention is paid to the derating factors for groups of cables. With groups of cables the rating of the hottest cable will be lower than if the same cable was installed alone due to mutual heating. A simple method to take into account this mutual heating effect is to calculate the rating of a single cable and apply a reduction factor (derating factor). Some new developments merging the IEC and Siemens approaches to obtain the derating factor for low and medium voltage cables will be discussed.

The paper also reviews a method to take into account dielectric losses when deriving reduction factors (presented in a Jicable'11 paper).

Then, the paper introduces derating factors for some homogeneous groups of cables which are not considered in the IEC standards.

- Large groups of touching cables side by side.

  Derating factors, derived from tests, are in line with values given by Heinhold for LV cables. Their extension to MV and HV cables is discussed.

- Groups of spaced cables side by side

  Where the clearance between cables is large enough to consider that the convective heat transfer is not affected, derating factors are readily determined from the calculation of the variation in heat transferred by radiation. This leads to the conclusion that the derating is not significant where the clearance is larger than about 0.5 times the external cables diameter for a group of 2 cables, and 0.75 times for a group of 3 cables, as stated in IEC 60287-2-2.

The paper also deals with the rating of cables in tunnels, stressing some issues to be considered when applying IEC formulae originally made for cables in still air. A way to take into account the variation of the ambient temperature when increasing the number of cables is proposed, with consideration on the external thermal resistance of the tunnel.

Finally, the rating derived using this approach is compared with the FEM calculations on several examples.